

DEPARTMENT OF THE INTERIOR
U. S. GEOLOGICAL SURVEY

Data report for the Great Valley, California,
axial seismic refraction profiles

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Open-File Report 89-494

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INTRODUCTION

In 1981, 1982, and 1983 the U.S. Geological Survey (USGS) acquired seismic refraction data along seven transects in the Great (or Central) Valley of California and its bordering regions. These transects were part of a geophysical study of the Great Valley which also included seismic reflection data (Zoback et al., 1984), aeromagnetic, gravity (Cady 1975). These Geophysical data were combined with surface geological data and geological borehole data to better constrain interpretations of the structure and evolution of this classic Mesozoic and early Cenozoic forearc.

Data from the southern cross-strike (east-west) profile shown on the insert to figure 1 has been published by Murphy and Walter (1984). The three shorter cross-strike profiles will be presented in a future report. This report is a compilation of the refraction data from the three axial profiles (figure 1). The data have been archived at the National Geophysical Data Center in Boulder, Colorado. Tapes are available from

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
325 Broadway
Boulder, CO 80303

Appendix C contains a description of the tape format.

COMPLETED ANALYSIS

Three papers presenting analysis of the seismic refraction data from this report were written by Hwang and Mooney (1986), Colburn and Mooney (1986), and Holbrook and Mooney (1987). Holbrook and Mooney and Colburn and Mooney presented 2-D velocity models of the central and western axial profiles, derived by forward modeling travel times using a 2-D raytracing algorithm (Luetgert, 1988; Cerveny, 1977) and modeling amplitudes with ray theoretical synthetic seismograms McMechan and Mooney (1980). In contrast to this method, Hwang and Mooney used a reflectivity synthetic seismogram method (Fuchs and Muller, 1971; Kind, 1978; 1979) to model data from one of the shot points (SP 11) on the western profile. Comparison of all three models were presented in Colburn and Mooney.

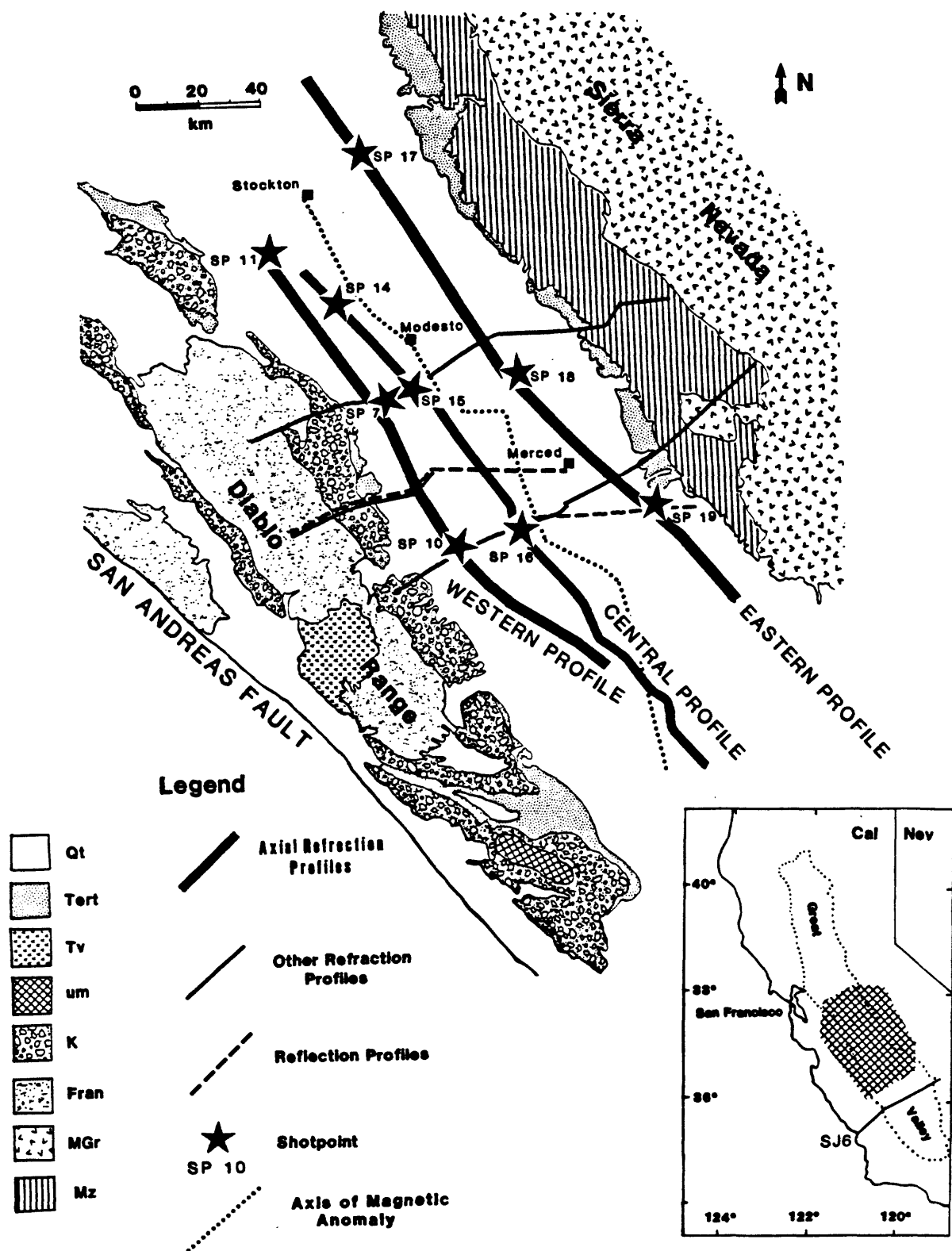


Figure 1. Map of the Great Valley, California showing locations of seismic profiles and generalized geology. Insert shows the southernmost profile (SJ6) - a coincident refraction-reflection transect. Qt = Quaternary sediments; Tert = Tertiary sediments; Tv = tertiary volcanics; um = ultramafics; K = Cretaceous sedimentary rocks, largely the Great Valley Sequence; Fran = Jurassic and Cretaceous Franciscan melange; MGr = Mesozoic granites and granodiorites of the Sierra Nevada; Mz = undifferentiated Mesozoic rocks, including Sierra greenstone belt.

Interpretation of a typical cross-strike (east-west) transect, constrained by all the geological and geophysical data sets, is presented by Wentworth et al. (1987). A more focused study of the Franciscan assemblage and Great Valley sequence interface is presented by Wentworth et al. (1984). These papers present evidence for overthrusting from the west and soleing of the Coast Range Thrust into the basement.

DESCRIPTION OF THE AXIAL PROFILES

Three profiles were deployed along the axis of the Great Valley between October 1981 and June 1982 (figure 1). The western profile extended from Tracy, California southeast to Mendota, California (west of Fresno). Three shots, fired at shot points 11, 7, and 10, were recorded along this profile. Shot points 10 and 11 were located within the profile and shot point 7 was 4 kilometers east of the profile. Within the northern portion of the profile, between shot points 10 and 11, the seismic recorder station spacing was 1 kilometer; south of shot point 10 the spacing was increased to 5 kilometers. Along the central profile seismic recorders were deployed from Manteca, California southeast to Helm, California (southeast of Fresno) with a station spacing of approximately 2 kilometers. In-line shots fired at shot points 14, 15, and 16 were recorded along this profile. The profile deployed along the eastern edge of the Great Valley extended southeast from Herald, California (Northeast of Lodi) to Madera, California (northwest of Fresno) with a station spacing of 2 kilometers. Three in-line shots were fired at shot points 17, 18, and 19.

Locations and elevations for seismic recording stations and shot points were determined using USGS 1:24,000 topographic maps. All the locations (Appendix A) are estimated to be accurate to within 15 meters.

Seismic sources were generated in 20 cm X 40 m drilled holes. Each hole was filled with an ammonium nitrate explosive and fired automatically with a shooting system described by Healy et al. (1982). A signal from a USGS master reference clock triggered the shooting system to fire an electric blasting cap, which sequentially caused the primacord, boosters, and the blasting agent to detonate. The blasting cap detonation signal (cap break), the USGS master reference clock's IRIG E time code, and the radio-received WWVB time code were recorded on a Kiowa paper strip-chart record. The shot origin times were read from the cap break on the paper record assuming that the explosives detonated at the exact time of the cap break. The reported shot times (table 1) are accurate to within ± 2 milliseconds

SHOT LIST

Shot Number	Shot Point	Date	Shot Time (Day, Hour, Min, Sec)
4	14	JUN 24, 1982	176:06:00:00.010
5	15	JUN 24, 1982	176:06:15:00.005
6	16	JUN 24, 1982	176:06:30:00.150
7	17	JUN 30, 1982	182:06:00:00.009
8	18	JUN 30, 1982	182:06:15:00.005
9	19	JUN 30, 1982	182:06:30:00.014
12	10	OCT 16, 1981	289:06:30:00.210
13	7	OCT 16, 1981	289:06:45:00.012
14	11	OCT 16, 1981	289:07:00:00.017

Table 1. Shot list. Shot times are Universal Time (UT)

INSTRUMENTATION AND DATA REDUCTION

The recording instruments used in the seismic-refraction surveys have been described by Murphy (1988) (figure 2). During the analog recording process, ground motion is sensed by a 2-Hz vertical-component seismometer. The voltage output from the seismometer is split without amplification and sent to three parallel amplifier circuit boards. Each circuit board amplifies the seismic signal in three stages and then frequency modulates the signal. Amplification at the last two stages can be set by the user. An internal precision clock signal is also frequency modulated. The three data carrier frequencies, the clock carrier frequency, and a tape-speed compensation carrier frequency are summed and recorded on a cassette tape.

Prior to deployment, field technicians program the memory and synchronize the clock unit of each instrument with a USGS master reference clock (the same clocks used to trigger the shooting system). After the shots have been recorded, the clock unit of each instrument is compared to the master reference clock, and a clock drift time (in milliseconds) is recorded in the field notes. USGS master clocks, which drift approximately one millisecond per week, are periodically checked against the standard WWVB time signal.

Information pertaining to the operation of each instrument is entered on data sheets. Chronometer corrections at shot time are calculated from each clock drift time assuming a linear drift rate (Appendix B). Both the data sheets and the chronometer corrections are written to a file which is used by the digitizing program. During the digitizing process, the cassette tapes are played back, and the signals are demultiplexed and demodulated. To

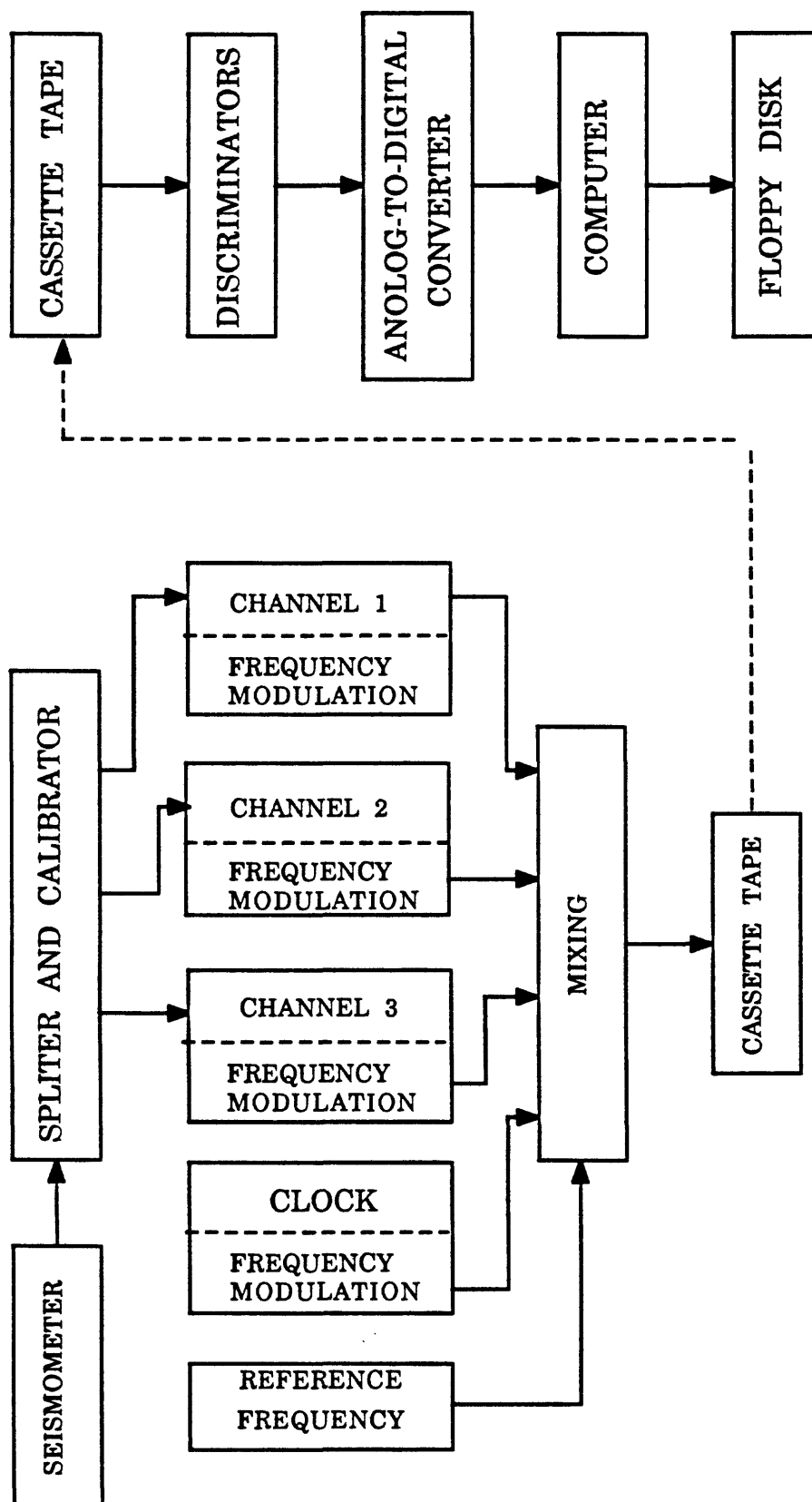


Figure 2. Schematic of the data acquisition and processing system.

prevent accidental shifting of the data-carrier frequencies, the tape-speed compensation carrier frequency is demultiplexed and sent to a circuit board which continuously adjusts the speed of the tape deck such that the tape-speed compensation carrier frequency matches a locally generated reference frequency. An analog-to-digital converter converts the signals to digital data which are stored on 8-inch floppy disks. The analog data were digitized for 20 seconds, starting $(X/6 - 2)$ seconds prior to shot time, where X is the shot point to recorder distance in kilometers (Appendix B). The sampling rate for digitizing is 200 samples per second.

The complete system velocity response is roughly flat between 2 and 30 Hz and the approximate ground motion is given by

$$A_g(t) = \frac{A(t)}{R_{GLE} R_{SA} R_{VCO} D_{DSC} D_{ADC}} = \frac{A(t)}{(409.6) R_{SA}}$$

where $A(t)$ is the amplitude response and R_{GLE} , R_{SA} , R_{VCO} , D_{DSC} , and D_{ADC} are the amplitude factors of the major components (table 2, figure 3). The recording unit also performs and records a series of diagnostic tests and calibrations prior to each separate seismic window. The calibrations provide a complete system calibration scheme and are used to verify the actual gain of each data channel and the operation of the seismometer.

TABLE 2.

Amplitude response values for the major components
of the data acquisition system

<u>component</u>	<u>value</u>
R _{GLE}	1 V/cm/sec
R _{SA}	dimensionless gain variable V/V
R _{VCO}	25 Hz/V
D _{DSC}	0.04 V/Hz
D _{ADC}	409.6 counts/V

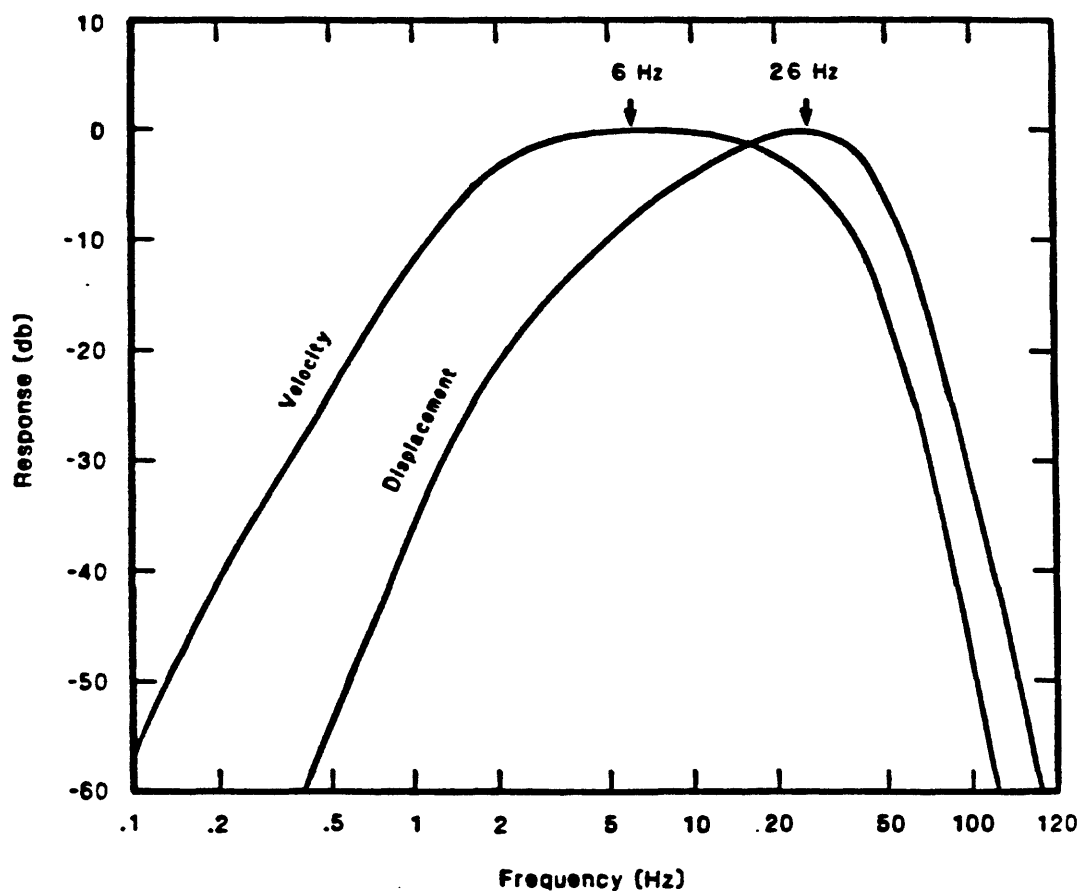


Figure 3. Theoretical transfer-function curves for the USGS short-period seismic refraction system (both recorder and digitizer). Solid lines are the displacement and velocity normalized amplitude. (From Dawson and Stauber, 1986)

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AVAILABLE COPY

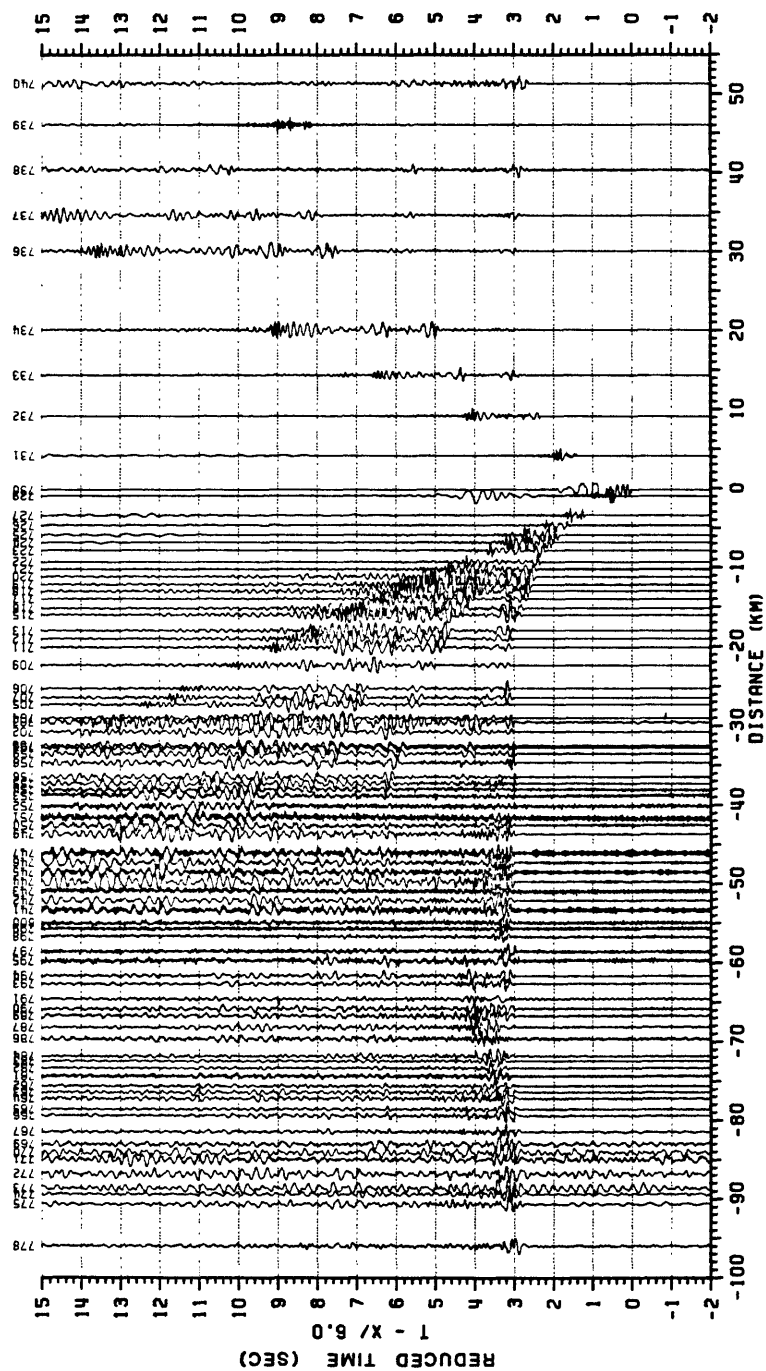


Figure 4. WESTERN PROFILE

SHOT 12 SHOT POINT 10

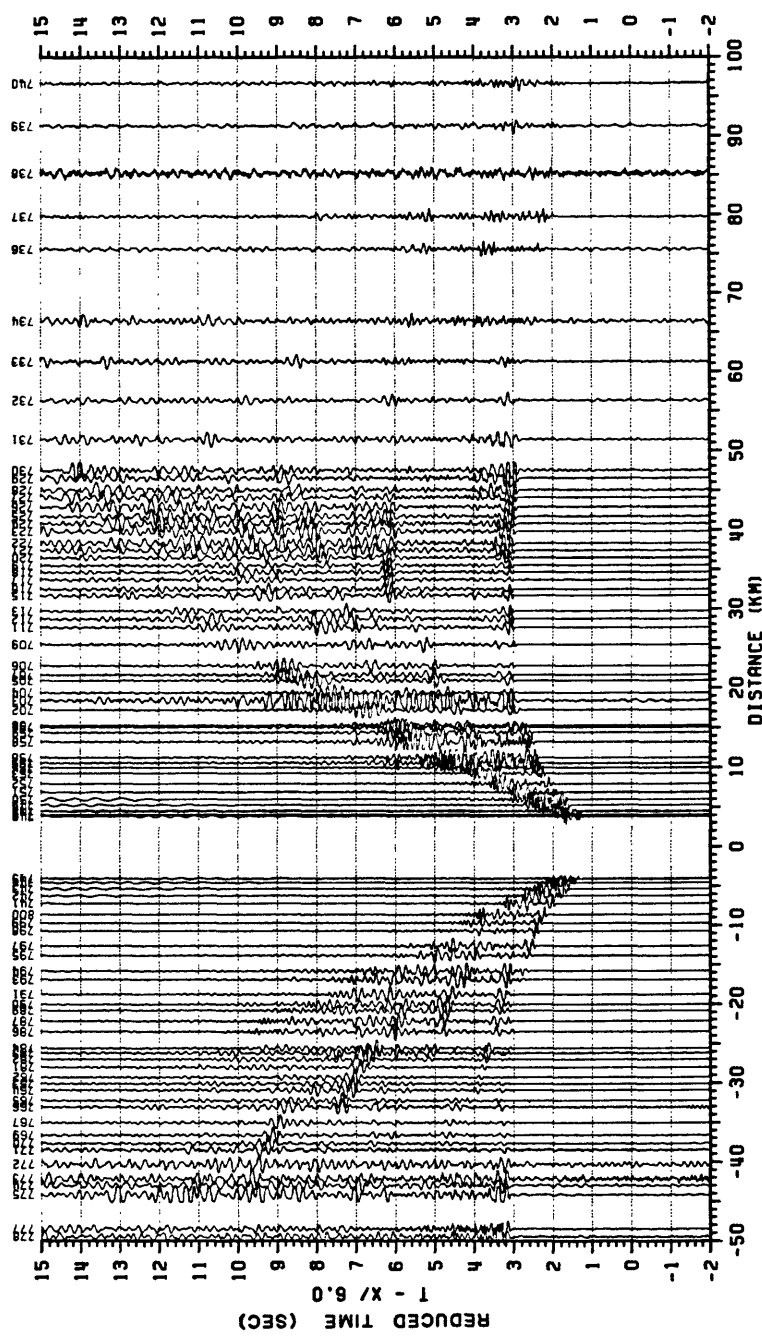


Figure 5. WESTERN PROFILE
SHOT 13 SHOT POINT 7

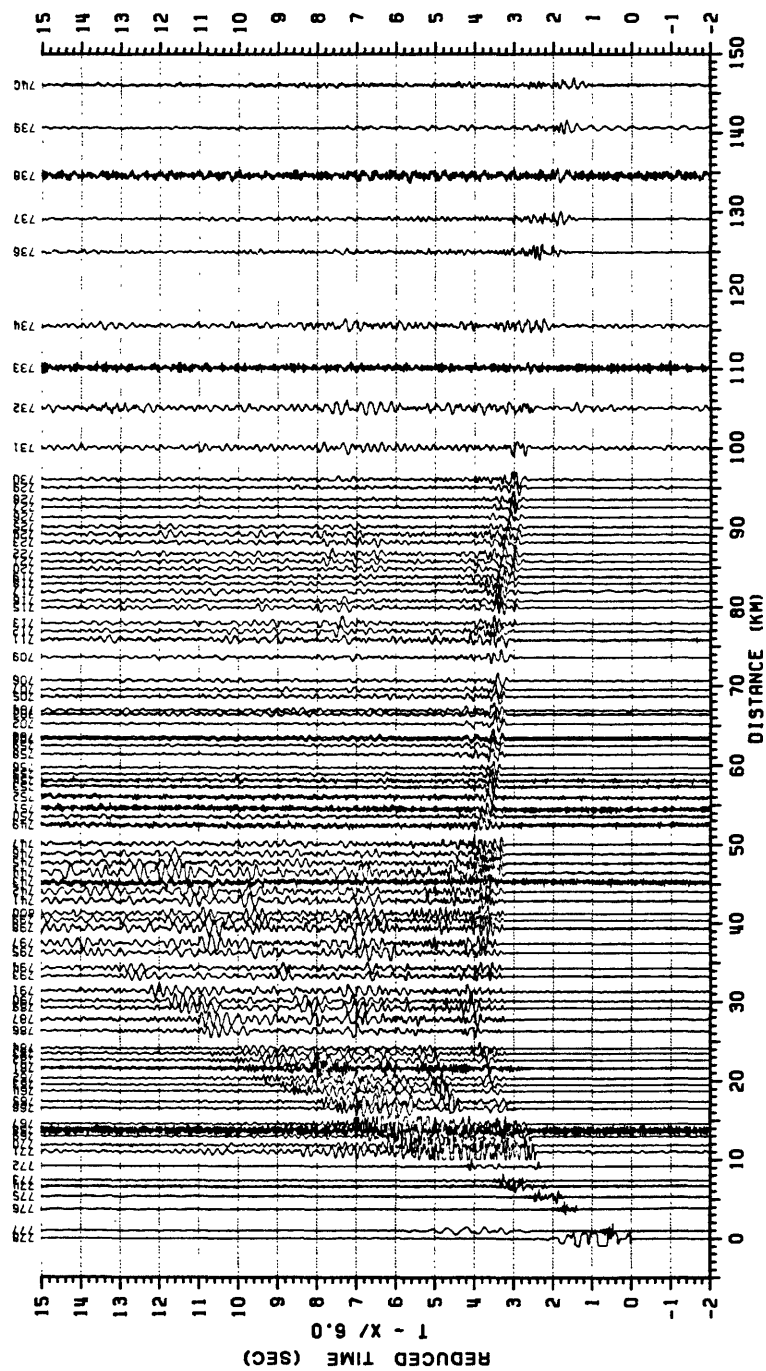


Figure 6. WESTERN PROFILE
SHOT 14 SHOT POINT 11

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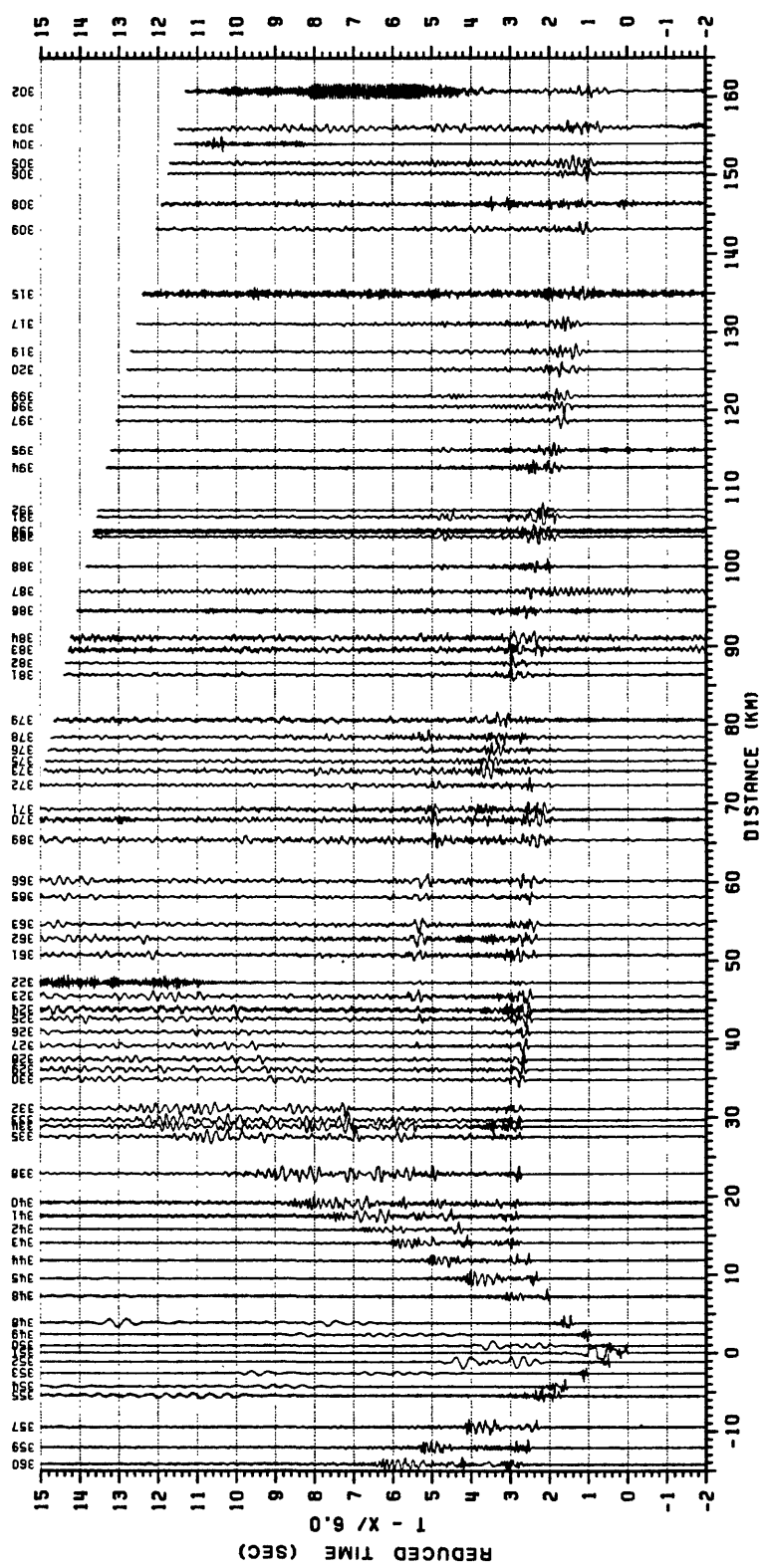


Figure 7. CENTRAL PROFILE
SHOT 4 SHOT POINT 14

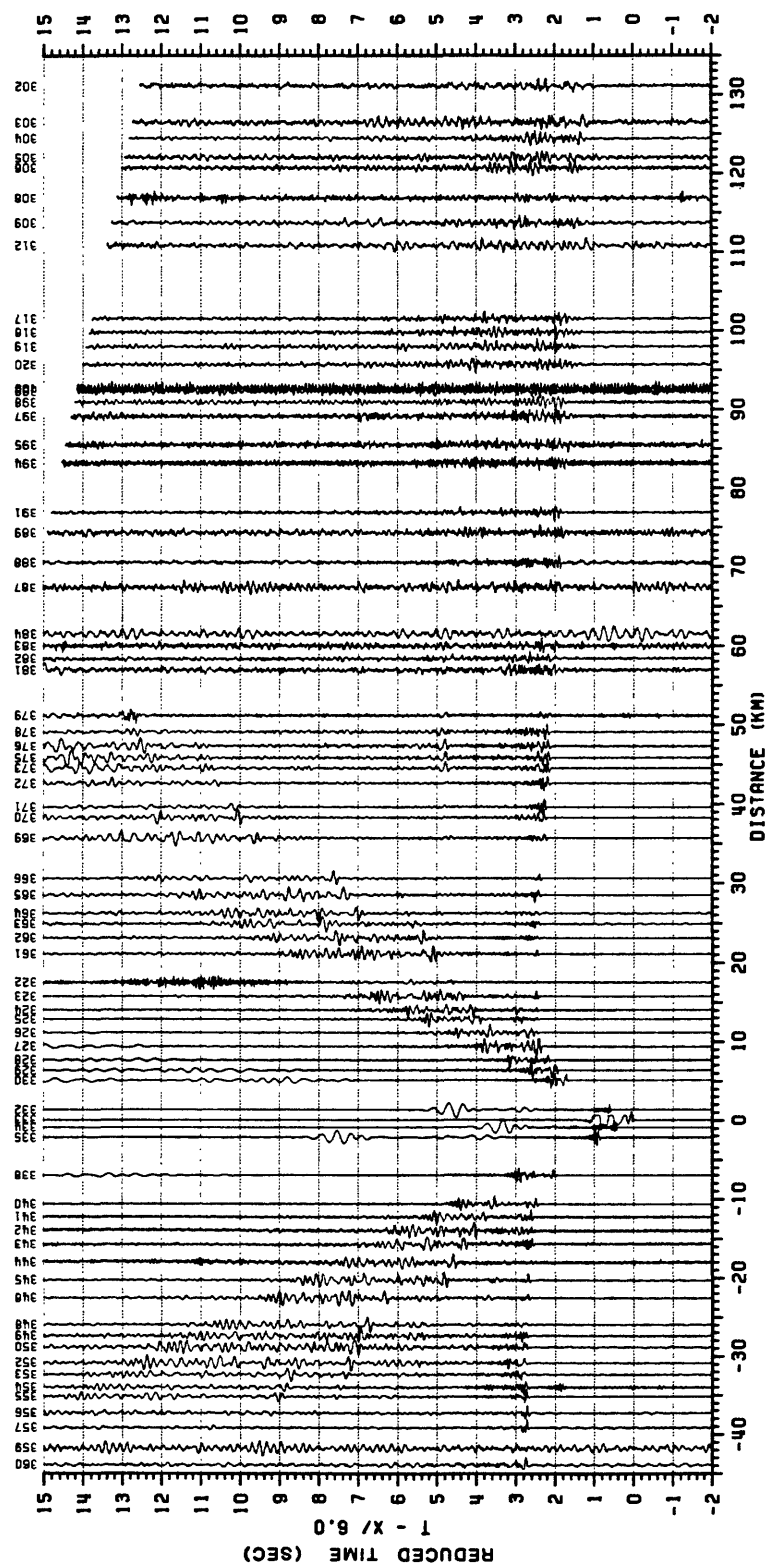


Figure 8. CENTRAL PROFILE

SHOT 5 SHOT POINT 15

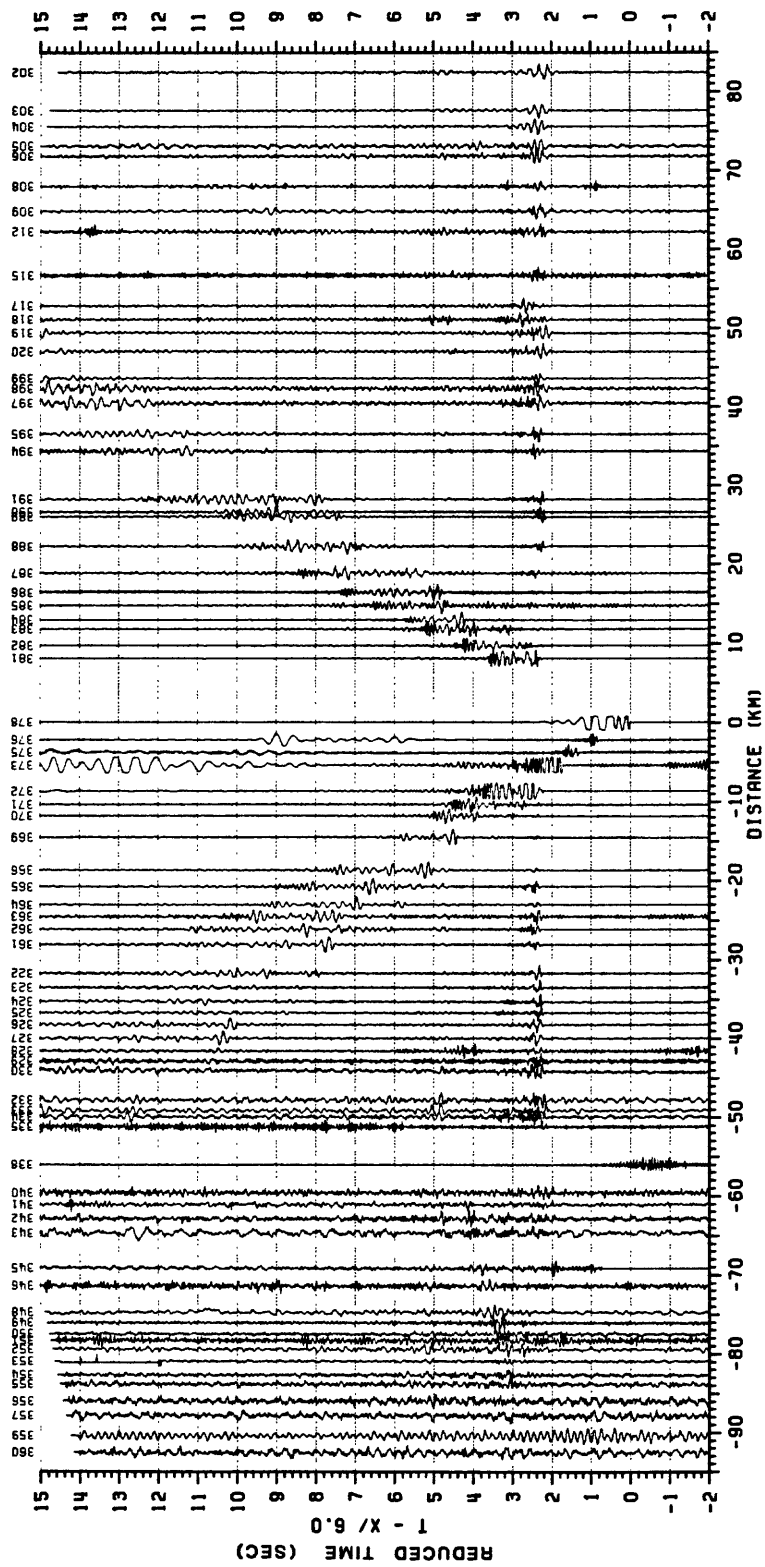


Figure 9. CENTRAL PROFILE
SHOT 6 SHOT POINT 16

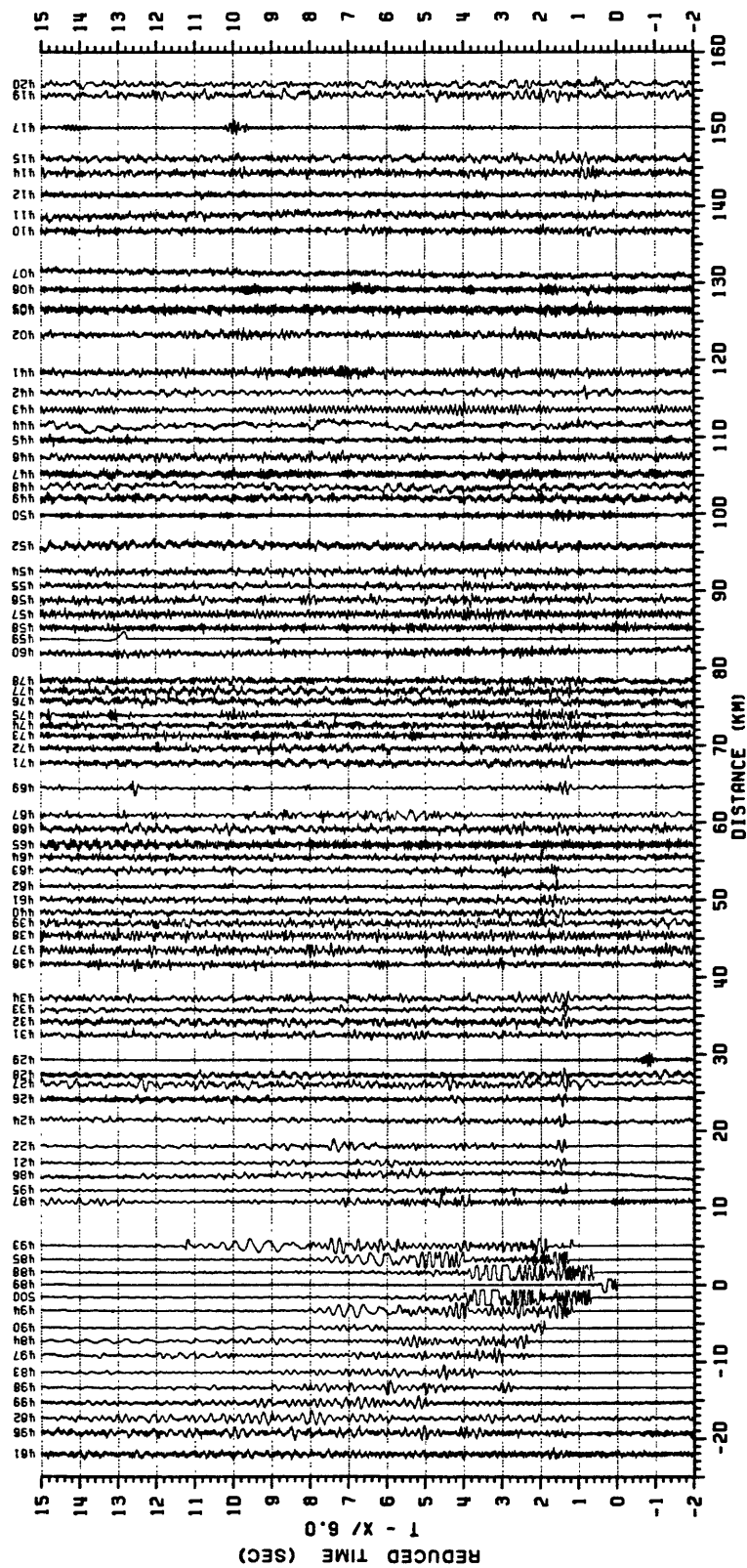


Figure 10. EASTERN PROFILE
SHOT 7 SHOT POINT 17

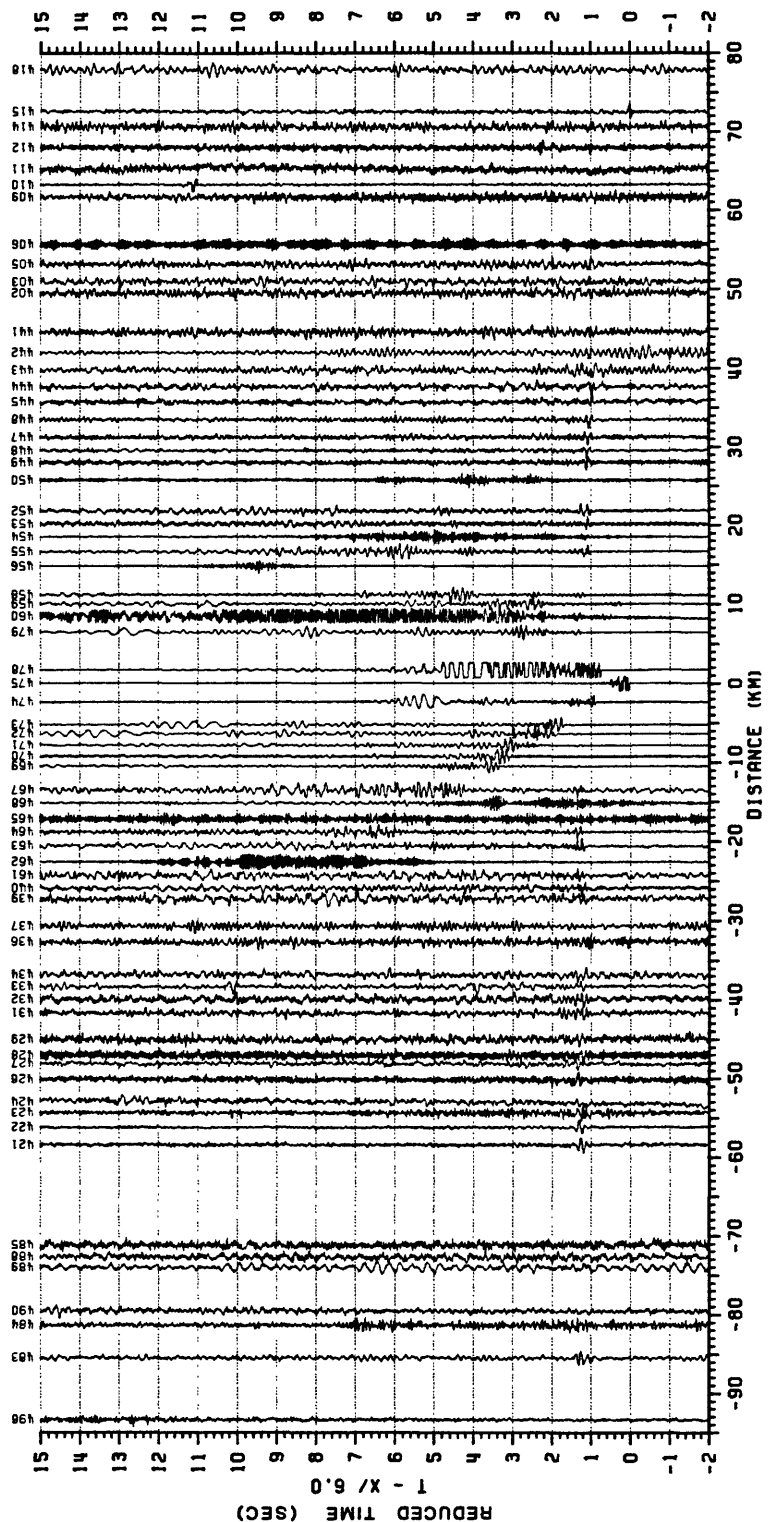


Figure 11. EASTERN PROFILE
SHOT 8 SHOT POINT 18

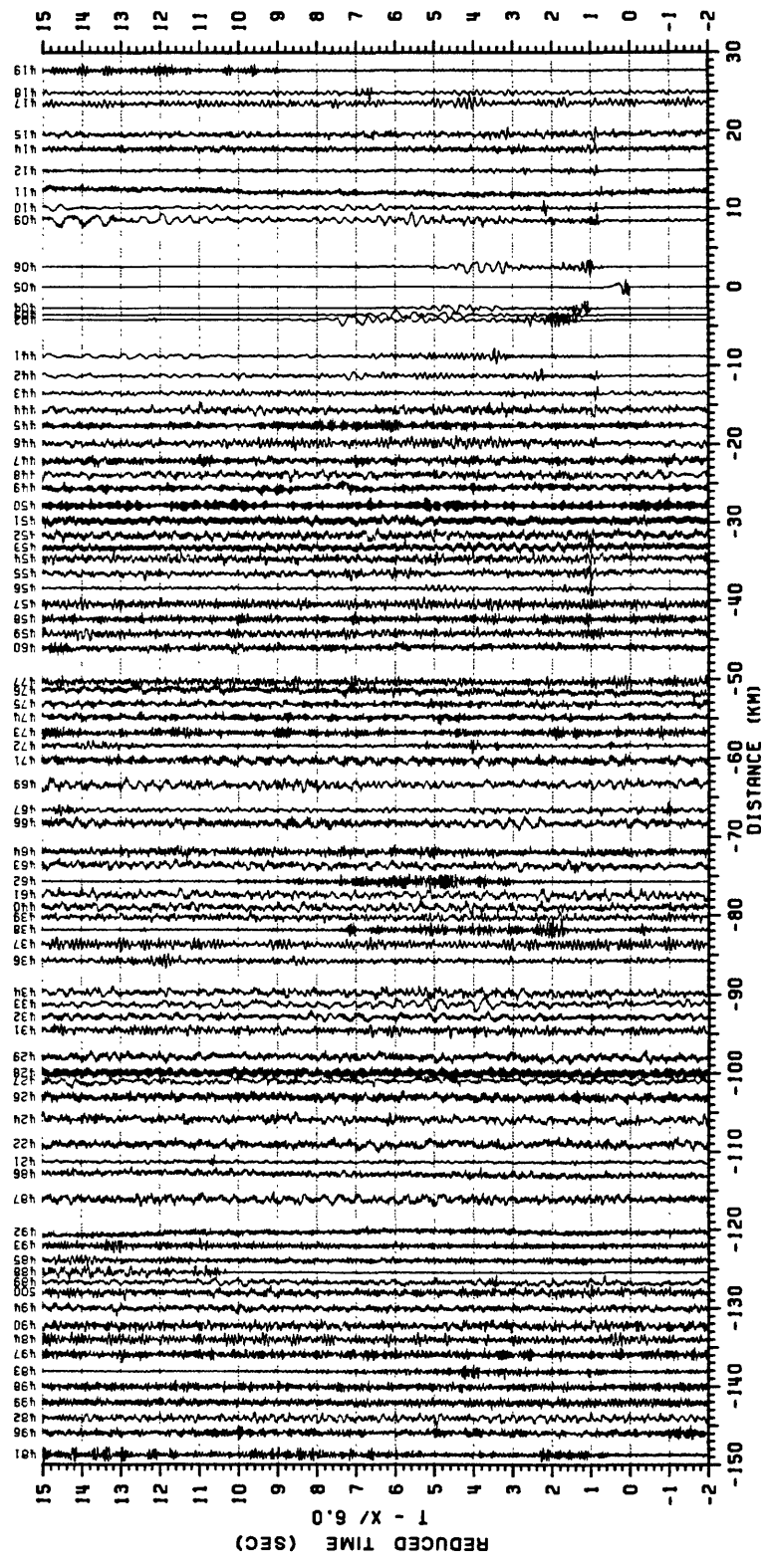


Figure 12. EASTERN PROFILE
SHOT 9 SHOT POINT 19

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Appendix A: Shot Point and Recorder Locations

SHOT POINT LOCATIONS

LOCATION NUMBER	LATITUDE (deg,min)	LONGITUDE (deg,min)	ELEV (m)
7	37 29.287	121 2.775	15
10	37 5.824	120 49.774	28
11	37 49.602	121 24.632	0
14	37 42.440	121 12.290	0
15	37 30.897	120 58.208	0
16	37 8.278	120 40.887	0
17	38 5.320	121 6.300	32
18	37 32.102	120 38.219	73
19	37 11.273	120 13.435	80

SEISMIC RECORDER STATION LOCATIONS

LOCATION NUMBER	LATITUDE (deg,min)	LONGITUDE (deg,min)	ELEV (m)	LOCATION NUMBER	LATITUDE (deg,min)	LONGITUDE (deg,min)	ELEV (m)
301	36 36.200	120 6.108	56	351	37 42.400	121 12.287	10
302	36 34.468	120 4.710	57	352	37 42.841	121 12.836	9
303	36 35.343	120 8.519	53	353	37 43.506	121 13.420	9
304	36 36.233	120 9.316	53	354	37 44.349	121 13.954	8
305	36 37.073	120 10.673	52	355	37 44.806	121 14.510	8
306	36 37.958	120 10.653	52	356	37 45.772	121 15.310	6
307	36 38.778	120 10.659	52	357	37 46.521	121 16.155	4
308	36 39.544	120 12.329	50	358	37 46.956	121 16.862	4
309	36 40.876	120 13.687	49	359	37 47.545	121 17.365	3
310	36 41.719	120 13.171	50	360	37 48.369	121 18.410	3
311	36 42.665	120 12.615	51	361	37 21.635	120 49.854	29
312	36 43.194	120 12.980	51	362	37 20.885	120 48.809	29
313	36 44.053	120 13.881	51	363	37 20.330	120 47.746	30
314	36 44.940	120 14.963	51	364	37 19.431	120 47.755	28
315	36 44.964	120 16.104	51	365	37 18.425	120 46.848	28
316	36 45.908	120 16.637	53	366	37 17.449	120 46.131	27
317	36 46.718	120 17.548	52	367	37 16.757	120 45.626	26
318	36 47.508	120 18.214	50	368	37 16.379	120 44.493	27
319	36 48.594	120 18.427	50	369	37 15.947	120 42.929	28
320	36 49.297	120 19.823	48	370	37 14.540	120 42.321	28
321	37 22.506	120 50.435	32	371	37 13.787	120 42.063	28
322	37 23.402	120 50.939	26	372	37 12.906	120 40.170	29
323	37 24.277	120 51.483	27	373	37 11.172	120 40.907	29
324	37 25.149	120 52.012	26	375	37 10.307	120 40.920	28
325	37 25.995	120 52.028	25	376	37 9.442	120 40.741	30
326	37 26.492	120 53.055	24	377	37 8.895	120 41.636	29
327	37 27.271	120 53.742	24	378	37 8.268	120 40.842	28
328	37 27.824	120 54.707	22	379	37 7.687	120 39.364	29
329	37 28.369	120 55.261	22	380	37 7.016	120 38.412	30
330	37 28.918	120 55.774	22	381	37 5.221	120 36.974	32
331	37 29.583	120 56.343	22	382	37 4.861	120 35.897	32
332	37 30.450	120 57.459	21	383	37 4.699	120 34.280	33
333	37 30.915	120 58.266	21	384	37 3.681	120 34.280	33
334	37 31.290	120 58.526	20	385	37 3.194	120 33.195	35
335	37 31.751	120 59.202	19	386	37 2.387	120 32.564	35
336	37 32.649	120 59.536	19	387	37 1.259	120 31.674	36
337	37 33.097	121 0.647	19	388	37 0.461	120 29.507	39
338	37 33.966	121 0.959	21	389	36 58.895	120 27.841	39
339	37 34.368	121 1.718	21	390	36 58.402	120 27.857	39
340	37 35.279	121 2.864	21	391	36 57.180	120 27.833	39
341	37 35.681	121 3.949	15	392	36 56.739	120 27.599	39
342	37 36.544	121 4.495	19	393	36 54.822	120 26.587	42
343	37 37.413	121 5.061	18	394	36 54.044	120 26.038	41
344	37 38.291	121 6.162	17	395	36 52.500	120 26.102	42
345	37 39.148	121 7.292	15	396	36 52.095	120 23.926	44
346	37 40.006	121 8.407	13	397	36 51.966	120 22.763	44
348	37 41.304	121 10.067	12	398	36 51.511	120 21.499	47
349	37 41.661	121 10.998	12	399	36 50.597	120 21.483	47
350	37 42.186	121 11.724	12	400	36 50.182	120 21.798	47

SEISMIC RECORDER STATION LOCATIONS

LOCATION NUMBER	LATITUDE (deg,min)	LONGITUDE (deg,min)	ELEV (m)	LOCATION NUMBER	LATITUDE (deg,min)	LONGITUDE (deg,min)	ELEV (m)
401	37 12.748	120 17.586	68	451	37 21.657	120 28.862	53
402	37 11.950	120 16.181	71	452	37 22.539	120 29.577	57
403	37 11.144	120 15.870	73	453	37 23.317	120 30.114	59
404	37 10.498	120 15.012	76	454	37 24.381	120 30.206	66
405	37 11.286	120 13.435	80	455	37 25.182	120 30.987	67
406	37 10.448	120 12.062	85	456	37 25.707	120 32.166	65
407	37 10.022	120 10.502	86	457	37 26.249	120 33.414	66
408	37 8.935	120 9.875	89	458	37 26.836	120 34.476	60
409	37 8.055	120 9.318	89	459	37 26.962	120 36.048	41
410	37 7.295	120 8.747	91	460	37 27.643	120 36.918	35
411	37 6.312	120 8.053	89	461	37 42.085	120 48.947	53
412	37 5.441	120 6.531	89	462	37 41.229	120 48.409	50
413	37 4.560	120 6.605	88	463	37 40.284	120 47.674	46
414	37 3.485	120 6.568	85	464	37 39.617	120 46.845	45
415	37 2.843	120 5.504	85	465	37 38.932	120 46.133	49
416	37 2.264	120 4.426	85	466	37 37.974	120 45.390	48
417	37 1.482	120 3.307	89	467	37 37.050	120 44.972	50
418	37 0.546	120 3.326	88	468	37 36.099	120 44.749	48
419	36 59.615	120 1.672	92	469	37 35.205	120 44.162	50
420	36 59.104	120 0.981	89	470	37 34.521	120 43.689	54
421	37 57.552	121 1.730	30	471	37 33.648	120 43.167	55
422	37 56.628	121 0.747	32	472	37 32.791	120 42.442	65
423	37 55.843	120 59.967	33	473	37 32.060	120 41.754	58
424	37 54.913	120 59.959	33	474	37 32.195	120 39.780	71
425	37 54.284	120 59.361	33	475	37 32.119	120 38.229	72
426	37 53.668	120 58.821	36	476	37 31.242	120 37.768	68
427	37 52.915	120 57.782	42	477	37 30.366	120 37.778	69
428	37 52.225	120 57.725	39	478	37 29.509	120 37.787	67
429	37 51.395	120 56.820	41	479	37 28.616	120 37.761	62
430	37 50.747	120 55.888	45	481	38 15.306	121 14.615	19
431	37 50.137	120 55.143	45	482	38 13.114	121 12.987	24
432	37 49.458	120 54.313	47	483	38 10.445	121 10.674	27
433	37 48.772	120 53.618	50	484	38 8.341	121 9.538	27
434	37 48.065	120 53.137	50	485	38 3.543	121 6.099	28
435	37 46.940	120 52.353	48	486	37 58.289	121 2.292	32
436	37 45.688	120 52.402	45	487	38 0.131	121 2.916	33
437	37 45.266	120 50.874	54	488	38 4.454	121 6.279	28
438	37 44.304	120 50.343	57	489	38 5.328	121 6.290	33
439	37 43.525	120 49.870	57	490	38 7.478	121 8.990	25
440	37 42.870	120 49.461	56	491	38 0.974	121 3.916	30
441	37 13.979	120 18.353	68	492	38 1.836	121 4.866	28
442	37 15.071	120 19.440	67	493	38 2.669	121 5.430	29
443	37 15.931	120 20.511	64	494	38 6.589	121 7.931	27
444	37 16.667	120 21.619	62	495	37 59.267	121 2.883	335
445	37 17.329	120 22.662	62	496	38 14.050	121 13.553	21
446	37 18.188	120 23.749	29	497	38 9.317	121 10.095	25
447	37 19.047	120 24.817	28	498	38 11.401	121 11.293	27
448	37 19.518	120 25.928	54	499	38 12.107	121 12.399	25
449	37 19.907	120 26.988	55	500	38 5.530	121 7.377	27
450	37 20.788	120 28.058	53				

SEISMIC RECORDER STATION LOCATIONS

LOCATION NUMBER	LATITUDE (deg,min)	LONGITUDE (deg,min)	ELEV (m)	LOCATION NUMBER	LATITUDE (deg,min)	LONGITUDE (deg,min)	ELEV (m)
701	37 21.349	121 0.411	21	751	37 25.571	121 3.194	21
702	37 20.201	121 0.199	22	752	37 24.985	121 2.500	21
703	37 19.628	120 59.790	21	753	37 24.297	121 2.196	23
704	37 18.966	121 0.495	24	754	37 23.943	121 1.923	24
705	37 18.230	120 59.748	22	755	37 23.673	121 1.458	24
706	37 17.344	120 58.944	22	756	37 23.376	121 1.004	22
707	37 17.941	120 59.222	22	757	37 22.980	121 0.830	0
708	37 16.436	120 59.393	25	758	37 22.280	121 0.985	24
709	37 16.174	120 57.545	22	759	37 21.674	121 0.728	23
710	37 15.694	120 57.188	22	760	37 21.291	121 0.192	21
711	37 15.122	120 56.805	22	761	37 40.184	121 15.874	11
712	37 14.596	120 56.464	22	762	37 40.637	121 16.617	14
713	37 14.115	120 56.136	22	763	37 40.968	121 16.979	12
714	37 13.642	120 55.820	22	764	37 41.287	121 17.361	12
715	37 13.162	120 55.501	22	765	37 41.887	121 17.886	11
716	37 12.782	120 55.237	22	766	37 42.255	121 18.194	10
717	37 12.201	120 54.849	22	767	37 43.119	121 19.000	11
718	37 11.739	120 54.534	22	768	37 43.439	121 19.411	10
719	37 11.335	120 54.262	22	769	37 43.756	121 19.727	8
720	37 10.856	120 53.941	22	770	37 44.292	121 20.081	7
721	37 10.409	120 53.630	24	771	37 44.733	121 20.283	6
722	37 9.956	120 53.354	24	772	37 45.547	121 21.020	3
723	37 9.264	120 52.865	24	773	37 46.350	121 21.727	4
724	37 8.801	120 52.497	25	774	37 46.466	121 22.425	3
725	37 8.389	120 52.119	25	775	37 47.211	121 22.589	1
726	37 7.870	120 51.600	25	776	37 47.871	121 23.324	1
727	37 7.332	120 51.090	27	777	37 49.193	121 24.218	1
728	37 6.916	120 50.690	27	778	37 49.602	121 24.632	0
729	37 6.278	120 50.038	28	781	37 40.205	121 15.909	11
730	37 5.830	120 49.644	29	782	37 39.715	121 15.553	15
731	37 4.144	120 47.927	29	783	37 39.222	121 15.419	15
732	37 1.998	120 45.865	30	784	37 38.921	121 15.216	15
733	37 0.030	120 43.361	32	785	37 38.350	121 14.772	15
734	36 58.317	120 40.025	34	786	37 37.872	121 14.506	15
735	36 56.946	120 37.435	36	787	37 37.128	121 14.129	16
736	36 55.354	120 34.281	39	788	37 36.881	121 13.956	16
737	36 54.128	120 31.571	42	789	37 36.427	121 13.671	16
738	36 52.342	120 28.390	43	790	37 35.960	121 13.467	16
739	36 49.515	120 26.313	49	791	37 35.466	121 12.872	15
740	36 47.108	120 24.246	50	792	37 34.972	121 12.482	15
741	37 31.090	121 7.109	18	793	37 34.615	121 12.101	16
742	37 30.532	121 6.694	18	794	37 34.271	121 11.505	16
743	37 29.974	121 6.280	18	795	37 33.564	121 10.464	16
744	37 29.420	121 5.855	18	796	37 33.412	121 10.197	16
745	37 28.843	121 5.449	18	797	37 33.136	121 9.829	17
746	37 28.272	121 5.055	18	798	37 32.381	121 8.908	19
747	37 27.695	121 4.642	18	799	37 31.985	121 8.403	21
748	37 27.134	121 4.227	18	800	37 31.849	121 7.672	18
749	37 26.570	121 3.853	19				
750	37 26.090	121 3.427	19				

Appendix B: Data Tables

SHOT 4 SHOT POINT 14 DATA TABLE

LOCATION NUMBER	DISTANCE (km)	AZMUTH (deg)	AMPLIFICATION (dB)	CLOCK CORRECTION (msec)	LOCATION NUMBER	DISTANCE (km)	AZMUTH (deg)	AMPLIFICATION (dB)	CLOCK CORRECTION (msec)
302	160.725	141.5	84	-203	353	-2.576	319.9	8	2
303	155.992	142.7	66	2	354	-4.294	325.3	8	-12
304	153.961	142.7	66	23	355	-5.457	323.3	8	9
305	151.506	143.0	66	-12	357	-9.445	323.1	28	0
306	150.211	142.6	66	9	359	-12.030	321.7	28	0
308	146.364	142.7	66	48	360	-14.180	320.7	28	-6
309	143.178	142.7	84	88	361	50.730	139.3	66	5
315	134.974	142.0	84	1	362	52.788	139.1	66	3
317	131.091	141.9	84	43	363	54.594	138.5	66	3
319	127.549	141.4	66	25	365	58.129	139.8	66	0
320	125.246	141.7	66	-10	366	60.194	140.2	84	0
322	47.214	138.2	66	5	369	65.382	138.5	84	2
323	45.472	137.6	66	0	370	67.938	139.4	84	6
324	43.757	137.0	66	-5	371	69.248	139.9	84	-14
325	42.608	135.6	66	-13	372	72.303	139.1	84	4
326	40.894	136.2	66	4	373	74.078	141.3	84	0
327	39.155	135.8	66	-6	375	75.324	142.1	84	5
328	37.430	136.2	66	9	376	76.756	142.7	66	-10
329	36.136	136.1	66	5	378	78.409	143.7	66	2
330	34.881	135.8	66	3	379	80.600	142.9	66	-5
332	31.118	135.5	66	-10	381	86.376	142.9	66	-23
333	29.674	135.9	66	4	382	87.868	142.3	66	-6
334	28.909	135.5	66	-13	383	89.574	141.2	66	13
335	27.602	135.8	84	-11	384	91.060	142.0	66	12
338	22.882	133.2	66	3	386	94.509	141.6	66	2
340	19.176	133.7	28	3	387	96.968	141.8	66	6
341	17.518	135.5	28	14	388	100.119	140.9	66	16
342	15.825	133.6	28	2	389	103.925	140.8	66	8
343	14.124	131.2	28	-19	390	104.623	141.1	66	17
344	11.837	130.4	28	-14	391	106.426	141.9	84	8
345	9.545	129.6	28	0	392	107.284	142.0	66	14
346	7.271	128.3	8	-46	394	112.658	142.6	66	10
348	3.886	122.8	8	21	395	114.900	143.5	66	14
349	2.386	127.2	8	2	397	118.666	141.9	66	7
350	0.956	119.5	8	1	398	120.482	141.4	66	-14
351	0.075	176.4	8	8	399	121.833	141.9	66	9
352	-1.092	312.7	8	0					

SHOT 5 SHOT POINT 15 DATA TABLE

LOCATION NUMBER	DISTANCE (km)	AZMUTH (deg)	AMPLIFICATION (dB)	CLOCK CORRECTION (msec)	LOCATION NUMBER	DISTANCE (km)	AZMUTH (deg)	AMPLIFICATION (dB)	CLOCK CORRECTION (msec)
302	131.134	142.8	66	-205	353	-32.326	316.2	66	2
303	126.488	144.4	66	2	354	-33.999	317.0	66	-12
304	124.457	144.4	66	23	355	-35.174	317.0	66	9
305	122.022	144.7	66	-12	356	-37.283	317.6	66	-2
306	120.698	144.3	84	9	357	-39.144	317.6	66	0
308	116.860	144.4	84	48	359	-41.740	317.5	66	0
309	113.679	144.5	84	89	360	-43.901	317.4	66	-7
312	110.820	142.8	84	0	361	21.104	144.3	66	5
317	101.537	143.6	84	44	362	23.134	143.2	66	3
318	99.773	143.6	84	3	363	24.905	141.7	66	3
319	97.965	143.0	84	26	364	26.223	144.0	66	2
320	95.687	143.6	84	-10	365	28.515	144.0	66	2
322	17.525	142.3	48	5	366	30.599	144.4	66	0
323	15.756	141.0	48	0	369	35.682	140.8	66	2
324	14.017	139.3	48	-5	370	38.280	142.2	66	6
325	12.854	134.9	48	-14	371	39.619	143.0	66	-14
326	11.139	137.0	48	4	372	42.622	141.3	66	4
327	9.398	135.5	48	-6	373	44.541	145.0	84	0
328	7.676	137.8	28	9	375	45.850	146.2	84	5
329	6.381	137.1	28	5	376	47.333	147.0	66	-10
330	5.125	135.6	28	3	378	49.092	148.5	66	2
332	1.379	126.8	8	-10	379	51.166	147.0	66	-5
333	0.091	291.6	8	4	381	56.922	146.5	66	-23
334	-0.865	327.2	8	-14	382	58.362	145.6	66	-6
335	-2.155	317.2	8	-11	383	59.987	143.9	84	13
338	-6.976	324.5	28	4	384	61.521	144.9	84	12
340	-10.618	319.8	28	4	387	67.409	144.4	66	6
341	-12.239	316.3	28	14	388	70.498	143.0	66	16
342	-13.958	318.5	28	2	389	74.298	142.8	84	9
343	-15.720	320.1	28	-20	391	76.860	144.2	84	8
344	-18.007	319.4	28	-14	394	83.178	145.1	84	10
345	-20.292	318.8	66	0	395	85.494	146.2	84	15
346	-22.568	318.3	66	-46	397	89.124	143.9	84	7
348	-25.985	317.8	66	21	398	90.908	143.3	84	-14
349	-27.400	316.6	66	2	399	92.291	143.9	84	9
350	-28.840	316.4	66	1	400	92.646	144.4	84	4
352	-30.846	315.7	66	0					

SHOT 6 SHOT POINT 16 DATA TABLE

LOCATION NUMBER	DISTANCE (km)	AZMUTH (deg)	AMPLIFICATION (dB)	CLOCK CORRECTION (msec)	LOCATION NUMBER	DISTANCE (km)	AZMUTH (deg)	AMPLIFICATION (dB)	CLOCK CORRECTION (msec)
302	82.481	139.3	66	-6	353	-80.954	323.6	84	2
303	77.620	141.7	66	13	354	-82.677	323.8	84	-12
304	75.591	141.6	66	12	355	-83.842	323.7	84	9
305	73.121	142.1	66	-15	356	-85.979	323.8	84	-2
306	71.852	141.3	66	2	357	-87.831	323.7	66	0
308	68.002	141.4	66	17	359	-90.410	323.5	66	0
309	64.814	141.4	66	9	360	-92.549	323.3	66	-7
312	62.207	138.2	84	15	361	-92.038	331.8	66	5
315	56.686	139.5	66	15	362	-26.095	333.3	66	3
317	52.824	139.0	66	7	363	-24.490	335.5	66	3
318	51.072	138.8	66	-14	364	-22.993	333.8	66	3
319	49.362	137.5	66	10	365	-20.736	334.8	66	0
320	47.006	138.3	66	4	366	-18.653	335.4	66	0
322	-31.676	332.0	66	5	369	-14.502	348.0	28	2
323	-33.483	332.1	66	0	370	-11.774	349.6	28	-6
324	-35.273	332.2	66	-5	371	-10.337	350.3	28	-14
325	-36.675	333.3	66	-14	372	-8.625	7.1	66	4
326	-38.189	331.9	66	4	373	-5.352	359.7	66	0
327	-39.937	331.6	66	-6	375	-3.753	359.2	8	5
328	-41.523	330.5	66	9	376	-2.164	5.7	8	-11
329	-42.803	330.3	66	5	378	0.070	105.8	8	2
330	-44.060	330.1	84	3	381	8.099	134.3	48	-24
332	-47.762	329.2	84	-10	382	9.726	130.5	48	-6
333	-49.113	328.5	84	4	383	11.817	124.1	48	13
334	-49.905	328.5	84	-14	384	12.967	131.0	48	12
335	-51.155	328.1	84	-11	385	14.776	129.5	48	-15
338	-56.001	328.0	66	4	386	16.457	131.5	48	2
340	-59.558	327.0	84	4	387	18.841	133.6	48	6
341	-61.061	326.1	84	15	388	22.217	130.6	48	17
342	-62.834	326.3	84	2	389	25.985	131.9	48	9
343	-64.634	326.5	84	-20	390	26.586	133.4	48	18
345	-69.130	325.7	66	0	391	28.213	136.7	48	8
346	-71.369	325.3	84	-47	394	34.325	140.1	66	10
348	-74.735	324.8	84	22	395	36.506	143.1	66	15
349	-76.069	324.3	66	2	397	40.414	138.3	66	7
350	-77.483	324.0	66	1	398	42.298	137.2	84	-14
351	-78.292	323.7	66	8	399	43.571	138.6	66	10
352	-79.427	323.6	84	0					

SHOT 7 SHOT POINT 17 DATA TABLE

LOCATION NUMBER	DISTANCE (km)	AZMUTH (deg)	AMPLIFICATION (dB)	CLOCK CORRECTION (msec)	LOCATION NUMBER	DISTANCE (km)	AZMUTH (deg)	AMPLIFICATION (dB)	CLOCK CORRECTION (msec)
402	123.249	143.2	84	-207	455	90.609	145.1	84	6
404	126.439	143.3	84	999	456	88.825	145.6	84	4
405	126.669	142.1	84	8	457	86.970	146.2	84	5
406	129.137	141.8	84	12	458	85.204	146.7	84	0
407	131.178	141.3	84	-11	459	83.767	147.9	66	3
410	136.754	141.7	84	4	460	82.020	148.2	84	-2
411	138.824	141.9	84	46	461	49.947	149.4	84	18
412	141.478	141.5	84	9	462	51.713	149.5	84	13
414	144.318	142.4	84	33	463	53.766	149.5	84	13
415	146.217	142.2	84	7	464	55.449	149.0	84	15
417	150.197	141.8	66	52	465	57.075	148.8	84	9
419	154.414	141.9	84	25	466	59.157	148.8	84	11
420	155.789	141.8	84	2	467	60.939	149.1	84	-32
421	15.851	155.0	84	-6	469	64.486	149.8	84	11
422	18.017	153.2	84	16	471	67.712	149.9	84	0
424	21.374	154.3	84	-11	472	69.619	149.8	84	18
426	24.178	153.1	84	12	473	71.297	149.6	84	2
427	26.118	151.5	84	-15	475	73.956	146.1	84	17
428	27.286	152.6	84	22	476	75.682	146.4	84	-20
429	29.263	151.7	48	13	477	77.031	147.1	84	11
431	32.496	149.8	84	13	478	78.362	147.7	84	0
432	34.195	149.1	84	13	474	72.592	147.6	84	16
433	35.809	148.7	84	-17	481	-22.107	326.7	66	-25
434	37.293	148.9	84	14	482	-17.415	325.9	84	1
436	41.639	150.7	84	3	483	-11.434	326.0	66	27
437	43.443	148.6	84	19	484	-7.323	319.7	66	25
438	45.370	149.0	84	8	485	3.301	174.9	66	1
439	46.963	149.1	84	10	486	14.269	155.7	84	9
440	48.312	149.3	84	11	487	10.801	152.7	66	14
441	118.321	143.4	84	7	488	1.603	178.9	66	27
442	115.740	143.4	84	4	489	0.021	45.6	8	18
443	113.522	143.6	84	-7	490	-5.602	315.4	66	33
444	111.459	143.9	84	-4	493	5.068	165.4	66	29
445	109.567	144.1	84	2	494	-3.346	314.5	66	17
446	107.341	144.3	84	-24	495	12.264	155.9	66	23
447	105.131	144.5	84	10	496	-19.314	326.7	84	-13
448	103.480	145.0	84	20	497	-9.243	323.1	66	14
449	102.002	145.5	84	5	498	-13.407	327.0	84	-10
450	99.765	145.7	84	2	499	-15.395	324.6	84	14
452	95.824	145.7	84	6	500	-1.621	283.9	66	11
454	92.482	145.0	84	-4					

SHOT 8 SHOT POINT 18 DATA TABLE

LOCATION NUMBER	DISTANCE (km)	AZMUTH (deg)	AMPLIFICATION (dB)	CLOCK CORRECTION (msec)	LOCATION NUMBER	DISTANCE (km)	AZMUTH (deg)	AMPLIFICATION (dB)	CLOCK CORRECTION (msec)
402	49.478	138.9	84	-209	449	27.988	143.7	84	5
403	50.908	139.6	84	8	450	25.740	144.4	84	2
405	53.119	136.5	84	8	452	21.801	144.2	84	6
406	55.643	136.0	84	12	453	20.171	143.7	84	5
409	61.649	136.2	84	112	454	18.534	140.4	84	-5
410	63.251	136.5	84	4	455	16.659	140.2	84	6
411	65.282	136.9	84	46	456	14.817	143.0	84	4
412	67.998	136.5	84	9	458	11.195	150.5	66	0
414	70.637	138.5	84	34	459	10.031	161.4	84	3
415	72.571	138.2	84	7	460	8.467	166.9	84	-2
418	77.893	138.5	84	4	461	-24.294	319.5	84	18
421	-58.387	323.7	84	-6	462	-22.580	318.4	84	13
422	-56.157	323.9	84	16	463	-20.560	317.4	84	13
423	-54.311	324.0	84	6	464	-18.827	317.6	84	15
424	-52.924	322.9	84	-11	465	-17.185	317.3	84	9
426	-50.080	322.8	84	12	466	-15.147	315.8	84	11
427	-48.051	323.2	84	-15	467	-13.514	312.6	84	-32
428	-46.984	322.4	84	23	469	-10.466	303.3	66	11
429	-44.958	322.5	84	14	470	-9.216	299.1	66	25
431	-41.617	323.3	84	13	471	-7.828	291.4	66	0
432	-39.883	323.6	84	13	472	-6.350	281.6	66	19
433	-38.256	323.7	84	-17	473	-5.207	269.2	66	2
434	-36.785	323.4	84	14	475	0.034	335.4	8	18
436	-32.661	320.3	48	3	476	1.724	157.3	66	-21
437	-30.651	322.6	84	19	479	6.483	174.0	66	8
439	-27.208	321.0	84	10	474	-2.306	274.3	8	17
440	-25.891	320.3	84	11	483	-85.464	326.1	84	27
441	44.537	138.8	84	8	484	-81.308	325.6	84	25
442	41.958	138.7	84	4	485	-71.117	324.9	84	1
443	39.719	138.9	84	-7	488	-72.648	325.5	84	27
444	37.618	139.4	84	-4	489	-73.993	326.2	84	19
445	35.688	140.0	84	2	490	-79.503	325.4	84	33
446	33.439	140.3	84	-24	496	-93.348	326.3	84	-13
447	31.209	140.7	84	11					
448	29.506	142.1	84	20					

SHOT 9 SHOT POINT 19 DATA TABLE

LOCATION NUMBER	DISTANCE (km)	AZMUTH (deg)	AMPLIFICATION (dB)	CLOCK CORRECTION (msec)	LOCATION NUMBER	DISTANCE (km)	AZMUTH (deg)	AMPLIFICATION (dB)	CLOCK CORRECTION (msec)
402	-4.252	287.1	66	-210	453	-33.226	312.1	84	5
403	-3.612	266.2	66	9	454	-34.672	314.4	84	-5
404	-2.739	238.5	66	999	455	-36.531	314.8	84	6
405	-0.024	360.0	8	8	456	-38.455	314.0	84	5
406	2.541	126.9	66	12	457	-40.480	313.2	84	5
409	8.519	134.3	66	113	458	-42.367	312.8	84	0
410	10.114	136.7	66	4	459	-44.251	311.0	84	3
411	12.154	139.0	66	46	460	-46.047	311.1	84	-2
412	14.862	136.5	84	9	461	-77.405	317.4	84	18
414	17.634	144.8	84	34	462	-75.706	317.0	84	13
415	19.523	143.0	84	8	463	-73.694	316.7	84	13
417	23.518	140.4	84	53	464	-71.960	316.8	84	15
418	24.859	142.9	84	4	466	-68.283	316.3	84	11
419	27.727	141.0	66	25	467	-66.628	315.7	84	-32
421	-111.296	320.3	84	-6	469	-63.376	314.3	84	11
422	-109.061	320.3	84	17	471	-60.327	313.3	84	0
424	-105.888	319.7	84	-11	472	-58.466	312.9	84	19
426	-103.053	319.6	84	12	473	-56.804	312.6	84	2
427	-101.006	319.7	84	-16	475	-53.168	316.5	84	18
428	-99.980	319.3	84	23	476	-51.530	315.8	84	-21
429	-97.951	319.3	84	14	477	-50.395	314.5	84	11
431	-94.582	319.5	84	13	474	-54.871	314.9	84	17
432	-92.837	319.5	84	13	481	-148.738	322.8	84	-26
433	-91.209	319.5	84	-17	482	-144.073	322.6	84	1
434	-89.757	319.3	84	14	483	-138.099	322.4	48	27
436	-85.742	317.9	48	3	484	-134.006	322.0	84	25
437	-83.668	318.7	84	19	485	-123.926	321.3	84	1
438	-81.818	318.3	84	8	486	-112.870	320.4	84	9
439	-80.281	318.0	84	10	487	-116.088	321.1	84	14
440	-78.985	317.7	84	11	488	-125.408	321.7	84	27
441	-8.832	304.5	84	8	489	-126.691	322.1	84	19
442	-11.326	308.3	84	4	490	-132.255	321.8	84	33
443	-13.557	309.5	84	-7	492	-120.334	321.0	84	24
444	-15.687	309.5	84	-4	493	-122.052	321.2	84	30
445	-17.654	309.4	84	2	494	-130.007	321.9	84	17
446	-19.905	310.0	84	-24	496	-145.950	322.7	84	-13
447	-22.137	310.5	84	11	497	-135.931	322.2	84	14
448	-23.953	309.5	84	20	498	-140.053	322.6	84	-10
449	-25.623	308.6	84	6	499	-142.073	322.4	84	14
450	-27.877	309.1	84	2	500	-127.967	321.7	84	11
451	-29.816	310.1	84	12					
452	-31.679	311.1	84	6					

SHOT 12 SHOT POINT 10 DATA TABLE

LOCATION NUMBER	DISTANCE (km)	AZMUTH (deg)	AMPLIFICATION (dB)	CLOCK CORRECTION (msec)	LOCATION NUMBER	DISTANCE (km)	AZMUTH (deg)	AMPLIFICATION (dB)	CLOCK CORRECTION (msec)
701	-32.744	331.3	60	19	750	-42.574	331.7	40	-13
702	-30.741	329.9	60	63	751	-41.567	331.5	40	10
703	-29.521	329.9	78	-29	752	-40.126	332.0	40	1
704	-29.026	326.9	60	-5	753	-38.793	331.7	40	13
705	-27.284	327.3	60	3	754	-38.025	331.8	40	6
706	-25.263	327.5	60	21	755	-37.262	332.4	60	8
707	-26.416	328.0	60	11	756	-36.466	332.9	60	17
709	-22.334	329.0	60	17	758	-34.661	331.4	60	-6
711	-20.102	328.8	60	-8	759	-33.496	331.1	60	13
712	-19.008	328.6	60	9	760	-32.495	331.7	60	-19
713	-17.998	328.4	60	5	761	-74.322	328.8	60	-3
715	-16.004	328.0	60	16	762	-75.607	328.4	60	-15
716	-15.200	327.9	60	5	763	-76.407	328.3	60	6
717	-13.985	327.5	60	-8	764	-77.206	328.2	60	46
718	-13.015	327.2	60	-12	765	-78.555	328.1	60	5
719	-12.169	326.9	60	18	766	-79.373	328.1	60	16
720	-11.168	326.5	60	15	767	-81.410	328.0	60	27
721	-10.224	326.0	40	86	769	-82.977	327.8	60	23
722	-9.303	325.2	40	19	770	-84.093	327.9	60	17
723	-7.840	324.3	40	17	771	-84.943	328.0	60	10
724	-6.827	323.8	40	13	772	-86.795	327.9	78	23
725	-5.880	323.8	40	12	773	-88.606	327.8	78	1
726	-4.652	324.4	20	8	774	-89.336	327.4	78	6
727	-3.403	325.0	20	19	775	-90.628	327.7	78	14
729	-0.927	335.0	20	8	778	-95.973	327.6	78	51
730	-0.192	86.5	8	10	781	-74.381	328.8	60	7
731	4.140	138.6	20	15	782	-73.334	328.7	60	7
732	9.145	140.7	40	13	783	-72.454	328.5	60	10
733	14.326	138.4	40	15	784	-71.823	328.5	60	22
734	20.043	133.8	60	26	786	-69.624	328.4	60	1
736	30.052	130.1	60	29	787	-68.161	328.2	60	0
737	34.600	128.7	60	14	789	-66.705	328.1	60	0
738	40.357	128.2	60	3	790	-65.814	327.9	60	24
739	46.070	130.9	60	-30	791	-64.574	328.1	60	22
740	51.329	132.4	60	19	793	-62.637	328.2	60	10
741	-53.293	331.3	78	14	794	-61.636	328.6	60	-40
742	-52.094	331.3	78	-8	795	-59.723	329.2	40	14
743	-50.896	331.4	78	11	797	-58.564	329.6	40	7
744	-49.697	331.4	40	-36	798	-56.675	330.1	40	1
745	-48.472	331.4	78	9	799	-55.670	330.4	40	13
746	-47.267	331.5	78	-16	800	-54.922	331.2	40	9
747	-46.038	331.5	78	3					
749	-43.654	331.5	78	13					

SHOT 13 SHOT POINT 7 DATA TABLE

LOCATION NUMBER	DISTANCE (km)	AZMUTH (deg)	AMPLIFICATION (dB)	CLOCK CORRECTION (msec)	LOCATION NUMBER	DISTANCE (km)	AZMUTH (deg)	AMPLIFICATION (dB)	CLOCK CORRECTION (msec)
701	15.090	166.6	60	19	749	5.271	197.6	40	13
702	17.230	167.3	60	63	750	5.991	189.2	40	-13
703	18.401	166.2	78	-29	751	6.901	185.1	40	10
704	19.384	170.0	60	-5	752	7.968	177.1	40	1
705	20.933	167.7	60	3	753	9.269	174.7	40	13
706	22.801	165.6	60	21	754	9.964	172.8	40	6
707	21.631	166.0	60	11	755	10.564	169.4	60	8
709	25.453	162.3	60	17	756	11.241	166.6	60	18
711	27.643	161.4	60	-8	758	13.227	168.5	60	-6
712	28.727	161.1	60	9	759	14.402	167.9	60	14
713	29.724	160.7	60	5	760	15.273	165.6	60	-20
715	31.701	160.2	60	16	761	-27.898	316.3	60	-3
716	32.495	160.0	60	5	762	-29.259	315.9	60	-15
717	33.702	159.7	60	-8	763	-30.069	315.9	60	6
718	34.665	159.4	60	-12	764	-30.884	316.0	60	46
719	35.505	159.3	60	18	765	-32.218	316.3	60	5
720	36.502	159.1	60	15	766	-33.024	316.6	60	16
721	37.439	158.9	78	87	767	-35.000	317.0	60	28
722	38.368	158.7	78	19	769	-36.590	317.0	60	23
723	39.823	158.4	78	17	770	-37.669	317.5	60	17
724	40.820	158.2	78	13	771	-38.473	318.0	60	10
725	41.737	157.8	78	12	772	-40.316	318.3	78	23
726	42.917	157.4	78	8	773	-42.116	318.5	78	1
727	44.127	157.0	78	19	774	-42.961	317.7	78	6
728	45.066	156.7	78	15	775	-44.147	318.7	78	14
729	46.535	156.1	78	8	777	-48.483	319.4	78	7
730	47.528	155.9	78	10	778	-49.452	319.5	78	51
731	51.424	154.7	78	15	781	-27.961	316.2	60	7
732	56.326	153.7	78	13	782	-26.945	315.7	60	7
733	61.258	152.1	78	15	783	-26.160	314.6	60	11
734	66.433	149.6	78	26	784	-25.557	314.2	60	22
736	75.607	146.1	78	29	786	-23.466	312.6	60	1
737	79.755	144.6	78	14	787	-22.136	310.9	60	0
738	85.234	143.3	78	3	789	-20.785	309.5	60	0
739	91.280	143.7	78	-30	790	-20.011	308.1	60	24
740	96.691	143.8	78	19	791	-18.759	307.5	60	22
741	-7.206	297.6	40	14	793	-16.908	305.7	60	10
742	-6.219	291.7	40	-8	794	-15.826	305.6	60	-40
743	-5.321	283.8	40	11	795	-13.818	304.9	40	14
744	-4.548	273.1	20	-37	797	-12.598	304.4	40	7
745	-4.027	258.2	20	9	798	-10.698	302.3	40	1
746	3.850	240.8	20	-16	799	-9.680	301.0	40	13
747	4.031	223.1	20	3	800	-8.634	303.3	40	9
748	4.520	208.3	20	29					

SHOT 14 SHOT POINT 11 DATA TABLE

LOCATION NUMBER	DISTANCE (km)	AZMUTH (deg)	AMPLIFICATION (dB)	CLOCK CORRECTION (msec)	LOCATION NUMBER	DISTANCE (km)	AZMUTH (deg)	AMPLIFICATION (dB)	CLOCK CORRECTION (msec)
701	63.263	145.7	60	19	751	54.505	144.6	40	10
702	65.203	146.5	60	63	752	55.982	144.4	40	1
703	66.421	146.6	78	-29	753	57.280	144.8	40	13
704	66.890	147.9	60	-5	754	58.048	144.9	40	6
705	68.629	147.7	60	3	755	58.851	144.6	60	8
706	70.649	147.6	60	21	756	59.687	144.4	60	18
707	69.497	147.4	60	11	758	61.365	145.4	60	-6
709	73.585	147.2	78	17	759	62.504	145.7	60	14
711	75.815	147.3	60	-8	760	63.535	145.5	60	-20
712	76.906	147.3	78	9	761	21.655	143.6	60	-3
713	77.916	147.4	78	5	762	20.337	144.6	60	-15
715	79.909	147.5	78	16	763	19.530	144.9	60	6
716	80.762	147.5	78	5	764	18.724	145.2	60	47
717	81.978	147.6	78	-8	765	17.373	145.2	60	5
718	82.950	147.7	60	-12	766	16.555	145.2	60	16
719	83.797	147.7	60	18	767	14.566	145.4	60	28
720	84.801	147.7	78	15	768	13.737	146.1	60	9
721	85.748	147.8	78	87	769	12.992	146.3	60	23
722	86.675	147.8	78	20	770	11.880	145.8	60	17
723	88.145	147.9	78	17	771	11.040	144.7	60	10
724	89.161	147.9	78	14	772	9.185	144.7	34	23
725	90.105	147.8	78	12	773	7.373	144.7	30	1
726	91.326	147.8	78	8	774	6.644	150.8	10	6
727	92.572	147.7	78	19	775	5.344	145.9	10	14
728	93.537	147.6	78	15	776	3.733	149.1	96	12
729	95.052	147.5	78	8	777	0.969	141.2	10	7
730	96.064	147.5	78	10	778	0.000	180.0	10	51
731	100.062	147.2	78	15	781	21.594	143.6	60	7
732	105.056	147.0	78	13	782	22.635	143.9	60	7
733	110.132	146.4	78	15	783	23.491	144.8	60	11
734	115.518	145.2	78	26	784	24.119	145.0	60	22
736	124.916	143.5	78	30	786	26.308	145.6	60	1
737	129.133	142.6	78	14	787	27.760	146.2	60	0
738	134.626	141.9	78	3	789	29.212	146.5	60	0
739	140.656	142.2	78	-30	790	30.100	147.0	60	24
740	146.062	142.3	78	19	791	31.344	146.5	60	22
741	42.854	143.0	78	14	793	33.284	146.4	60	10
742	44.047	143.2	78	-8	794	34.300	145.8	60	-40
743	45.238	143.4	40	12	795	36.247	144.9	78	14
744	46.434	143.5	78	-37	797	37.434	144.5	78	7
745	47.650	143.7	78	9	798	39.359	144.0	78	1
746	48.845	143.9	78	-16	799	40.388	143.8	78	13
747	50.067	144.0	78	3	800	41.234	142.8	78	9
749	52.436	144.3	40	13					
750	53.524	144.3	40	-13					

Appendix C: SEG-Y Tape Format

Archive Tape Data Format

Archive data tapes are written in SEG Y standard format (Barry et al, 1975). Recording density is 1600 bpi, phase encoded (PE). In order to accomodate seismic refraction data, some minor changes have been made to the tape header fields. A complete list of header fields is provided in the card image portion of the reel identification header, shown below:

C 1	REEL IDENTIFICATION HEADER BYTES :	
C 2	3217 -3218	SAMPLING INTERVAL (MICROSECS).
C 3	3221 -3222	NUMBER OF SAMPLES PER TRACE.
C 4	3225 -3226	DATA SAMPLE FORMAT CODE.
C 5	3255 -3256	MEASUREMENT SYSTEM (1 = METERS; 2 = FEET)
C 6		
C 7		
C 8	TRACE IDENTIFICATION HEADER BYTES :	
C 9	1 - 4	TRACE SEQUENCE NUMBER WITHIN REEL.
C10	5 - 8	TRACE SEQUENCE NUMBER WITHIN REEL.
C11	9 - 12	STATION LOCATION NUMBER.
C12	29 - 30	TRACE ID CODE (1 = SEISMIC DATA).
C13	37 - 40	SHOTPOINT-RECEIVER DISTANCE (M).
C14	41 - 44	STATION ELEVATION (M).
C15	45 - 48	SHOTPOINT ELEVATION (M).
C16	49 - 52	SOURCE DEPTH (M).
C17	69 - 70	SCALAR TO BE APPLIED TO ALL ELEVATIONS.
C18	71 - 72	SCALAR TO BE APPLIED TO ALL COORDINATES.
C19	73 - 76	SHOTPOINT COORDINATE - X.
C20	77 - 80	SHOTPOINT COORDINATE - Y.
C21	81 - 84	RECEIVER COORDINATE - X.
C22	85 - 88	RECEIVER COORDINATE - Y.
C23	89 - 90	COORDINATE UNITS (1 = METERS; 2 = SECONDS OF ARC).
C24	115 - 116	NUMBER OF SAMPLES IN THIS TRACE.
C25	117 - 118	SAMPLE INTERVAL IN MICROSECONDS FOR THIS TRACE.
C26	121 - 122	INSTRUMENT ATTENUATION IN DB.
C27	157 - 158	SHOT TIME - YEAR.
C28	159 - 160	SHOT TIME - DAY OF YEAR.
C29	161 - 162	SHOT TIME - HOUR OF DAY (24 HOUR CLOCK).
C30	163 - 164	SHOT TIME - MINUTE OF HOUR.
C31	165 - 166	SHOT TIME - SECOND OF MINUTE.
C32	167 - 168	TIME BASIS CODE (2 = GMT).
C33	181 - 182	SHOT TIME - MILLISECONDS.
C34	183 - 184	SHOTPOINT LOCATION NUMBER.
C35	185 - 186	RECORDING INSTRUMENT UNIT NUMBER.
C36	191 - 192	DISTANCE WEIGHTING EXPONENT (HUNDREDTHS).
C37	193 - 194	SHOT SEQUENCE NUMBER (SHOT NUMBER).
C38	195 - 196	SHOT SIZE (KG).
C39	197 - 200	SHOTPOINT - STATION AZIMUTH (SEC OF ARC).
C40	201 - 204	TIME OF FIRST POINT MINUS SHOT TIME (MSEC)

The data point format is "32 bit floating point", and the appropriate bytes (3225-3226) of the binary reel id header contain a value of 1. The trace amplitudes have not been adjusted for instrument gain, but the gain correction factor can be estimated from the instrument attenuation value (att) specified in bytes 121-122. To correct for gain, the data should be demeaned and then multiplied by

$$\frac{(att/20)}{10}.$$

The measurement system (bytes 3255-3256 of the binary reel header) is set to 1, meters.

Shotpoint and receiver coordinates are in seconds of arc (byte field 89-90). The coordinate scalar multiplier (bytes 71-72) is set to -100, so the coordinates (bytes 73-88) are in hundredths of a second of arc.

Bytes 157-166 and bytes 181-182 refer to the shot detonation time. The time of the first data sample is found by adding the shot detonation time to the time specified in bytes 201-204.

Since there is no weighting of amplitudes with distance for archive tapes, the distance weighting exponent (bytes 191-192) is not used.

Shot sequence number (bytes 193-194) refers to the order in which shots were fired during the field campaign.

REFERENCE

Barry, K.M., D.A. Cavers, and C.W. Kneale (1975). Recommended Standards for Digital Tape Formats, *Geophysics* 40, 344-352.