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UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

WASATCH FRONT URBAN AREA SEISMIC RESPONSE DATA REPORT

By

K. W. King, W. W. Hays, and P. J. McDermott

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1983

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ABSTRACT

Little strong-motion data exists for seismic motions in the Intermountain seismic belt. Measurements of low-strain ground motions at 82 different locations in the urban areas of the Intermountain seismic belt were made to investigate the variations of ground-motion characteristics of a seismic data base for ground-motion hazards study. The low-strain ground-motion data used in this report were measured from underground nuclear testing at the Nevada Test Site, Nevada.

The ground-motion data seismograms, derived spectra, and spectral ratios of alluvium to rock sites are presented in this report. The average spectral amplification on soils observed using induced horizontal ground motions varied from a factor of 1.2-18.3.

INTRODUCTION

A single strong-motion seismogram recorded in Logan, Utah, from the 1962 Cache Valley earthquake is the only earthquake-induced, strong-motion accelerogram available from the Intermountain seismic belt (ISB). Empirical seismic data are needed from the urban areas located in the ISB to facilitate ground shaking hazard investigations and future urban planning. Ground motions induced by distance sources were recorded at selected sites in the major urban areas of the Wasatch urban corridor. The data were used to derive seismic transfer functions between the sites underlain by unconsolidated sediment and sites underlain by bedrock to help define frequency-dependent ground response.

This report presents the seismic time histories, site response spectra and the site transfer functions derived from seismic data recorded at 78 different locations in urban areas along the Wasatch front. The data are used to help define the frequency-dependent ground response of urban areas in the ISB.

Portable broad-band seismic systems were used to record seismic data at sites chosen to include specific types of geologic ground conditions and (or) at urban areas of concern. The seismic systems recorded velocity ground motions that were induced by underground nuclear tests at the Nevada Test Site, Nev.; an earthquake located approximately 50 kilometers east of Salt Lake City, Utah; an explosion at the Kennecott mine at Bingham, Utah; and local ambient seismic background. A general map of the source areas is shown in figure 1.

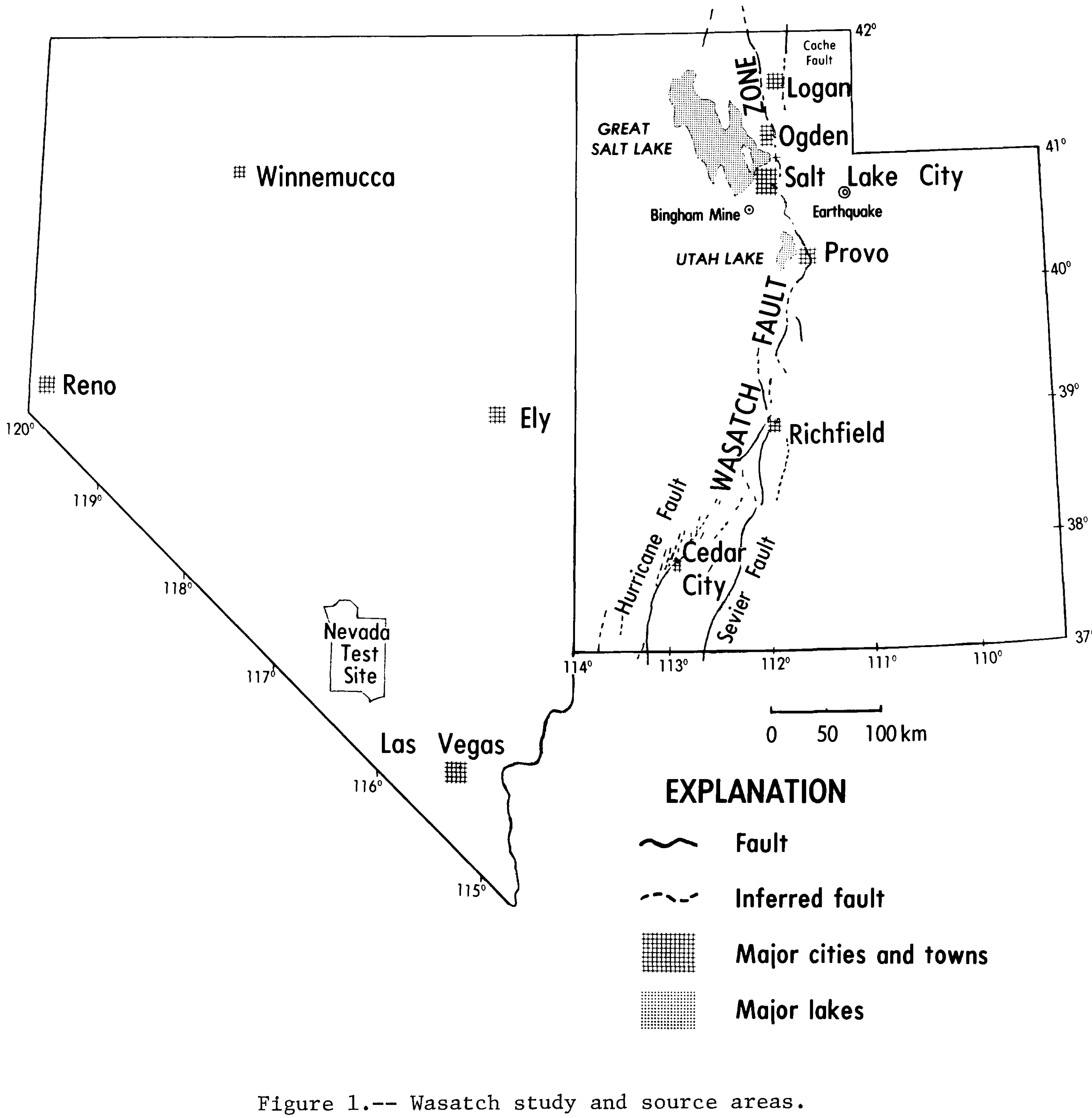


Figure 1.-- Wasatch study and source areas.

One nuclear event was recorded at 5 separate sites at Logan, Utah, and two nuclear events were recorded at 13 sites at Ogden, Utah (fig. 2). Ground motions induced by seven different nuclear tests, the earthquake, and the quarry explosion were recorded at 40 separate locations in the Salt Lake City area (fig. 3). One nuclear event was recorded at 11 sites at Provo, Utah, and one nuclear event was recorded at 9 sites at Cedar City, Utah (fig. 4). The station coordinates and addresses are listed in table 1, and the size and locations of the seismic sources are listed in table 2.

DATA COLLECTION AND PROCESSING

The seismic data presented in this report were obtained from recordings by portable, three-channel, L-7 seismic systems. The L-7 seismic system is an accurately calibrated, portable seismograph system that records on analog magnetic tape (King, 1969). The system has a maximum absolute sensitivity of 6400 volts/centimeter/second of ground velocity and a flat (± 2 percent) response to ground velocity over a frequency range of 0.125 to 34 Hz. Each recording site was occupied by an L-7 system that used a tripartite seismometer array oriented orthogonally with the radial component oriented to true north.

The event data, along with 20-30 seconds of pre-event site ambient seismic background, were read from the magnetic tape and filtered by a 40 Hz, 24 db/octave high-pass filter. Non-filtered time histories of the data were recorded on permanent graphs for inspection and preliminary analysis (appendix A).

The horizontal component data were digitized at 100 samples per second by an analog to a digital hybrid computer. The digitized data were processed by a Multics computer system to derive response spectra by using a pseudo-relative velocity algorithm (PSRV) (Park and Hays, 1977). The PSRV spectra is approximately equal to a smoothed Fourier amplitude spectrum when the damping is small (Jenschke, 1970). This investigation used 5 percent damped response spectra.

Normalization of the response spectra for the differences in distance and azimuth from the recording sites to the energy source was not considered necessary. The response spectra amplitude difference due to the slight distance differences (<5 percent) and azimuthal differences ($<1^\circ$) between the individual sites to the induced energy source account for an attenuation error of less than 1 percent when the response amplitudes are compared by using a PSRV prediction equation (Environment Research Corporation, 1974).

Seismic response spectra were derived from 20 to 30 seconds of pre-event recordings. Spectra peak amplitudes between the periods of 0.2 and 6.0 seconds from the induced ground-motion events were compared to ambient spectra peak amplitudes. Event data which exhibited an event signal to background signal ratio lower than two or contained electrical spikes were eliminated from further analysis. Data with a period less than 0.2 seconds usually had a signal to noise ratio of less than two and were also eliminated. Fifteen seismic event records from Salt Lake City locations, four from Provo locations, three from Cedar City locations, and one from Logan locations were

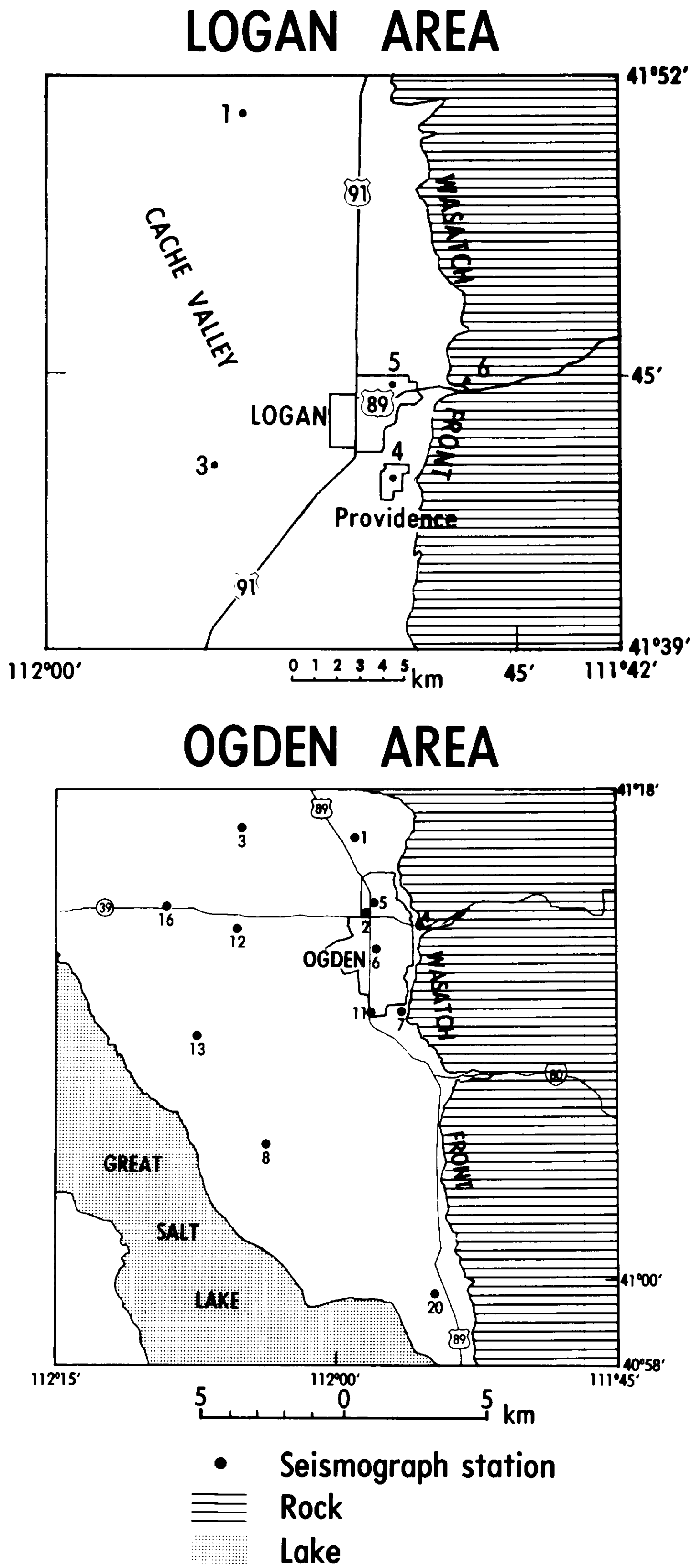
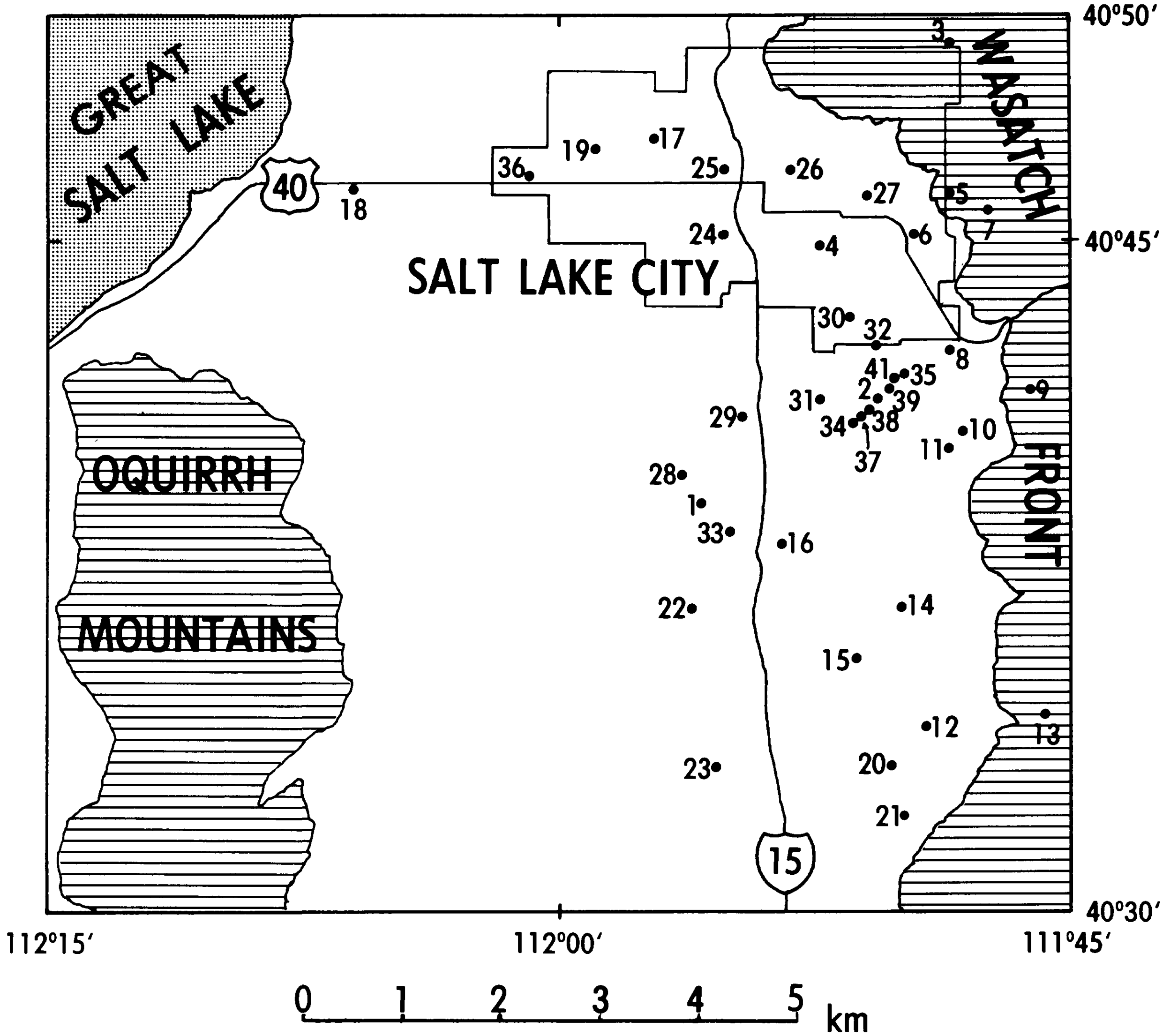


Figure 2.--Station locations in the Logan and Ogden areas.

SALT LAKE CITY AREA



Event	Stations
Banon	1,2,3,4,5,6,7,8,9,10,11,13,14,15,16,17,18,19
Bulkhead	1,4,7,13,15,20,21,22
Draughts	2,7,28,29,30,31,32,33,34,35, 36
Marsilly	1,4,6,7,12,15,20,21,22,23
Rummy	2,7,28,29,30,31,32,34,35, 36
Sandreef	13,37,38,39
Scantling	3,24,25,26,27
Earthquake	2,5,19,34,37,38,39,41
Quarry	2,5,9,19,34,35,37,38,39,41

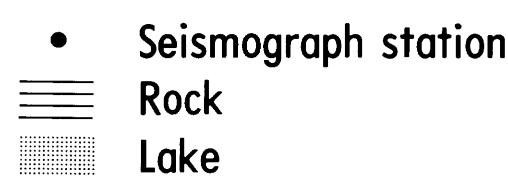


Figure 3.--Station locations in the Salt Lake City area.

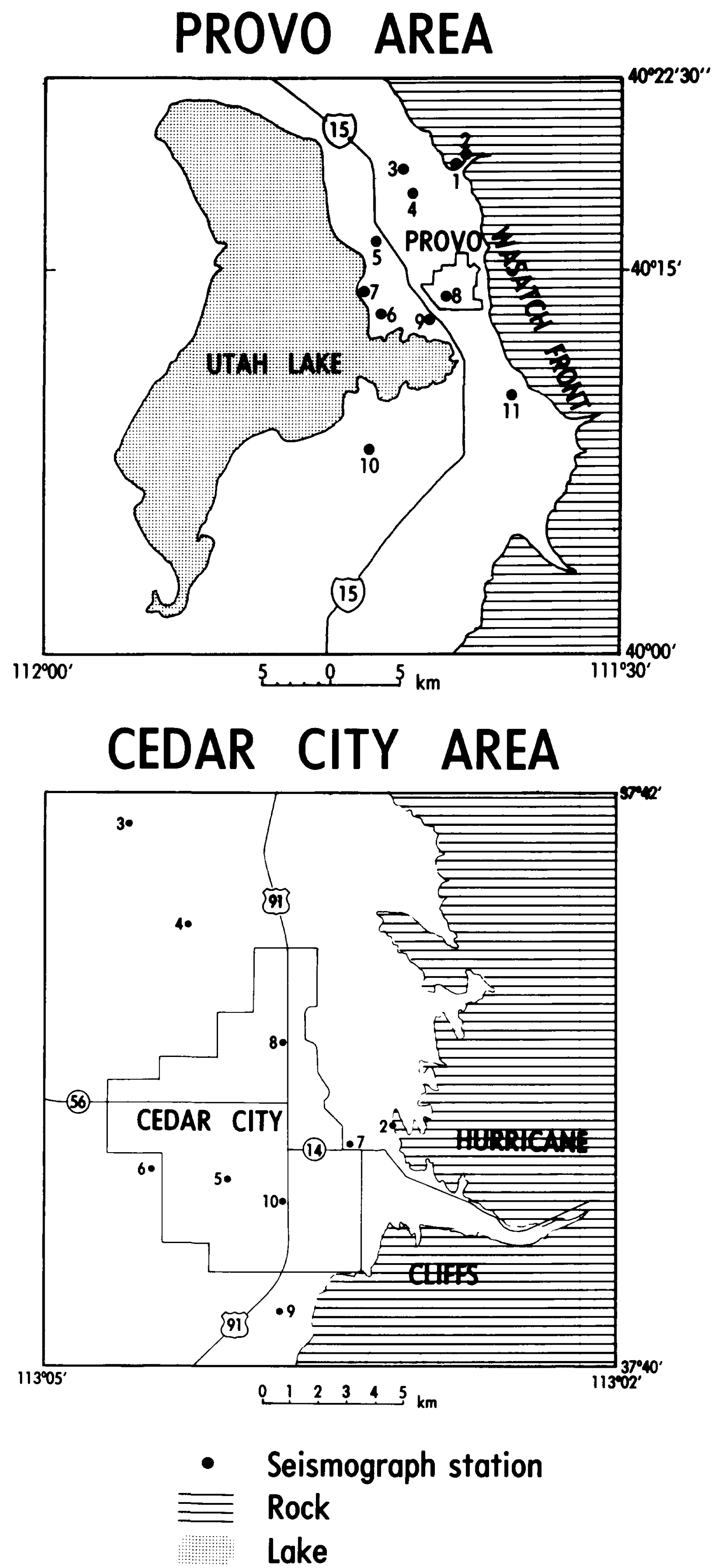


Figure 4.--Station locations in the Provo and Cedar City areas.

Table 1.--Locations of seismic recording stations

Station	Location	Lat N. (degrees)	Long W. (degrees)
	Logan Area		
1	Logan Airport	41.846	111.894
3	Young Ward	41.708	111.909
4	90 S. Main, Providence	41.707	111.816
5	Utah State University	41.745	111.813
[1]6	Logan Canyon	41.741	111.786
	Ogden Area		
1	2095 N 100 E	41.288	111.983
2	1049 Kiesel	41.246	111.974
3	4376 W 2350 N	41.303	112.086
[1]4	Rainbow Bowling Lanes	41.236	111.928
5	Rogers Poultry Farm	41.253	111.969
6	Weber Main Library	41.221	111.964
7	4463 Forrest Green Dr.	41.180	111.942
8	Syracuse Fire Dept.	41.092	112.055
11	4725 S 300 W	41.180	111.970
12	2550 S 4476 W; Taylor	41.235	112.087
13	Hooper Post Office	41.164	112.123
16	6675 900 S; West Warren	41.266	112.152
20	100 N 844 W; Farmington	39.989	111.912
	Salt Lake City Area		
1	West Bank of Jordan River	40.652	111.929
2	1663 Mt. View	40.639	111.844
[1]3	Rotary Park	40.826	111.801
4	Liberty Park	40.749	111.870
[1]5	Georges Hollow, Ft. Douglas	40.768	111.809
6	Utah Geol. & Min. Survey	40.755	111.827
[1]7	3100 Kennedy Dr.	40.757	111.791
8	So. Side of Parleys Creek	40.708	111.809
[1]9	Mill Creek Canyon	40.692	111.770
11	Castro Springs	40.673	111.809
10	4500 South Street	40.679	111.801

[1]Sites underlain by rock; other sites underlain by unconsolidated sediments.

Table 1.--Locations of seismic recording stations--Continued

Station	Location	Lat N. (degrees)	Long W. (degrees)
	Salt Lake City Area		
12	North Bank of Dry Creek	40.569	111.821
[1]13	Little Cottonwood Canyon	40.573	111.763
14	1932 Parkridge	40.616	111.839
15	Sandy City Fire Station	40.580	111.872
16	Murray City	40.639	111.892
17	Salt Lake Int'l. Airport	40.785	111.955
18	Saltair	40.769	112.101
19	SLC Airport-Fire Station	40.783	111.979
20	Hidden Valley G. C.	40.556	111.839
21	12000 S 1700 E	40.536	111.830
22	Bateman Dairy Farm	40.612	111.927
23	10875 S 12 W	40.554	111.922
24	North Jordan Park	40.752	111.918
25	SLC Fire Station #7	40.776	111.920
26	Capitol Building	40.777	111.887
27	University of Utah	40.766	111.847
28	Taylorsville	40.663	111.949
29	4060 S 725 W	40.683	111.910
30	Sugar House Library	40.721	111.866
31	3702 S 645 E	40.691	111.872
32	2838 Imperial	40.709	111.843
33	6100 S 700 W	40.641	111.917
34	4130 S 1221 E	40.682	111.856
35	2270 E. Evergreen St.	40.699	111.832
36	1560 Industrial Rd.	40.773	112.011
37	4036 So. Golden Cir.	40.684	111.852
38	3915 Brooklane Dr.	40.687	111.848
39	1759 Mt. View	40.691	111.841
41	1964 E. Evergreen St.	40.697	111.832
	Provo Area		
1	Olmstead Office Bldg.	40.315	111.655
[1]2	Olmstead	40.326	111.639
3	Orem Fire Station	40.314	111.695
4	Orem City Offices	40.299	111.693
5	Cherry Hill Farm	40.264	111.717

[1]Sites underlain by rock; other sites underlain by unconsolidated sediments.

Table 1.--Locations of seismic recording stations--Continued

Station	Location	Lat N. (degrees)	Long W. (degrees)
	Provo Area		
6	Provo Airport	40.221	111.718
7	Boat House, Utah Lake	40.236	111.736
8	Provo City offices	40.238	111.671
9	K-96 Radio Station	40.213	111.671
10	Youd Farm	40.133	111.730
11	Springville Fire Station	40.167	111.610
	Cedar City Area		
1	Three Peaks	37.717	113.225
[1]2	Coal Canyon	37.679	113.050
3	Rush Lake	37.864	113.064
4	Stevensville	37.786	113.092
5	College of Southern Utah	37.675	113.067
6	SUSC Football Field	37.676	113.077
7	Highway 14 Trailer Park	37.678	113.055
8	Cemetery	37.689	113.063
9	Settling Pond	37.656	113.068
10	Imperial 400 Motel	37.673	113.061

[1]Sites underlain by rock; other sites underlain by unconsolidated sediments.

Table 2.--Date, coordinates, and M_b magnitude of the seismic sources

Event	Date	Lat N. (degrees)	Long W. (degrees)	Size M_b
		Logan Array		
Sheepshead	26 Sept 79	37.228	116.364	5.5
		Ogden Array		
Lowball	12 July 78	37.079	116.044	5.5
Panir	31 Aug 78	37.276	116.357	5.6
		Salt Lake City Array		
Banon	26 Aug 76	37.126	116.068	5.4
Bulkhead	27 Apr 77	37.095	116.028	5.5
Draughts	27 Sept 78	37.080	116.051	4.8
Marsilly	5 Apr 77	37.120	116.062	5.7
Rummy	9 Sept 78	37.073	116.019	5.7
Sandreef	9 Nov 77	37.072	116.050	5.8
Scantling	19 Aug 77	37.110	116.054	5.4
Earthquake	30 Jan 75	39.270	108.650	3.7
Quarry	30 Jan 75	40.520	112.150	*
		Provo Array		
Reblochon	23 Feb 78	37.124	116.064	5.3
		Cedar City Array		
Burzet	3 Aug 79	37.084	116.069	<5

*No magnitude derived, event was equivalent to 10 tons of dynamite.

eliminated from the data set because of seismic or electrical noise. Of the 148 seismic records made, 125 were selected for further analysis.

Several locations in the Ogden and Salt Lake City areas were reoccupied to record seismic data from different events. These data were used to establish a base comparison of spectra amplitudes. The Salt Lake City seismic location number 7, which is underlain by bedrock, was reoccupied and recorded for five different events. Salt Lake City seismic location number 2, which is underlain by deep unconsolidated sediments, was reoccupied and recorded three different nuclear events. The comparison of the spectra indicates a good agreement in the general shape of the spectra (fig. 5). The difference in amplitude is mainly attributed to the difference in source magnitude.

The response spectra were used to derive site transfer functions from the sites located on rock to the sites underlain by unconsolidated sediments. The site transfer function (STF) was calculated by the formula of:

$$STF(T) = \frac{Sa(T)}{Sr(T)}$$

where T = period in seconds, Sa = spectra of site underlain by unconsolidated sediments, and Sr = spectra of site underlain by rock. The method for deriving this transfer function is discussed by Rogers and others (1979). The site transfer function has suggested a relation between the derived spectra ratio and parameters of the unconsolidated sediments (Borcherdt and others, 1975; Hays, 1978; Rogers and others, 1979). The site transfer functions derived from nuclear explosion-induced ground motions have shown to be in reasonable agreement with site transfer functions derived from earthquake-induced ground motions (Rogers and Hays, 1978). The site transfer functions from this study were used to define the frequency-dependent ground response of pertinent urban areas along the Wasatch front. The response spectra are shown in appendix B. The site transfer functions are shown in appendix C. An enlarged and clearly defined typical example of a nuclear event time history, a response spectra, and a site transfer function is shown in figure 6. This figure allows close inspection of units for the data.

Response spectra were derived from the pre-event seismic background data for the sites underlain by rock and selected sites underlain by unconsolidated sediments that are in areas of high ambient seismic noise. The spectra derived from the background data were used to calculate the rock to unconsolidated sediment transfer functions and were compared to the spectra similarly derived from the ground-motion data from the nuclear explosion inputs (figs. 7, 8, 9, 10).

SPECTRA COMPARISON

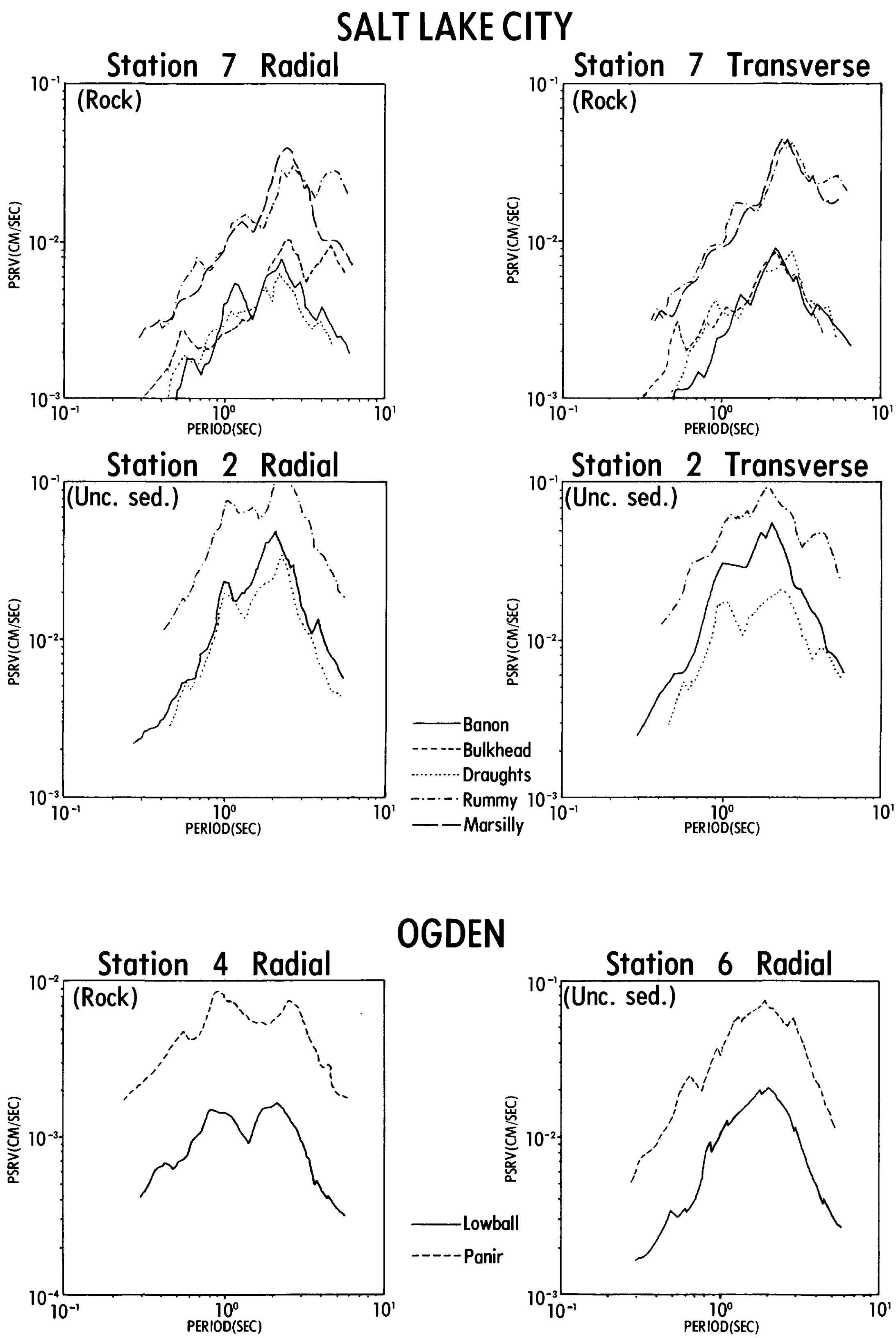
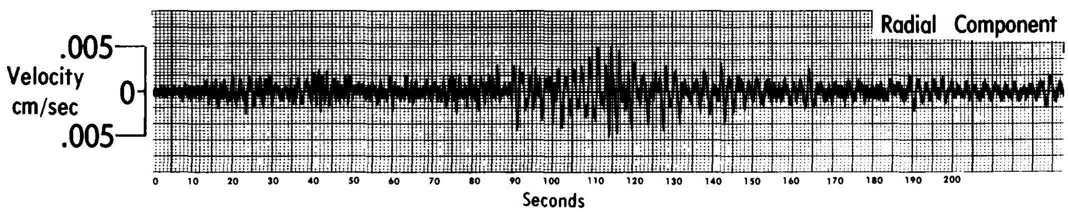
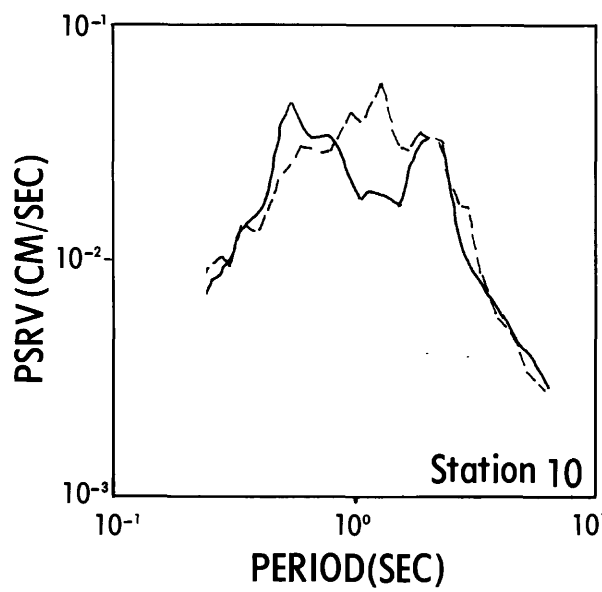


Figure 5.--Spectra comparison.

Example of a time history from Appendix A



Example of a resonse spectra from Appendix B



Example of a site transfer function fom Appendix C

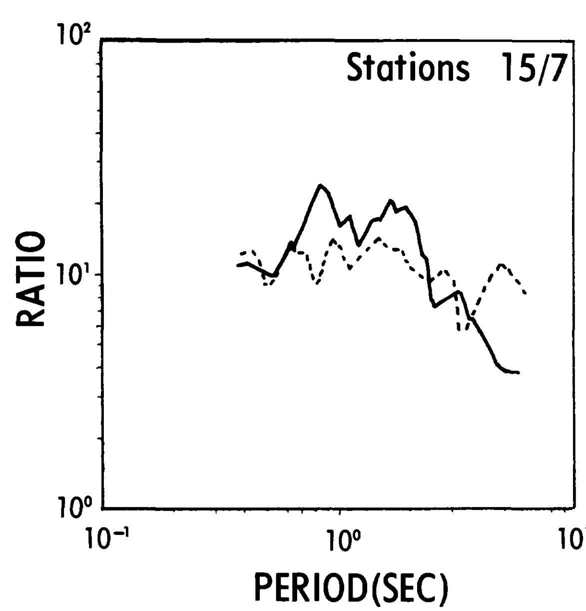


Figure 6.--Examples of data appearing in the appendices.

LOGAN SEISMIC BACKGROUND STUDY

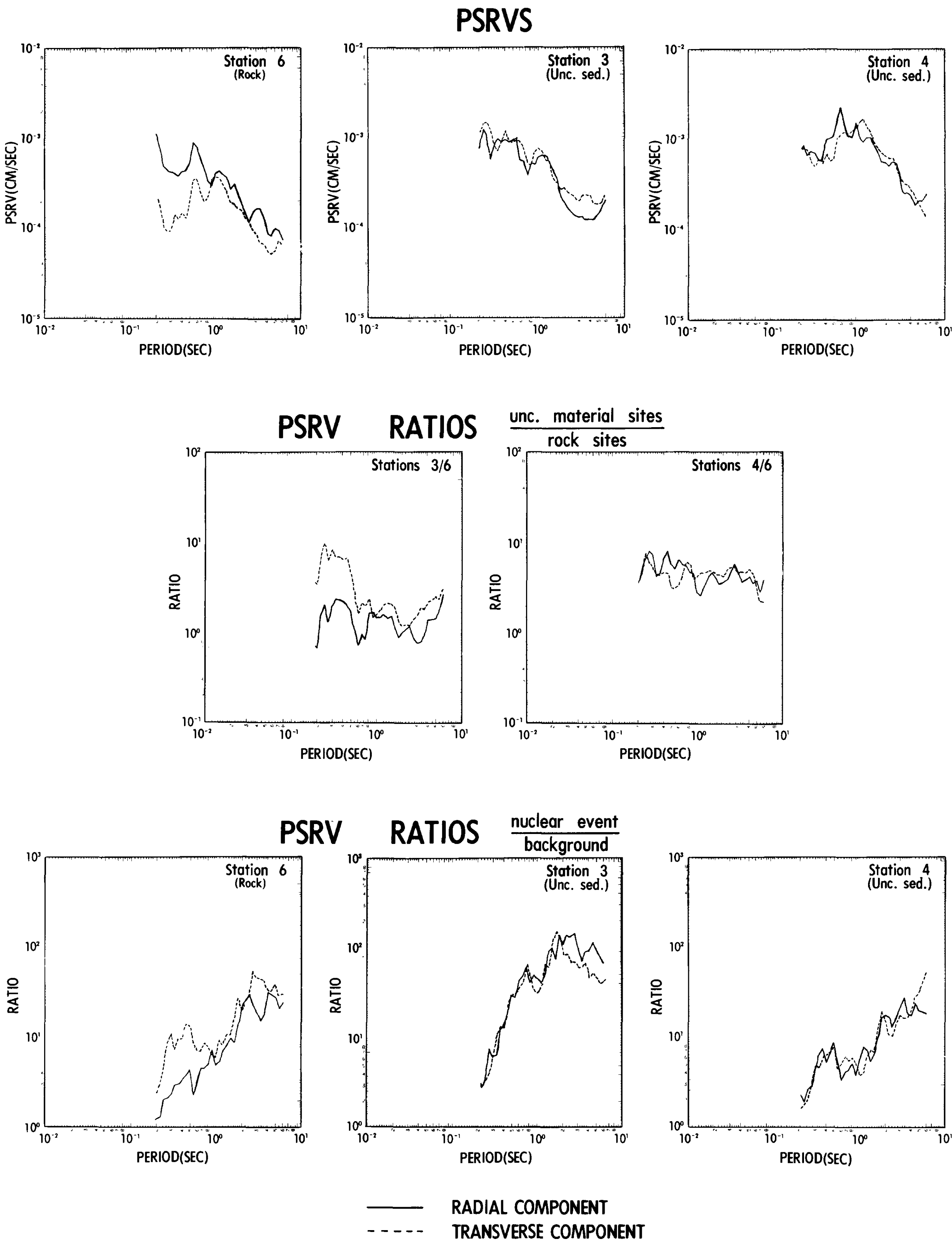


Figure 7.--Seismic background study for Logan.

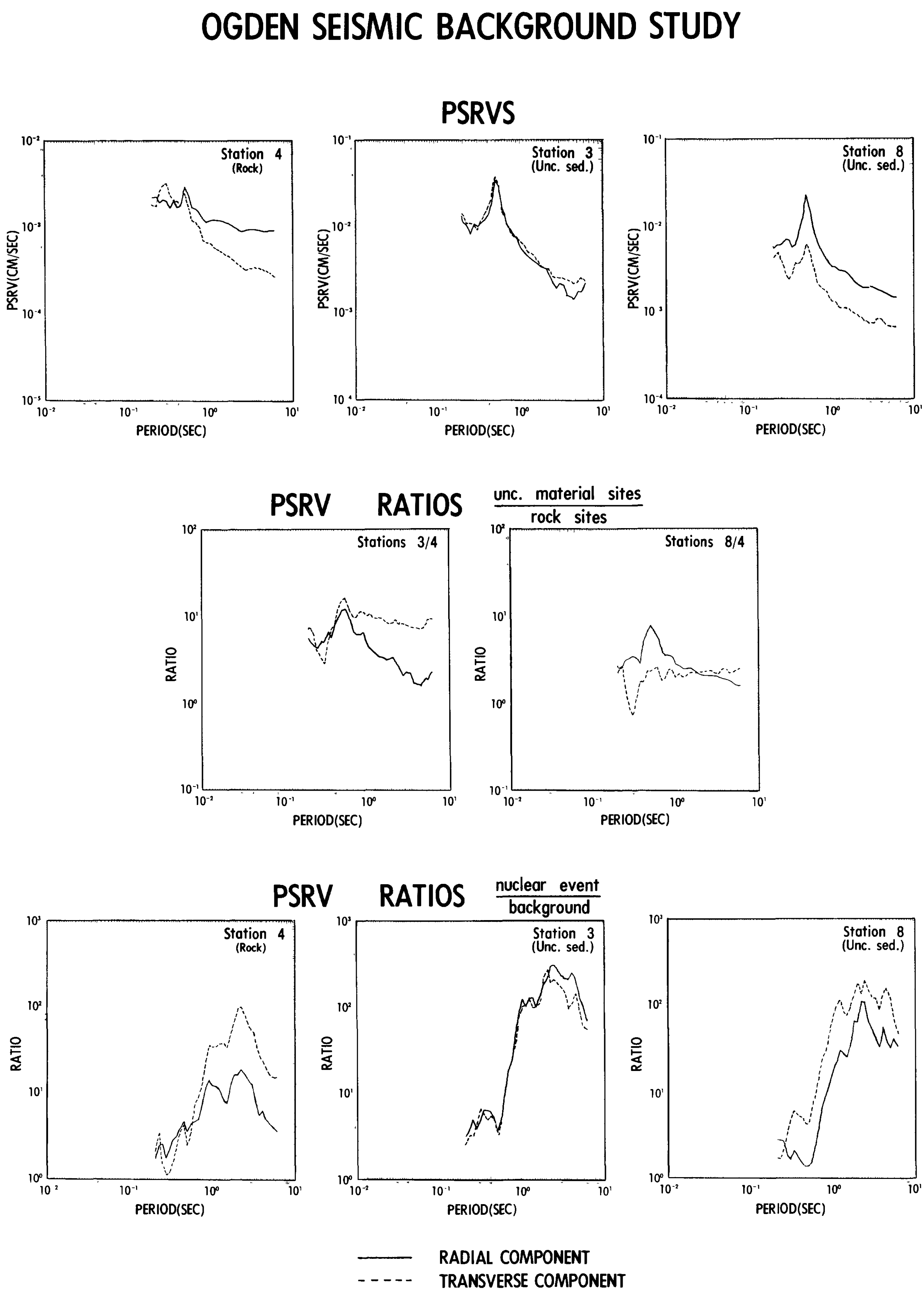


Figure 8.--Seismic background study for Ogden.

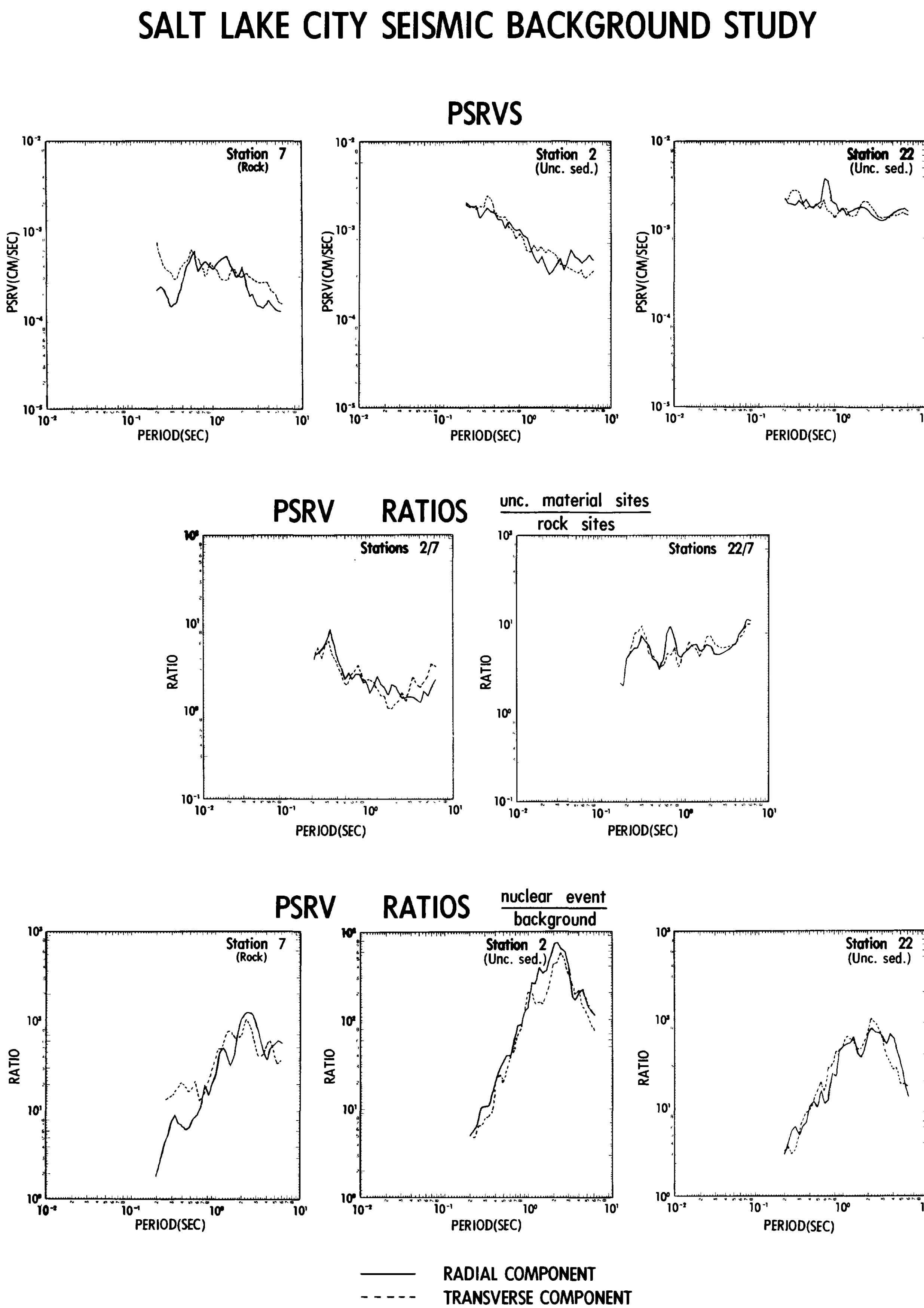


Figure 9.--Seismic background study for Salt Lake City.

CEDAR CITY SEISMIC BACKGROUND STUDY

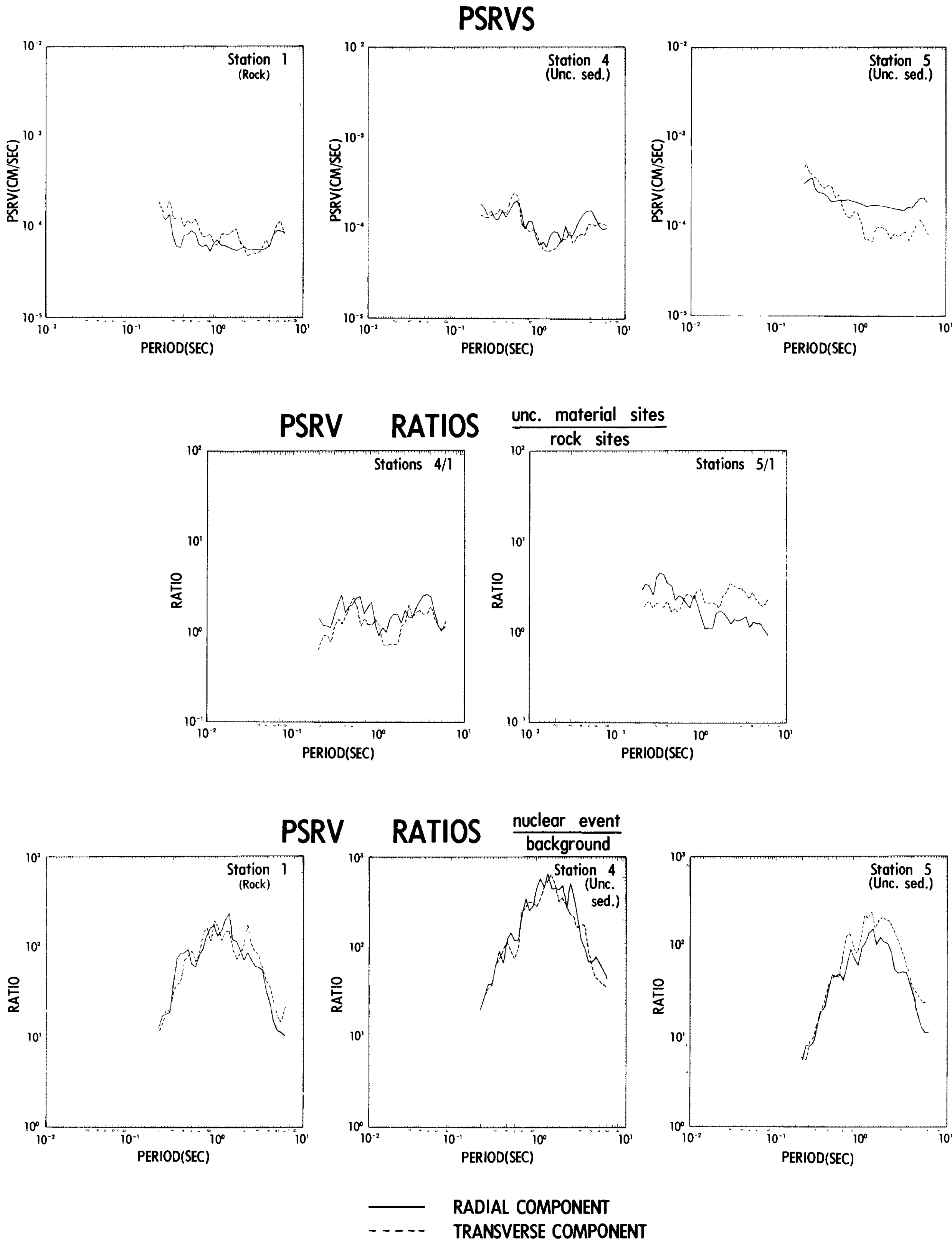


Figure 10.--Seismic background study for Cedar City.

The spectral comparisons were made by:

$$Sc(T) = \frac{Sn(T)}{Sb(T)}$$

where T = period in seconds, Sn = spectra derived from nuclear event induced ground motion, Sb = spectra derived from ambient seismic background, and Sc = spectra comparison. An Sc number at or near 1.0 would indicate that site response spectra could be derived from ambient background seismic ground-motion data as adequately as from induced low strain-type seismic ground-motion data.

CONCLUSIONS

The comparison of the spectra derived from the ambient background ground motion and the spectra derived from the nuclear-event-induced ground motion at periods between 0.2 second and 6.0 seconds indicate that the maximum ground response frequencies are more prominent from the induced ground motion. The ground motion periods shorter than 0.2 second show little difference between the background and the induced ground motion, which is due to attenuation of those frequencies from the more distant induced ground motion. Similar results were found by Gibbs and Borcherdt (1974) in their study of the San Francisco Bay region.

The alluvium transfer functions derived from nuclear-event-induced ground motions show that the sites underlain by unconsolidated sediments have higher spectral amplitudes by factors ranging between 1.3 and 18.2. The response periods of most general concern are those between 0.2 and 0.7 second because ground motions in this range predominantly influence structures 2-10 stories high. The peak spectral response amplification factor for the sites underlain by unconsolidated sediments to the site underlain by rock in the period band of 0.2 to 0.7 second for the Logan, Utah, area is 8.8; for the Ogden, Utah, area is 4.5; for the Salt Lake City, Utah, area is 10.8; for the Provo, Utah, area is 8.1; and for the Cedar City, Utah, area is 6.5. The transfer function factors will be used to construct a contour map showing areas of similar relative ground motion response and to make a correlation with the site/soil parameters. The maps and correlations will be presented in a future report.

ACKNOWLEDGMENTS

We appreciate the support the Nevada Operations of the U.S. Department of Energy gave in providing the seismograph systems that made this study possible. The fieldwork was accomplished by Gene Sembera, Walter Jungblut, and Joe Glotzie. Robert Parks and Duane Dobbs were responsible for the basic analog to digital computer data conversion. Al Rogers gave important support in the data reduction.

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APPENDIX A

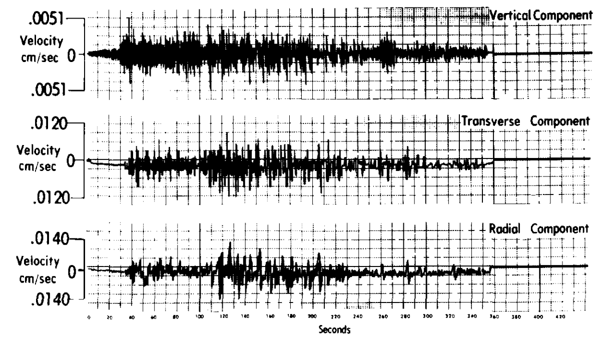
Event time histories by recording area.

TIME HISTORIES

Logan

Event: Sheepshead

Station 1



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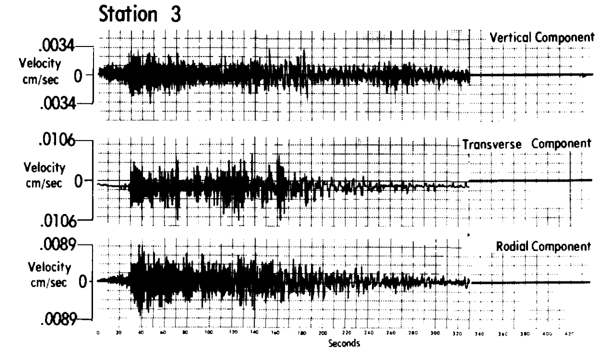

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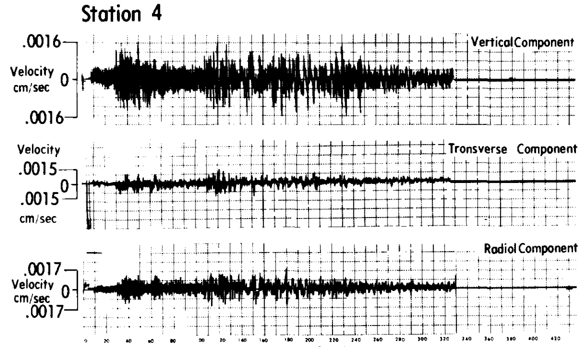

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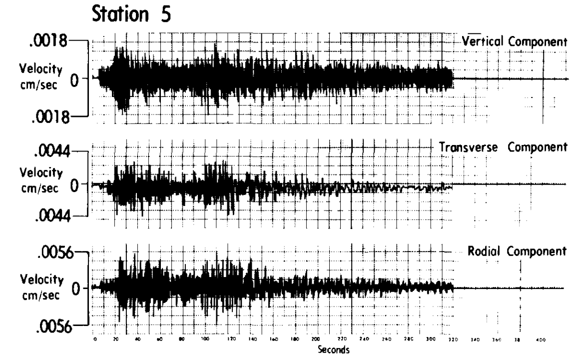

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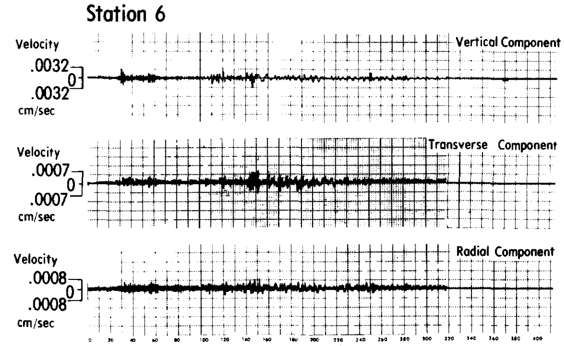
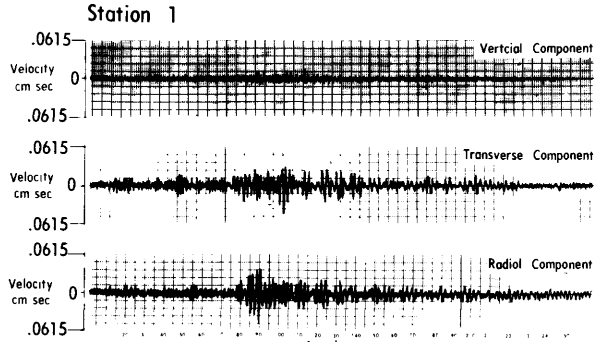


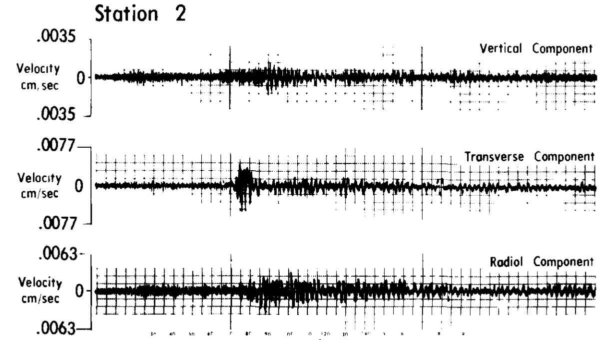
Ogden

Event: Lowball

Station 1



Station 2

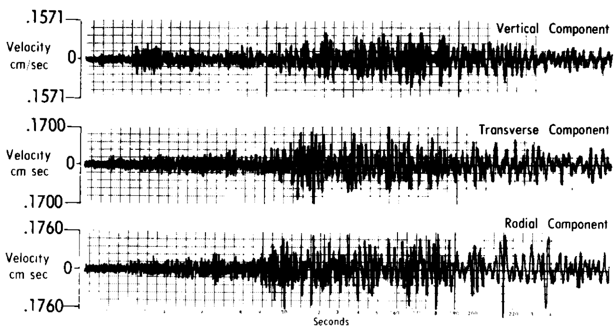


TIME HISTORIES

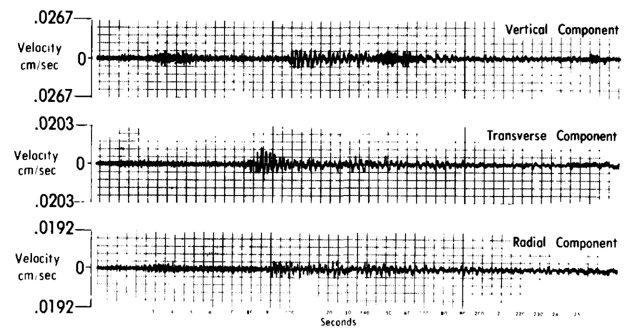
Ogden

Event: Lowball

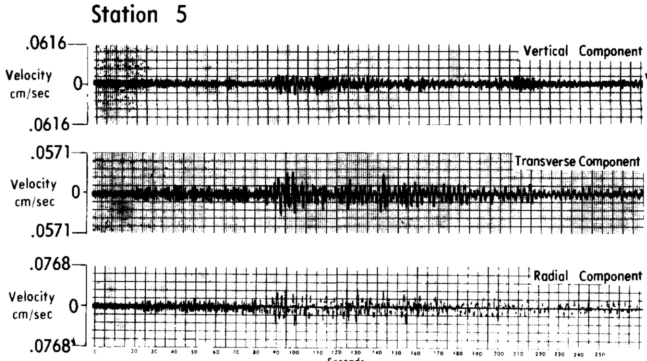
Station 3



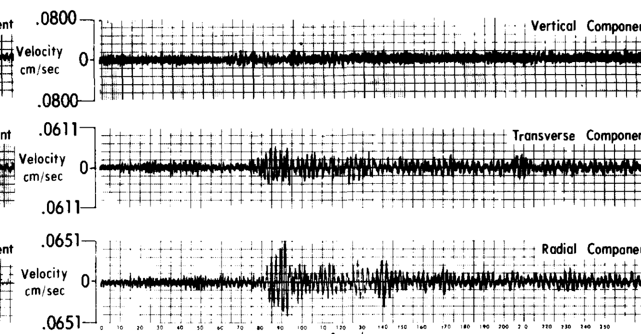
Station 4



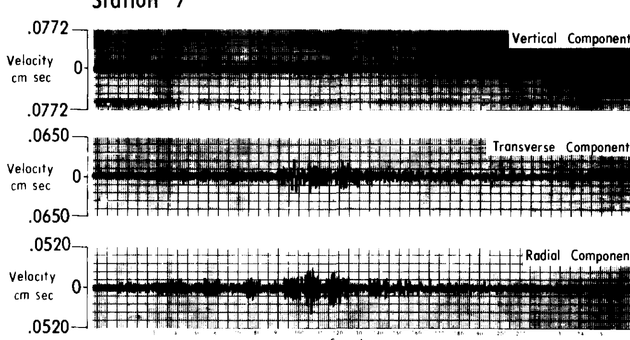
Station 5



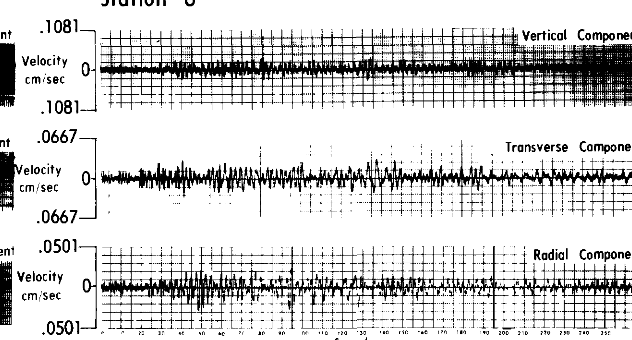
Station 6



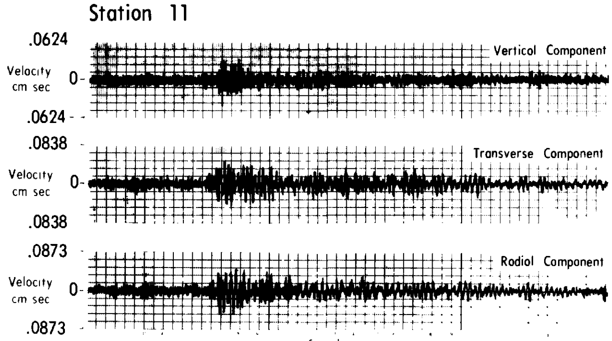
Station 7



Station 8



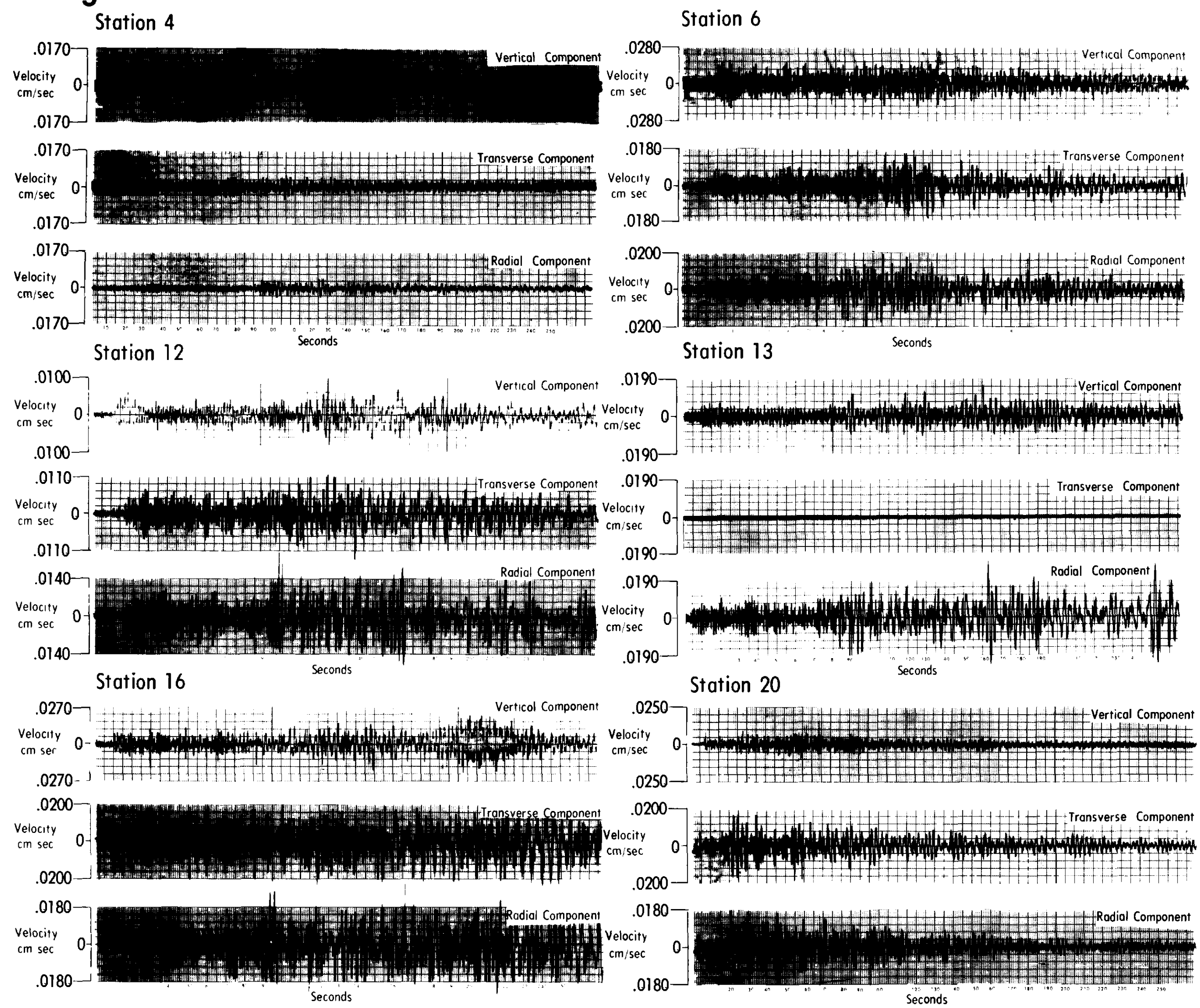
Station 11



TIME HISTORIES

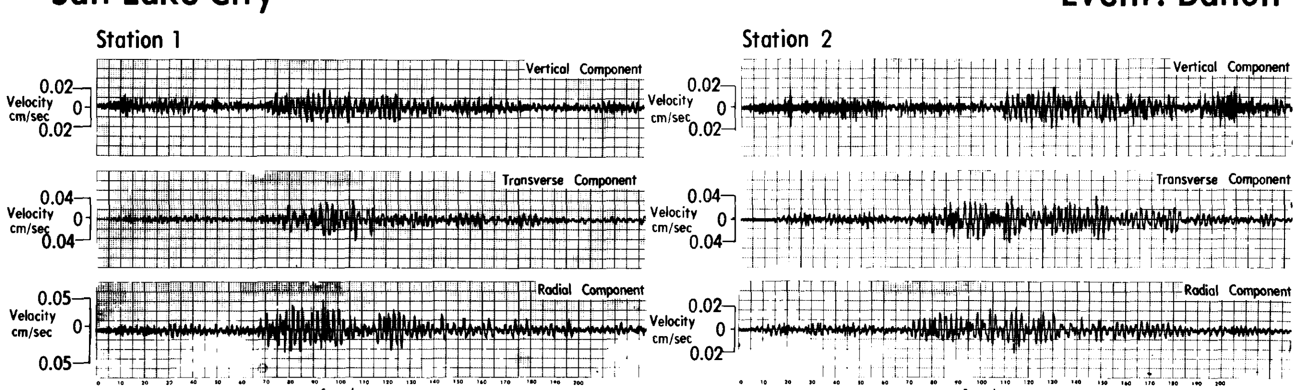
Ogden

Event: Panir



Salt Lake City

Event: Banon

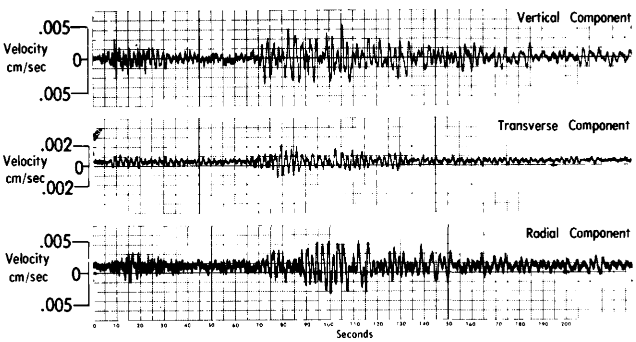


TIME HISTORIES

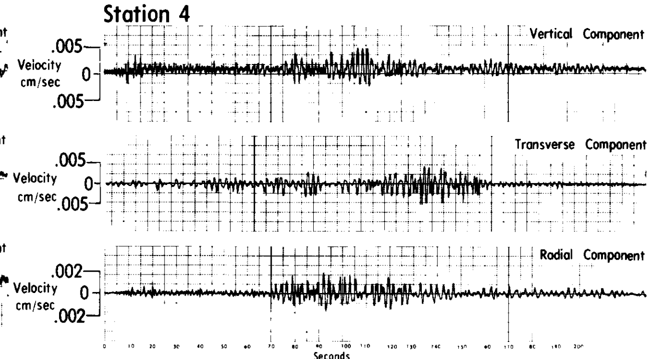
Salt Lake City

Event: Banon

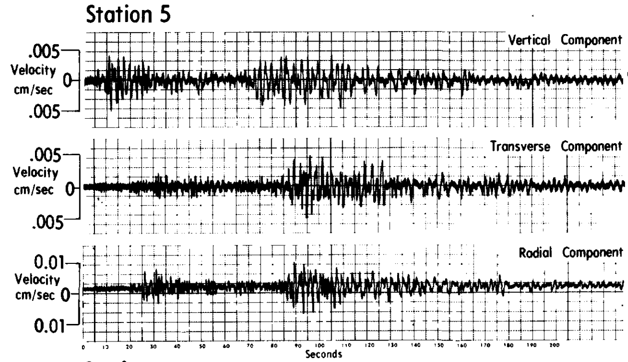
Station 3



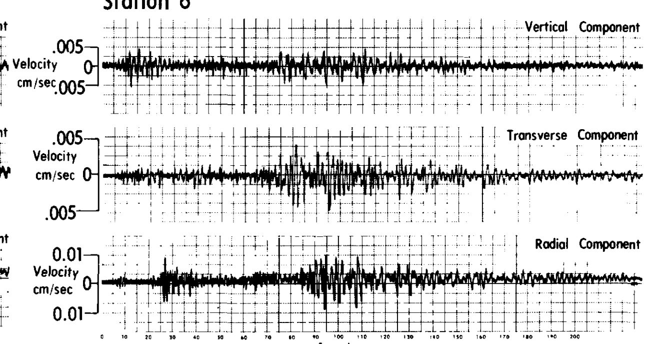
Station 4



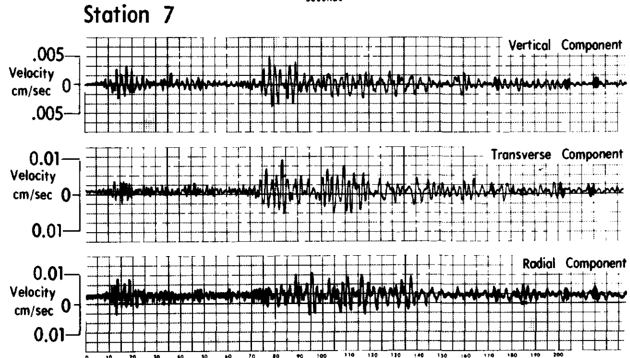
Station 5



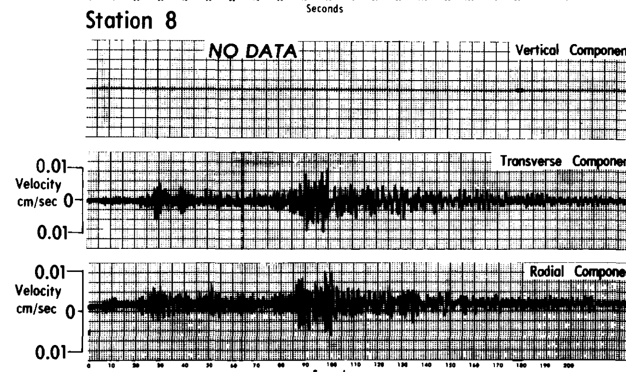
Station 6



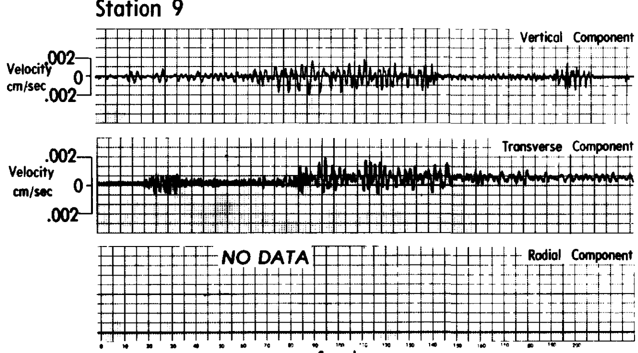
Station 7



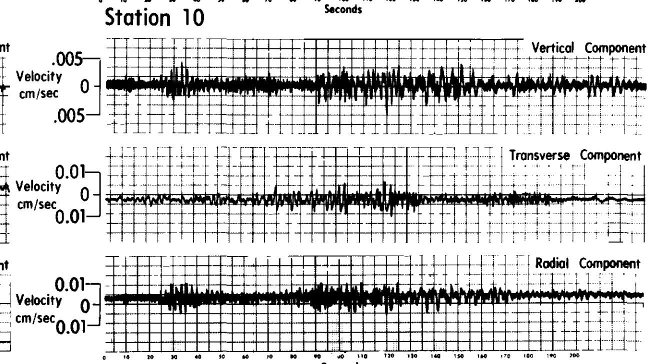
Station 8



Station 9



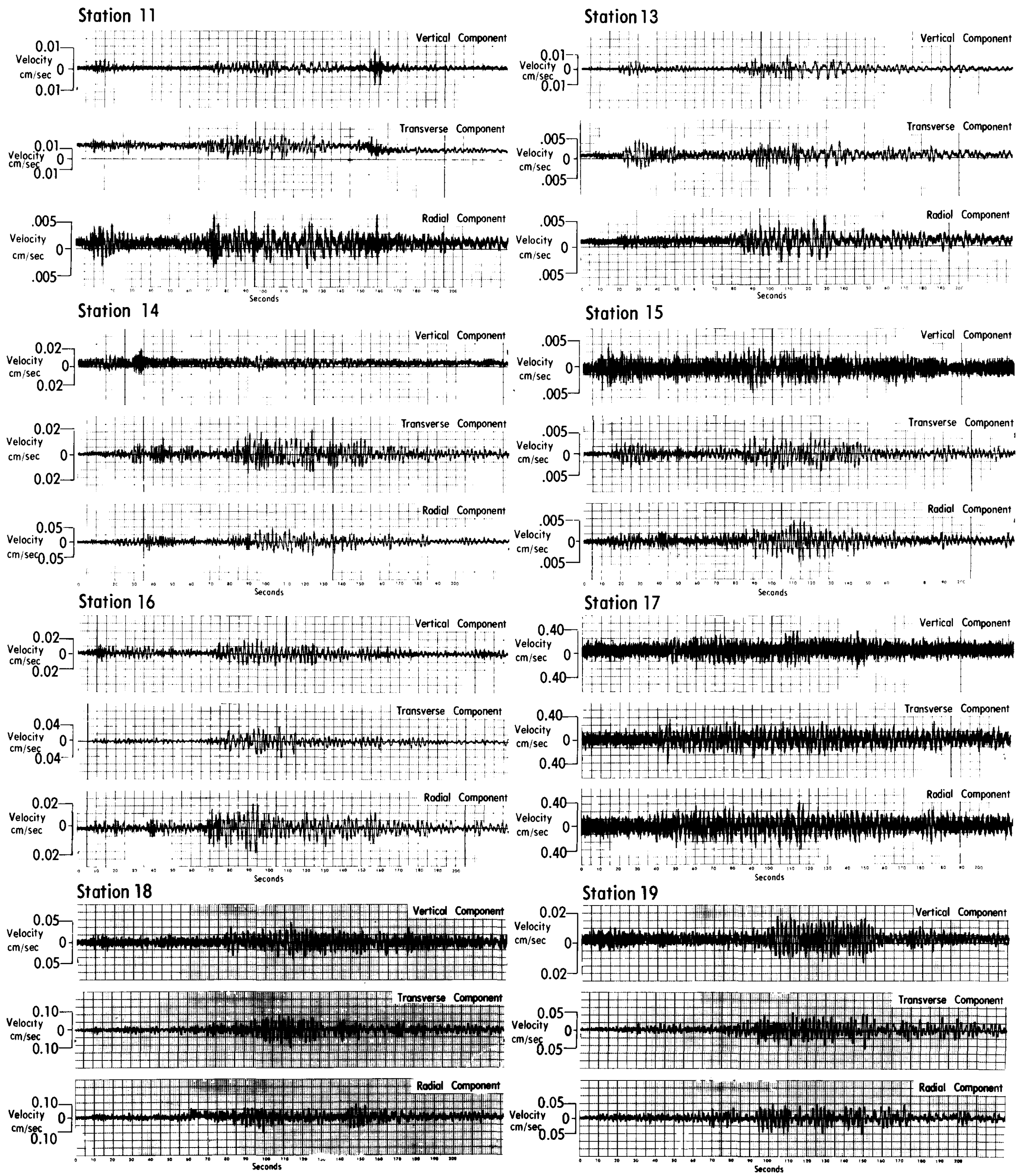
Station 10



TIME HISTORIES

Salt Lake City

Event: Banon

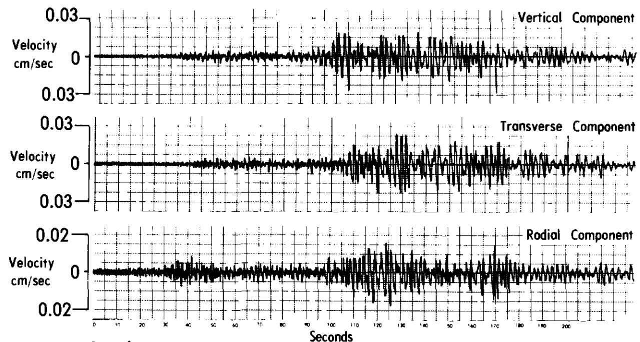


TIME HISTORIES

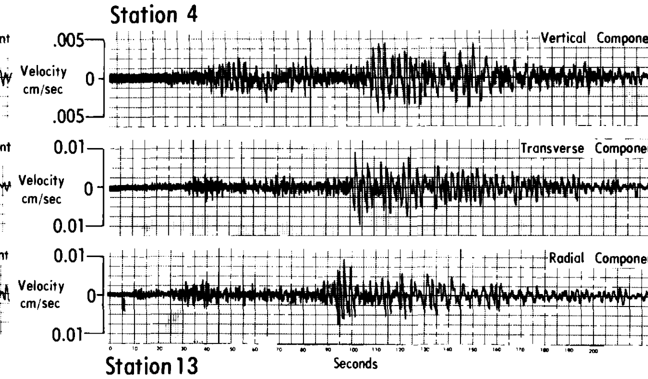
Salt Lake City

Event: Bulkhead

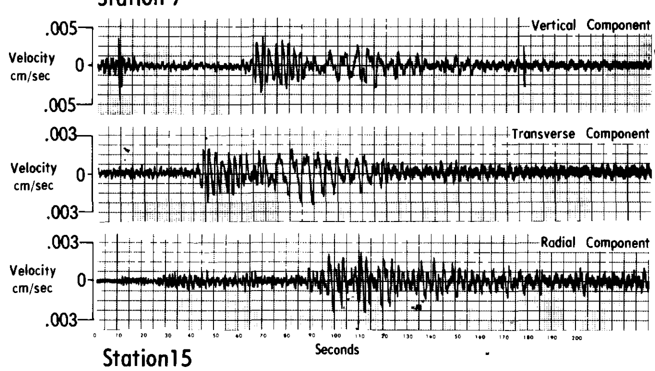
Station 1



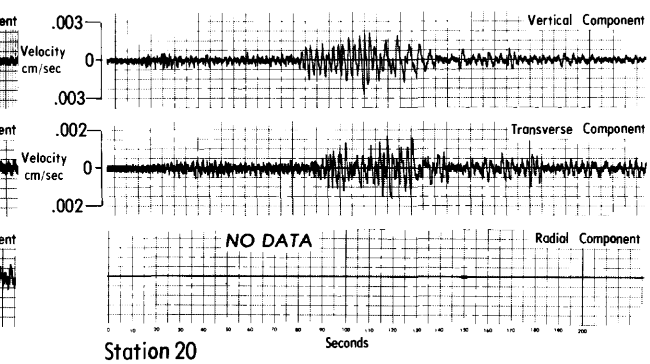
Station 4



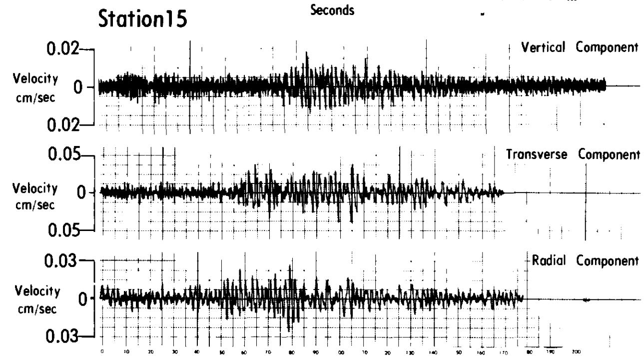
Station 7



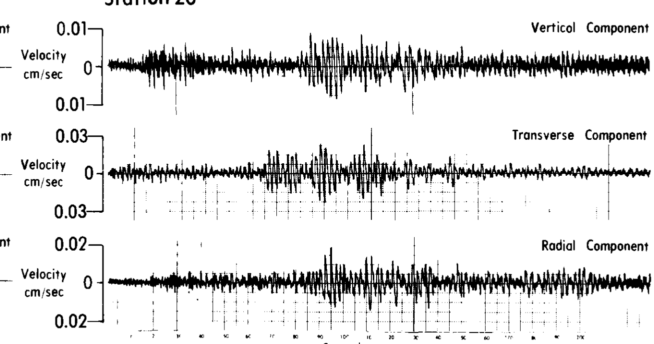
Station 13



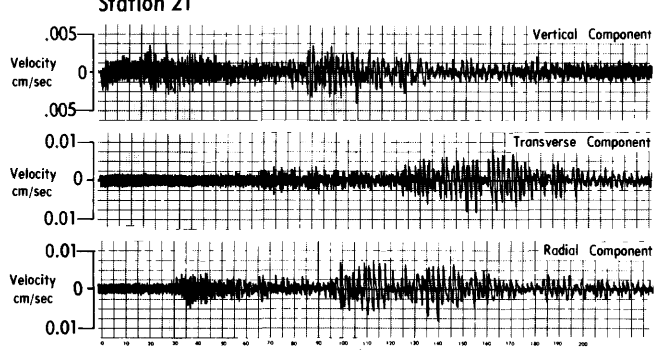
Station 15



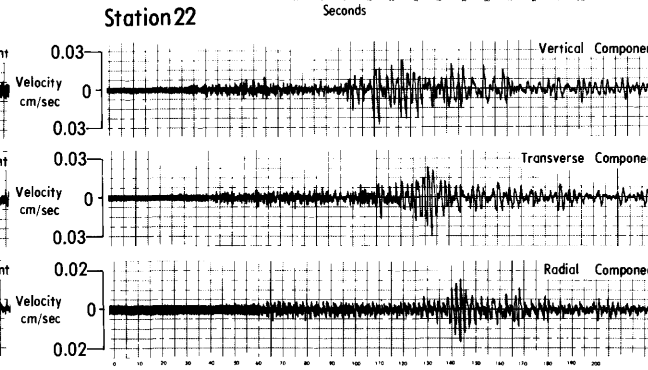
Station 20



Station 21



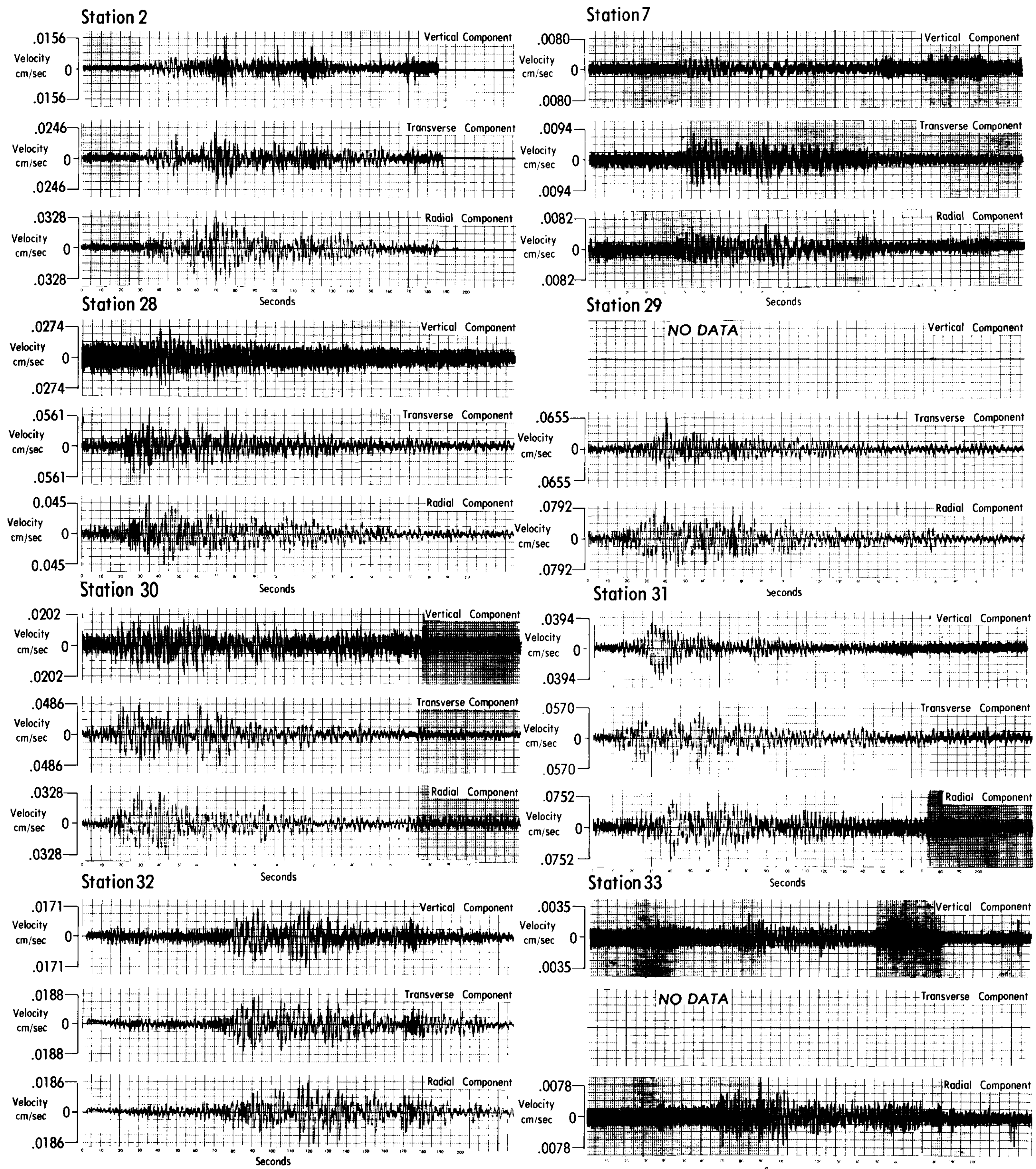
Station 22



TIME HISTORIES

Salt Lake City

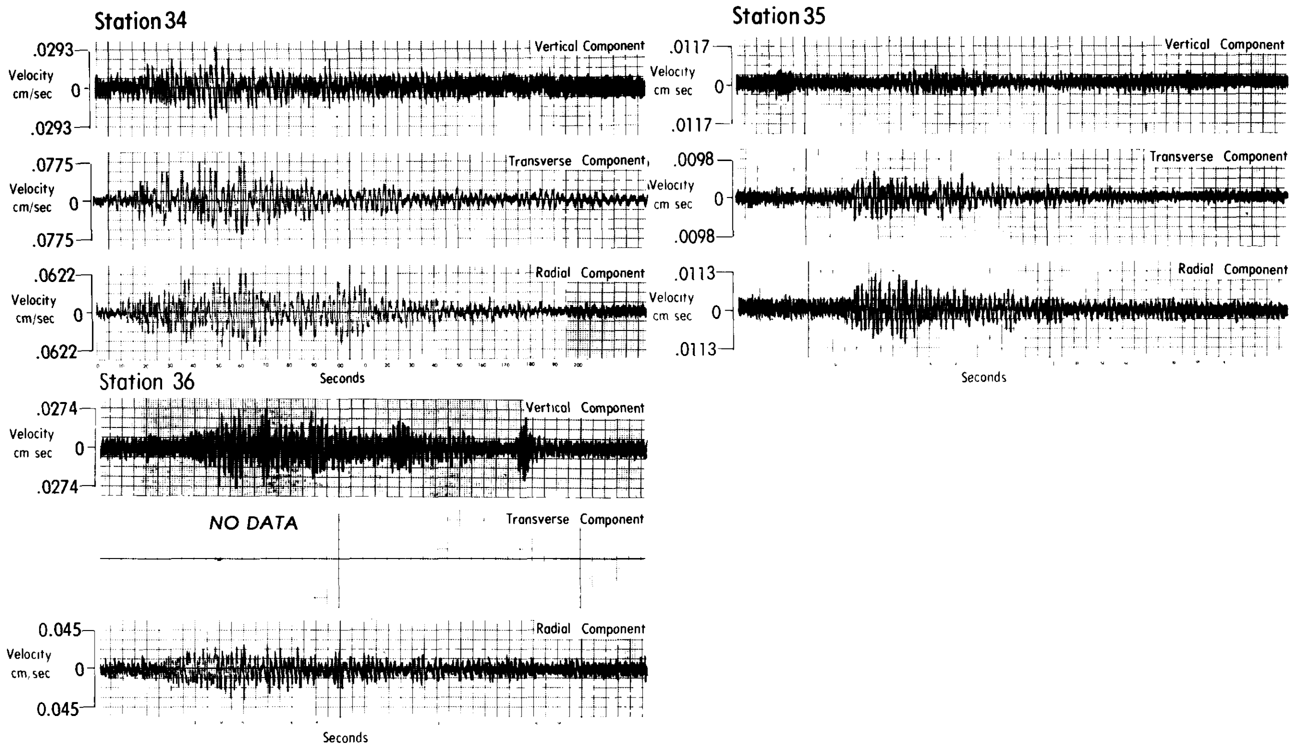
Event: Draughts



TIME HISTORIES

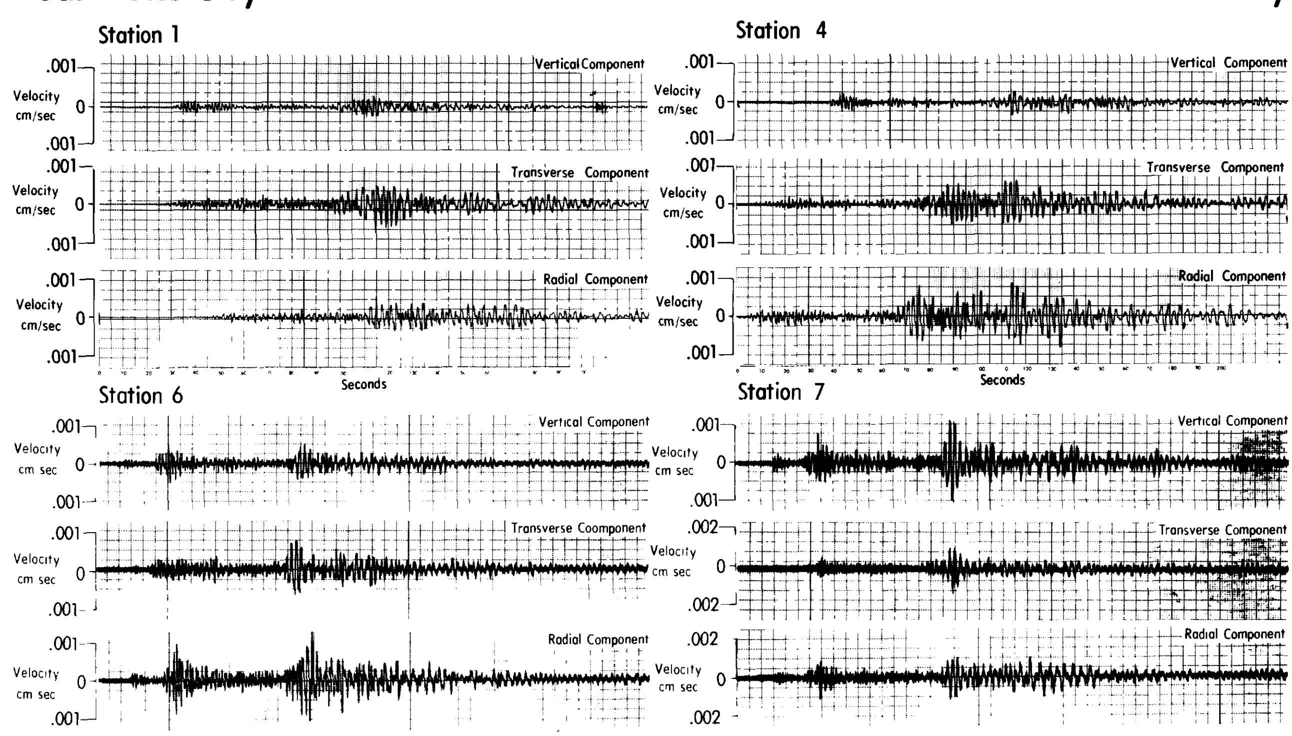
Salt Lake City

Event: Draughts



Salt Lake City

Event: Marsilly

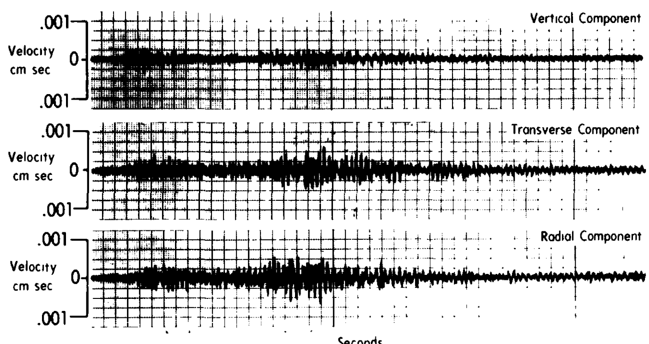


TIME HISTORIES

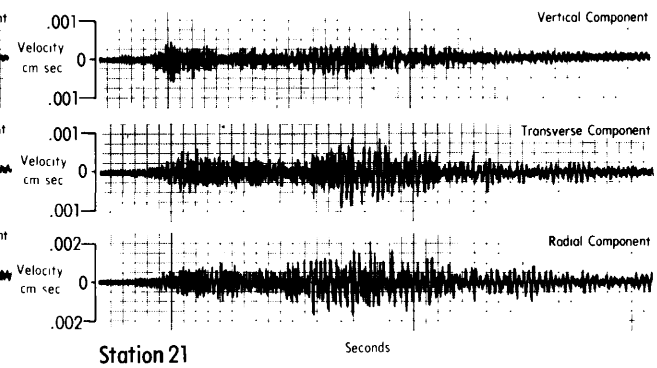
Salt Lake City

Event: Marsilly

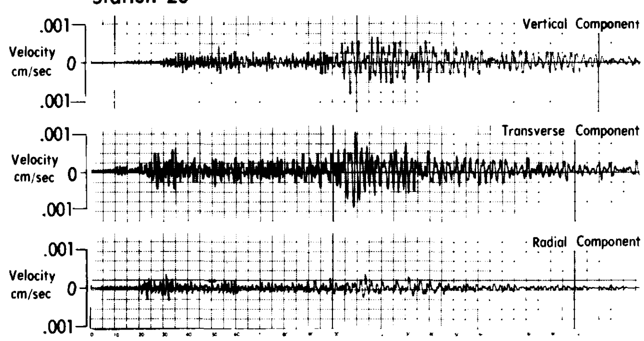
Station 12



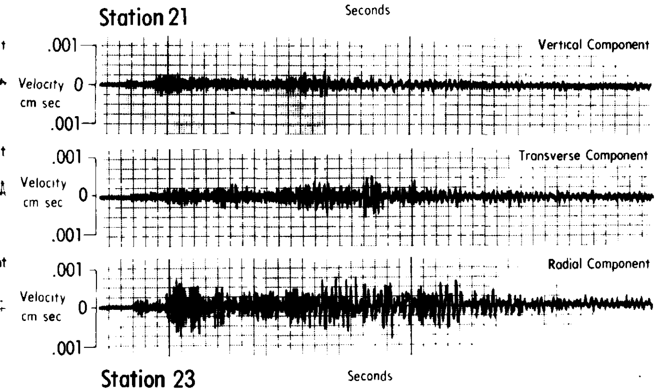
Station 15



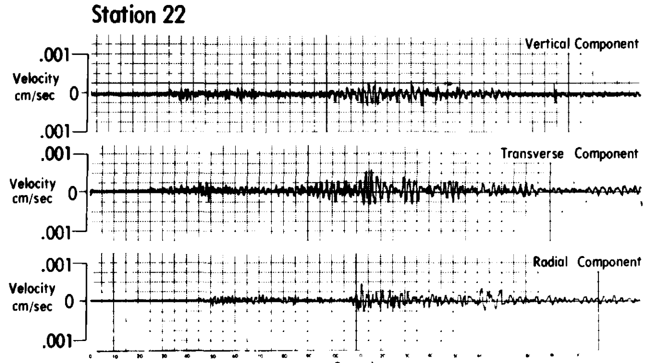
Station 20



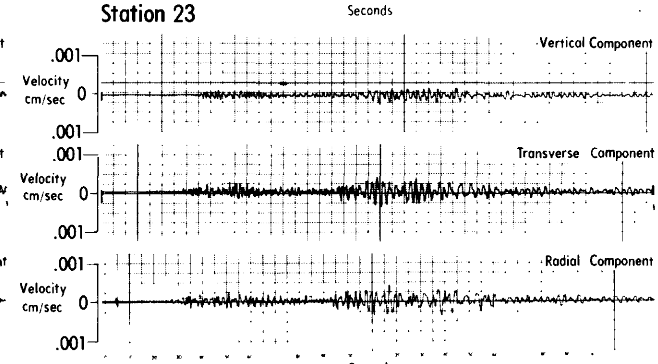
Station 21



Station 22



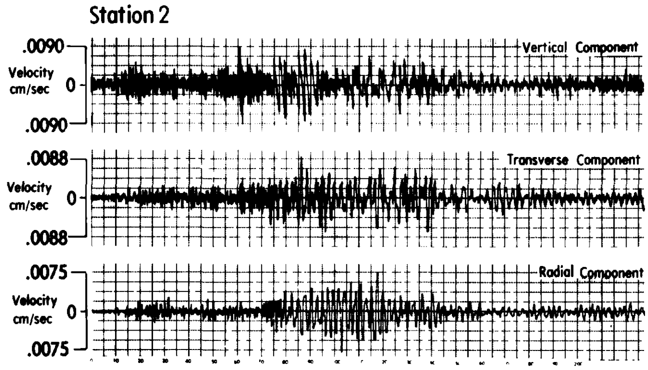
Station 23



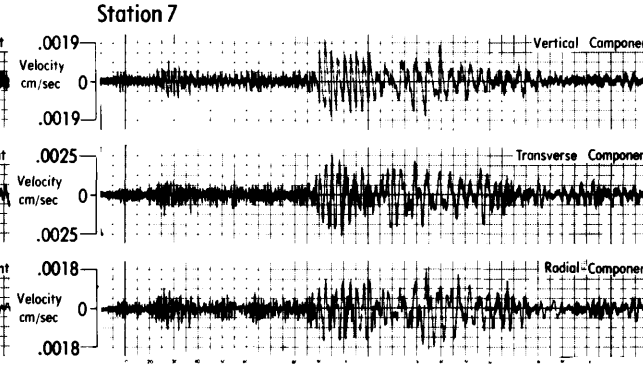
Salt Lake City

Event: Rummy

Station 2



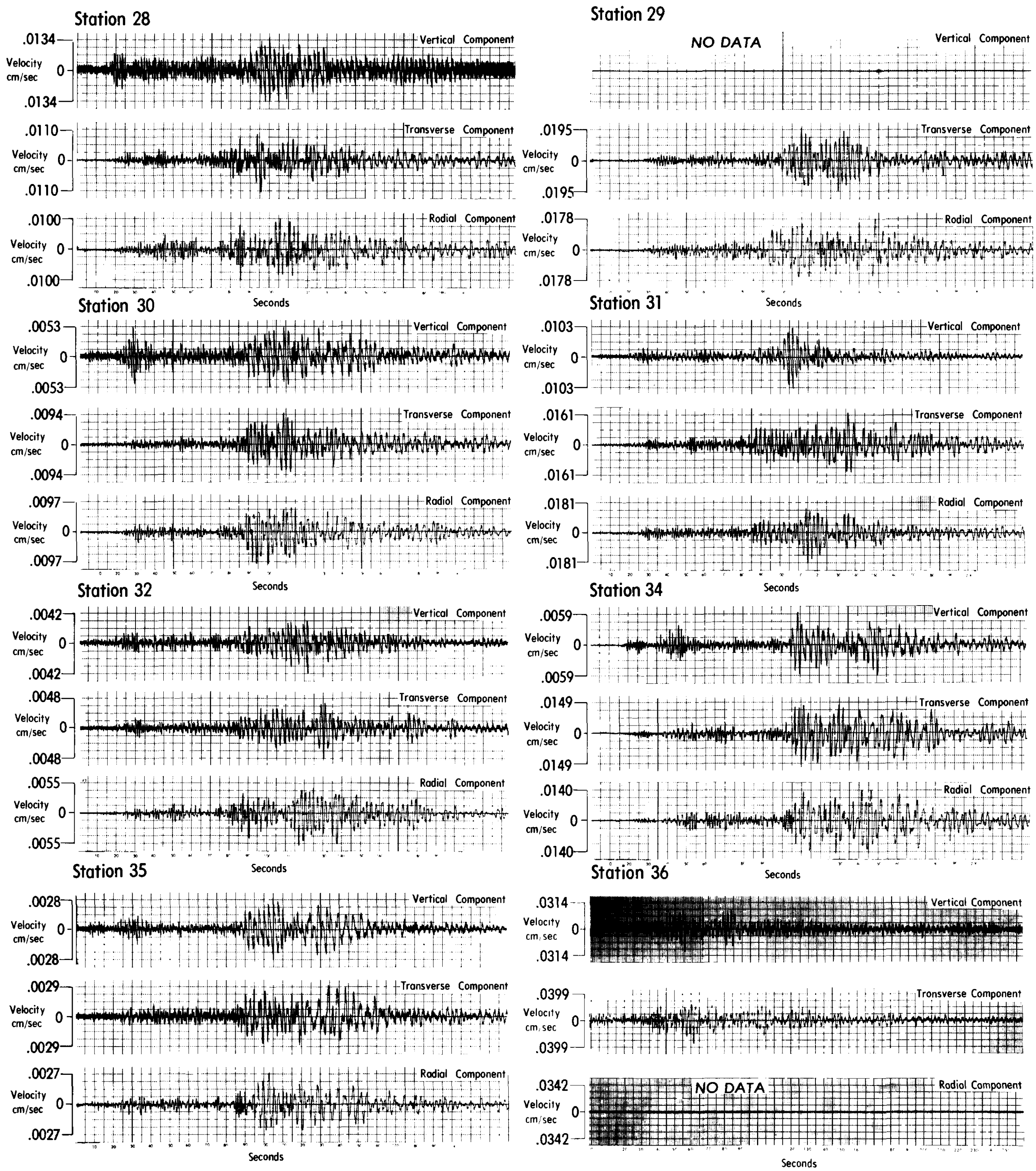
Station 7



TIME HISTORIES

Salt Lake City

Event: Rummy

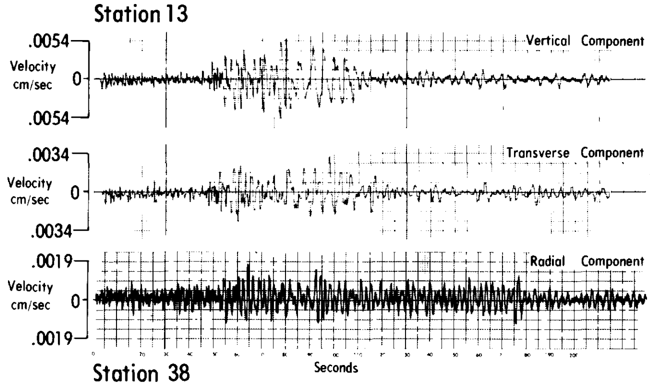


TIME HISTORIES

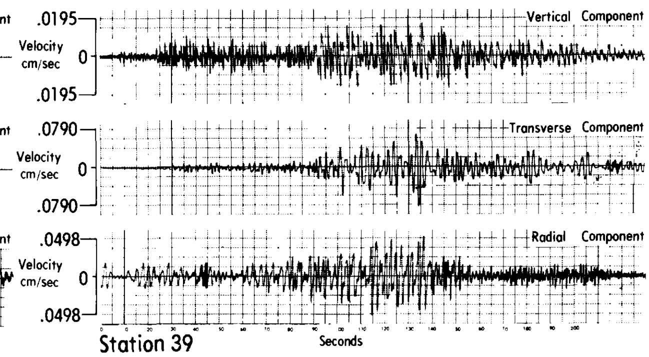
Salt Lake City

Event: Sandreef

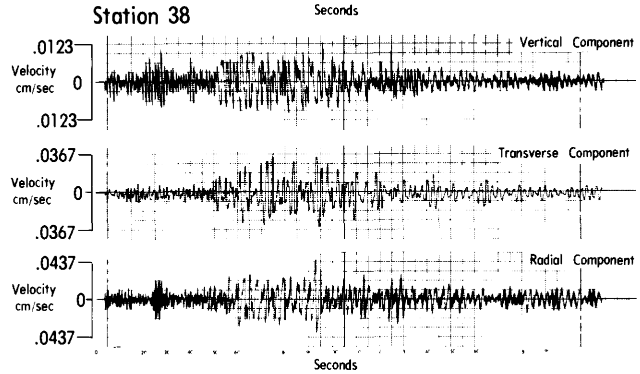
Station 13



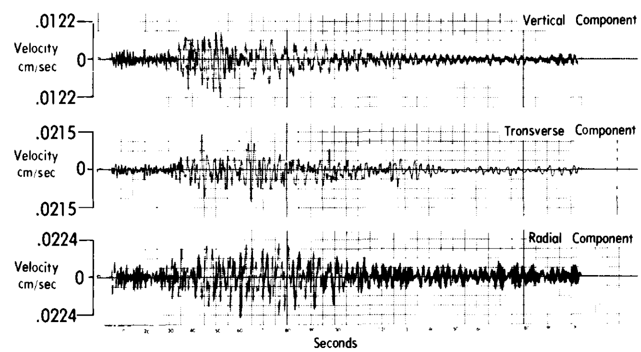
Station 37



Station 38



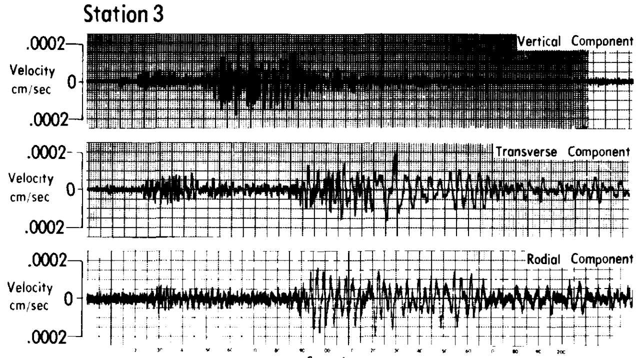
Station 39



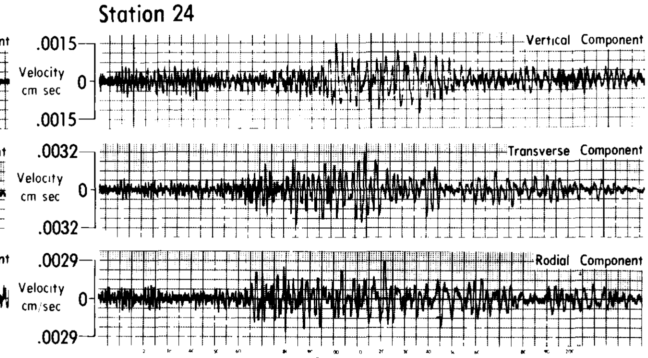
Salt Lake City

Event: Scantling

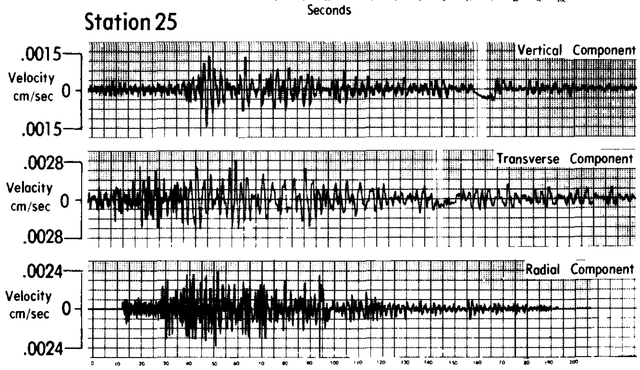
Station 3



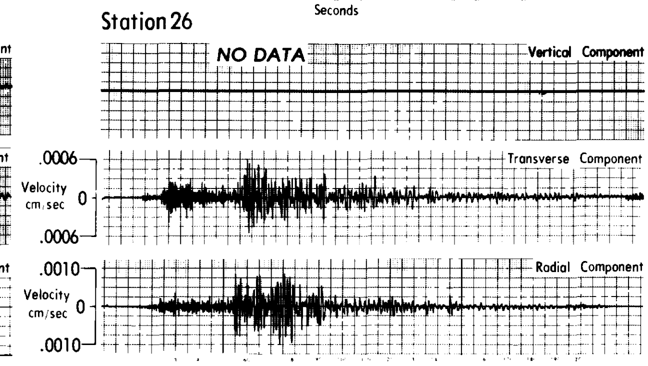
Station 24



Station 25



Station 26

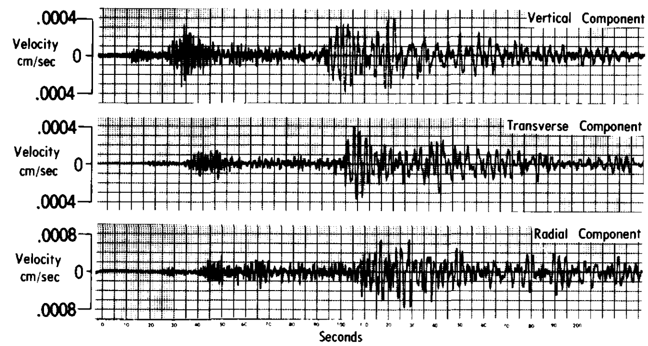


TIME HISTORIES

Salt Lake City

Event: Scantling

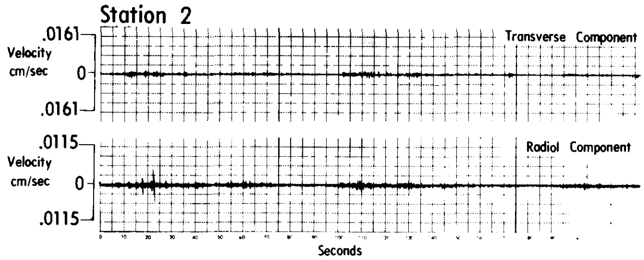
Station 27



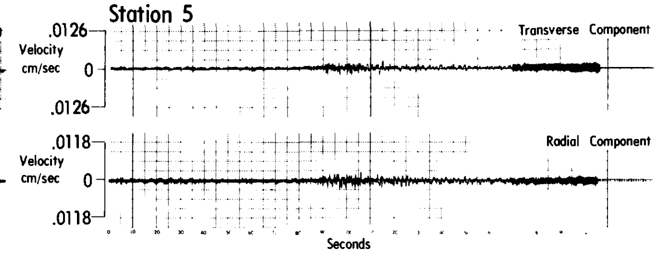
Salt Lake City

Event: Earthquake

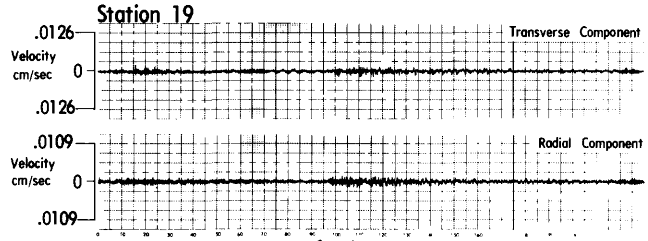
Station 2



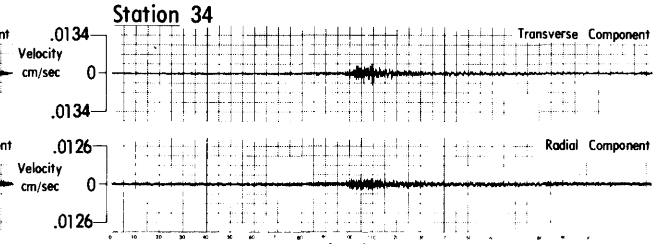
Station 5



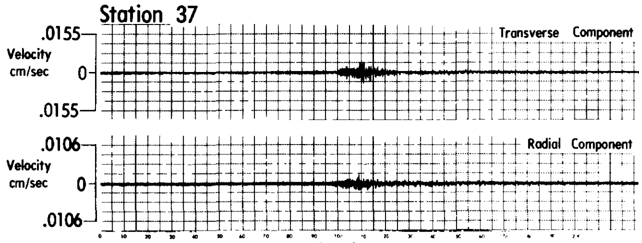
Station 19



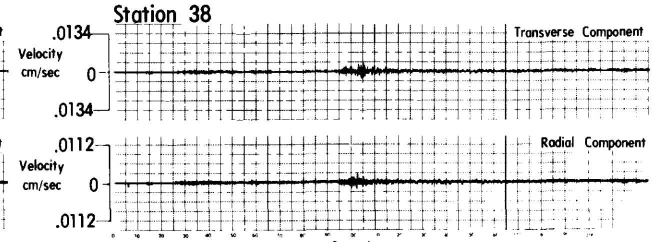
Station 34



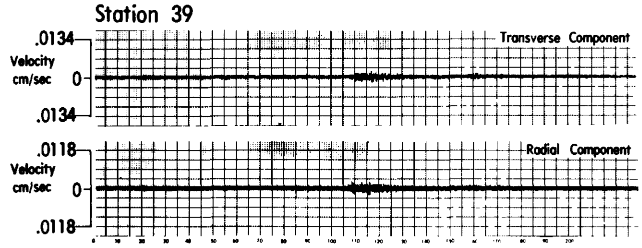
Station 37



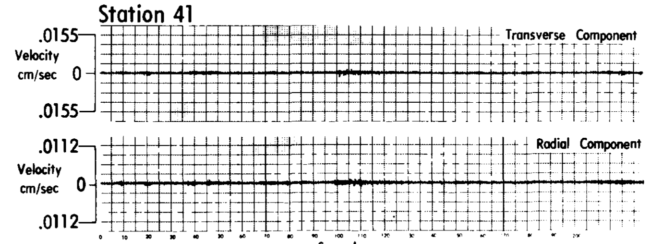
Station 38



Station 39



Station 41

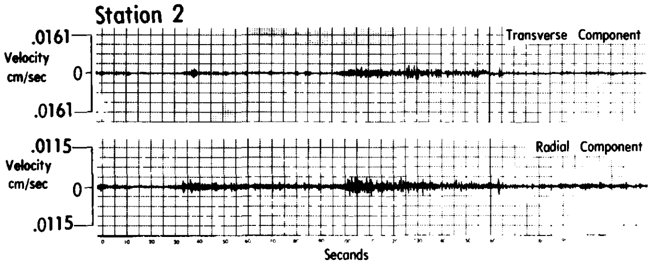


TIME HISTORIES

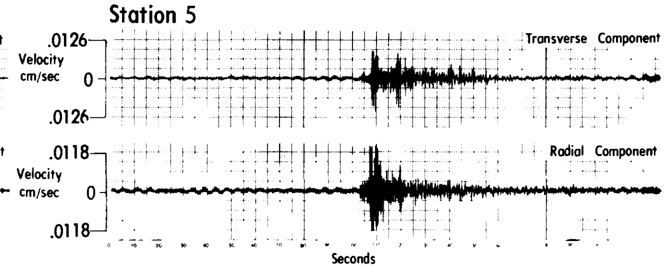
Salt Lake City

Event: Quarry Explosion

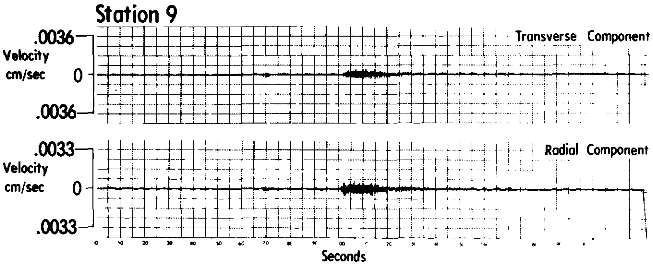
Station 2



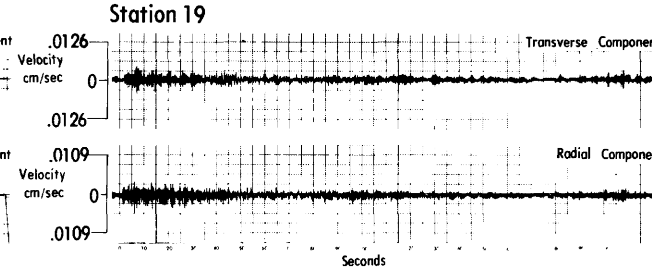
Station 5



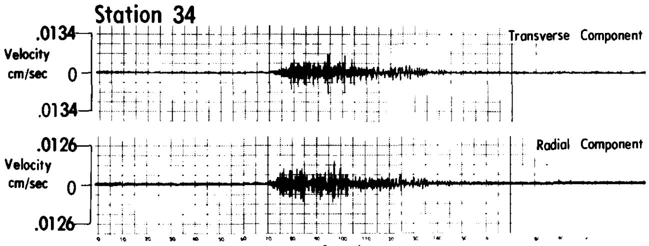
Station 9



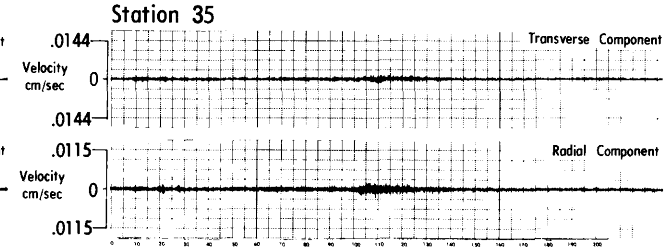
Station 19



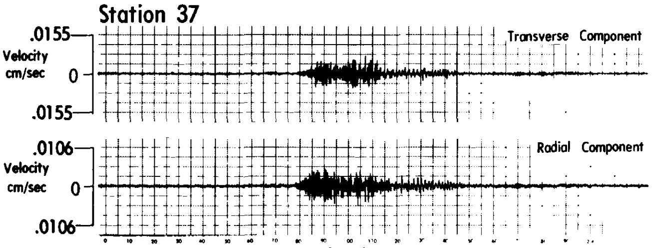
Station 34



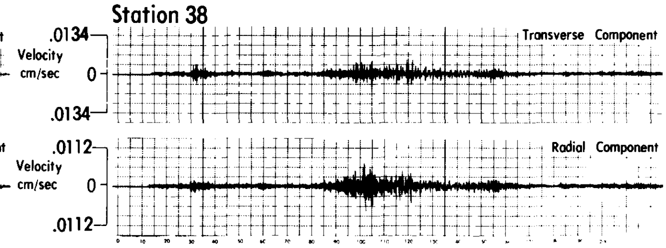
Station 35



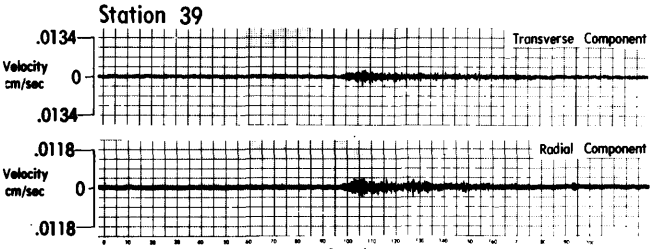
Station 37



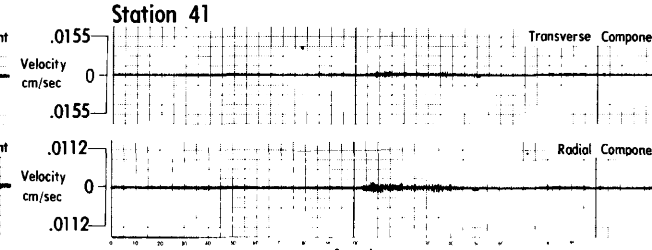
Station 38



Station 39



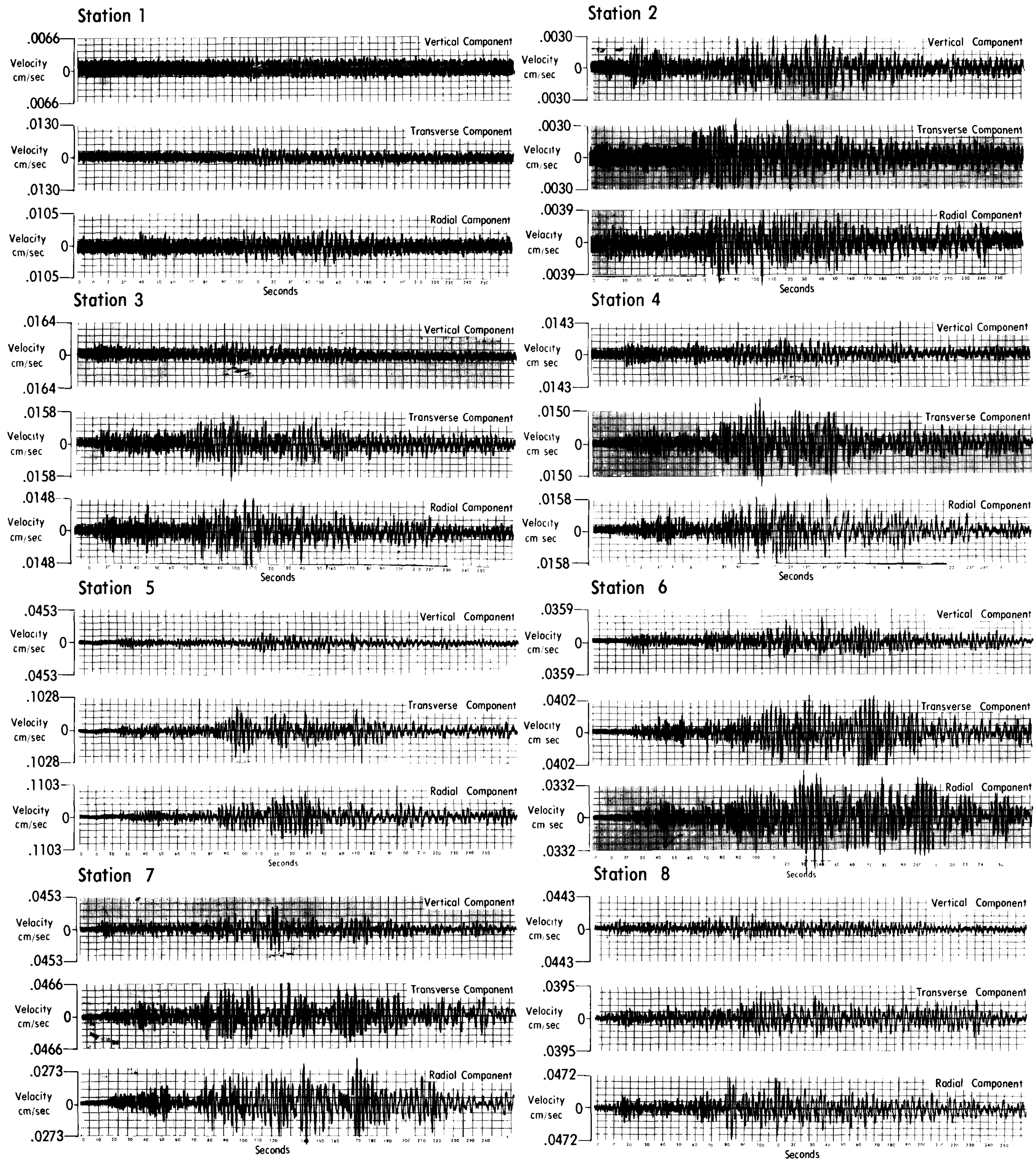
Station 41



TIME HISTORIES

Provo

Event: Reblochon

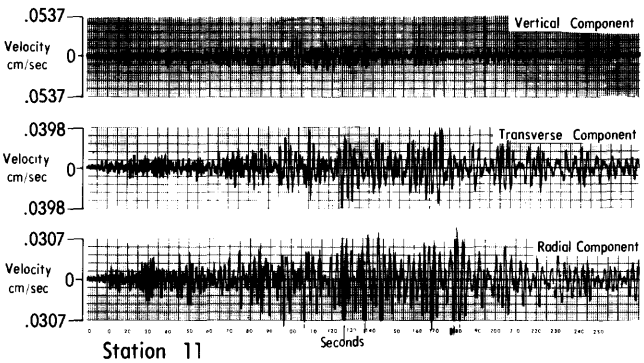


TIME HISTORIES

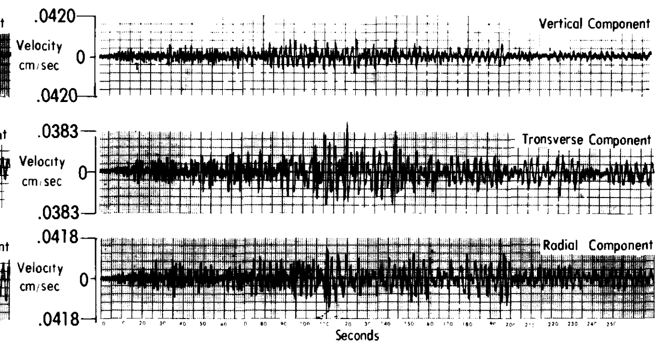
Provo

Event: Reblochon

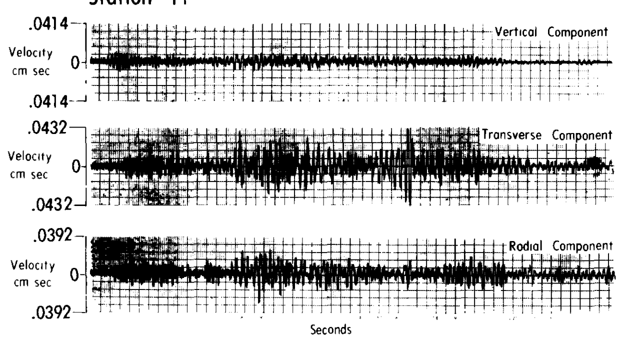
Station 9



Station 10



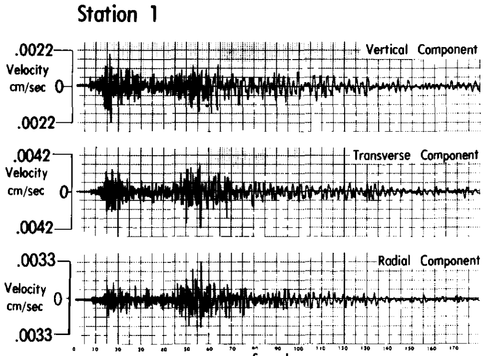
Station 11



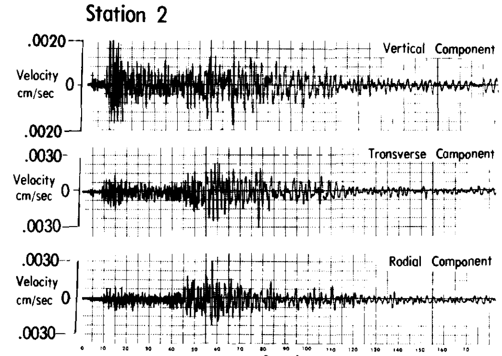
Cedar City

Event: Burzet

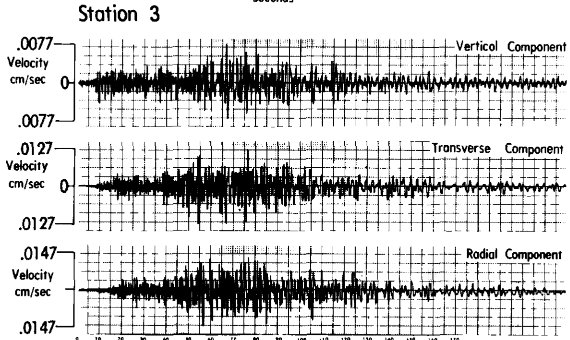
Station 1



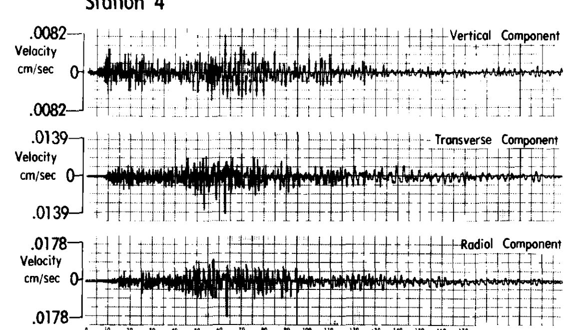
Station 2



Station 3



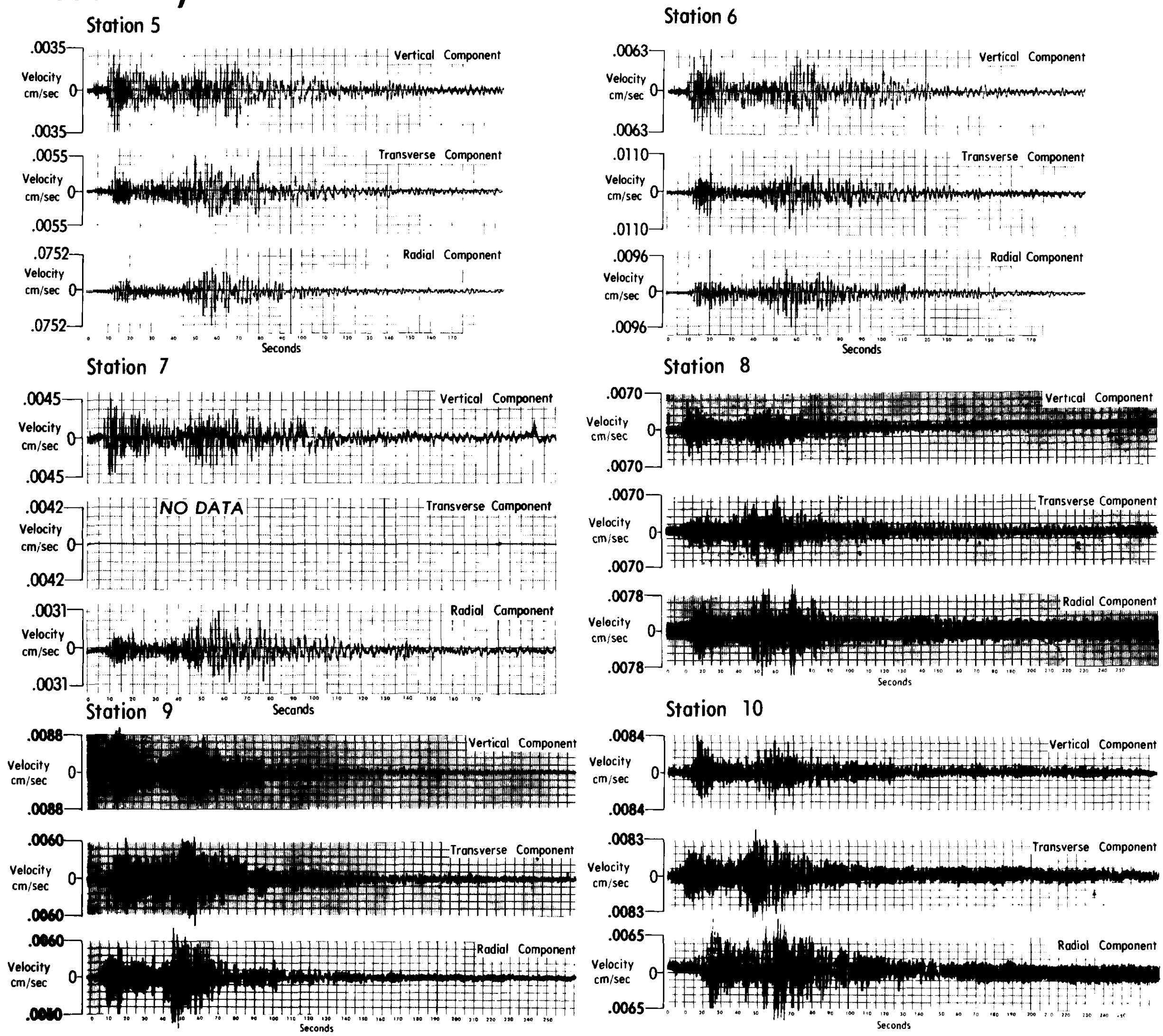
Station 4



TIME HISTORIES

Cedar City

Event: Burzet

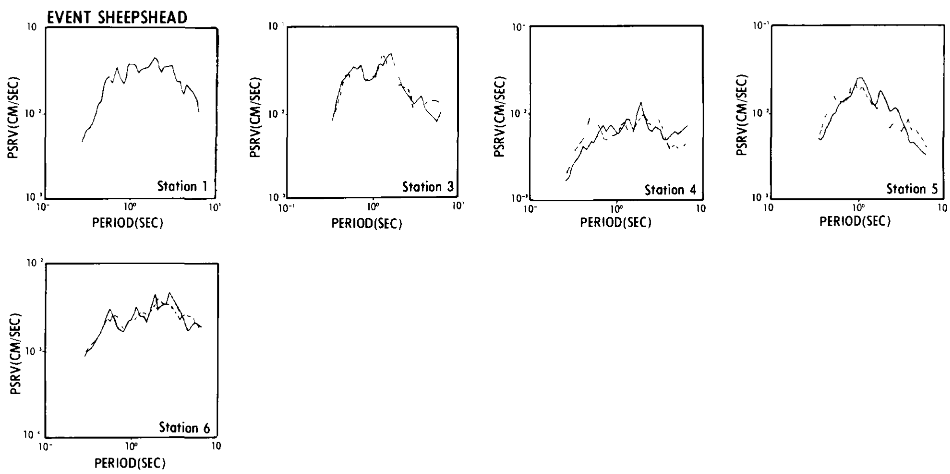


APPENDIX B

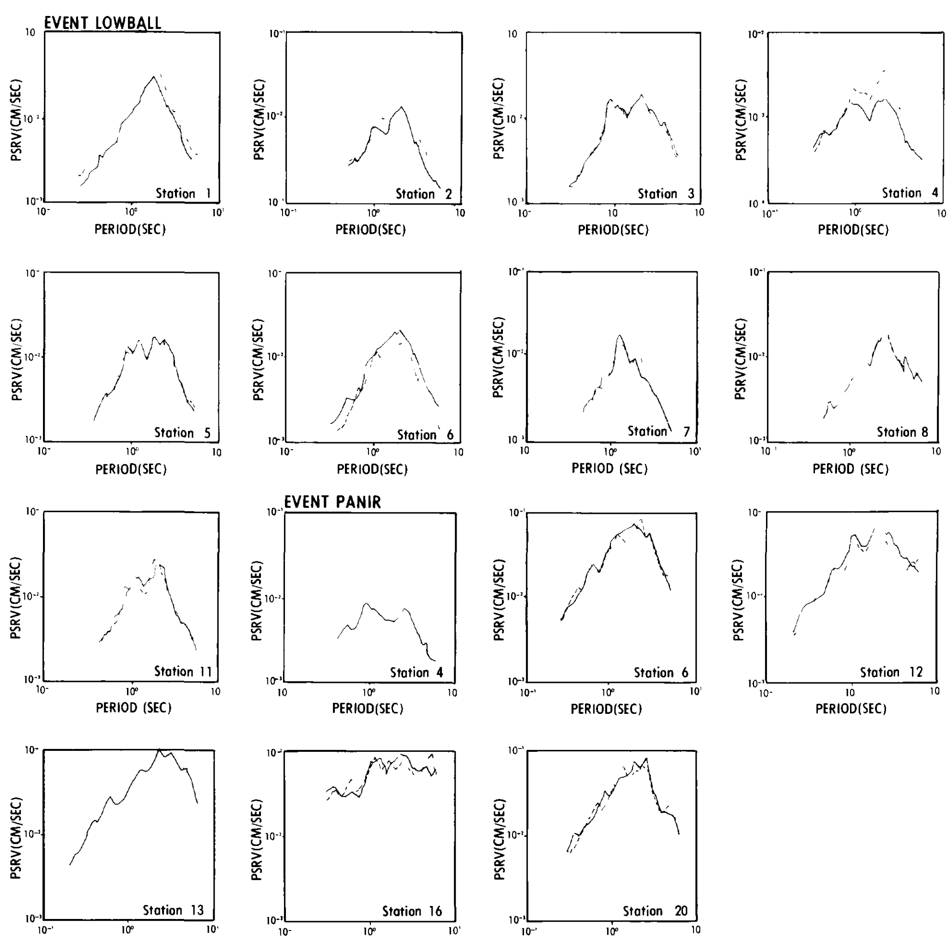
Response spectra (psrv) arranged according to recording area.

SITE RESPONSE SPECTRA

LOGAN



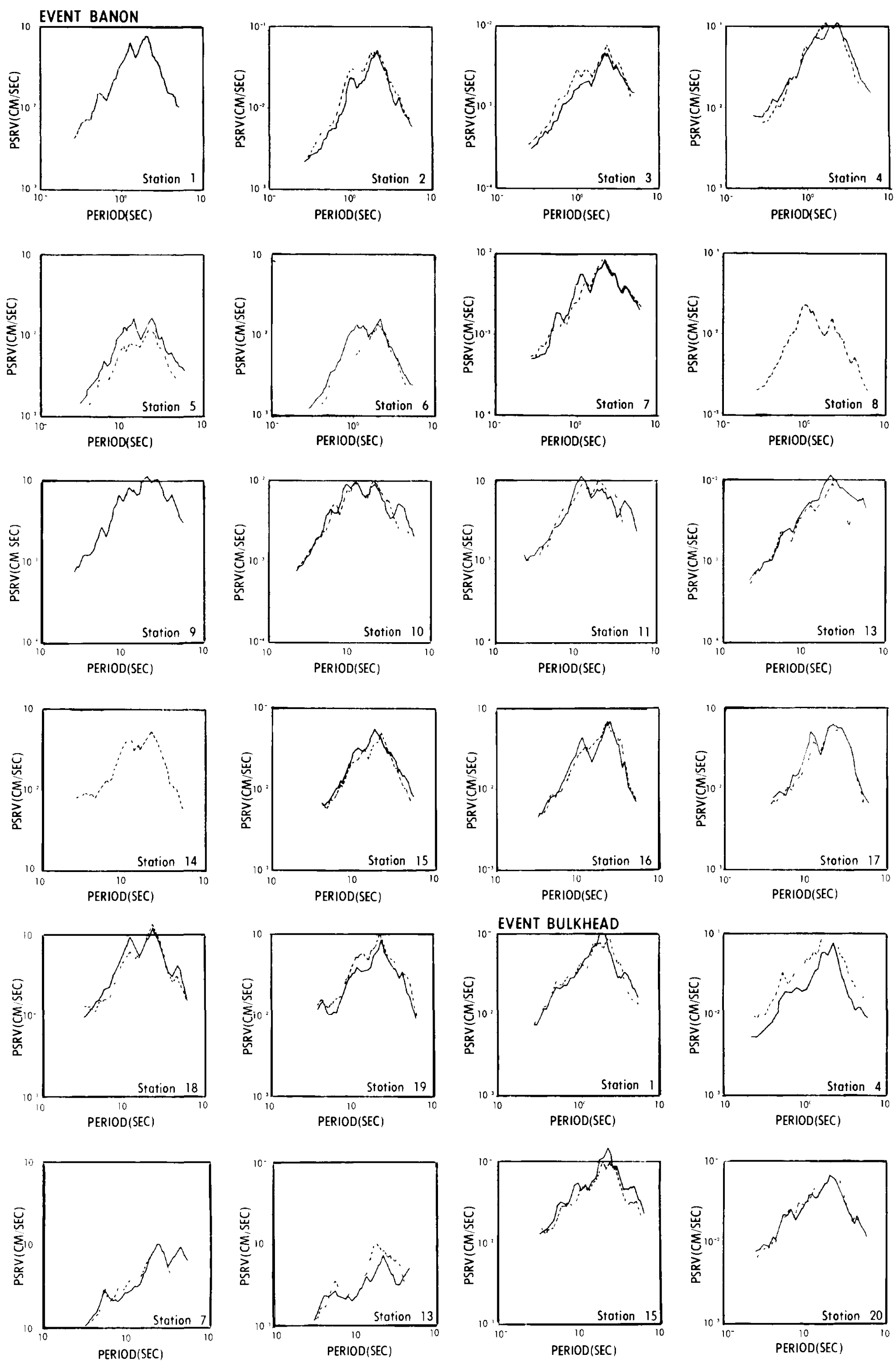
OGDEN



—— RADIAL COMPONENT
----- TRANSVERSE COMPONENT

SITE RESPONSE SPECTRA

SALT LAKE CITY

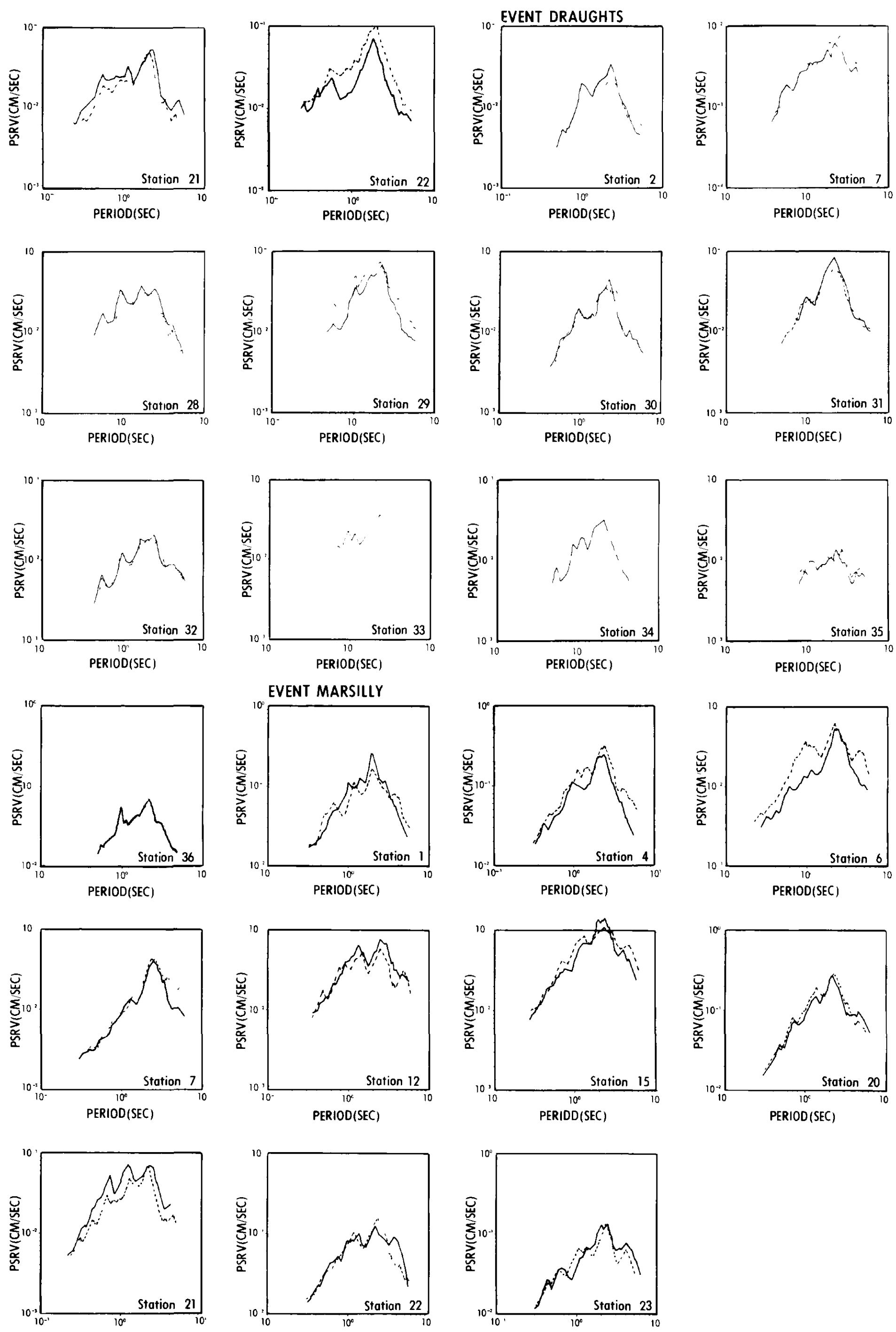


—— RADIAL COMPONENT

---- TRANSVERSE COMPONENT

SITE RESPONSE SPECTRA

SALT LAKE CITY

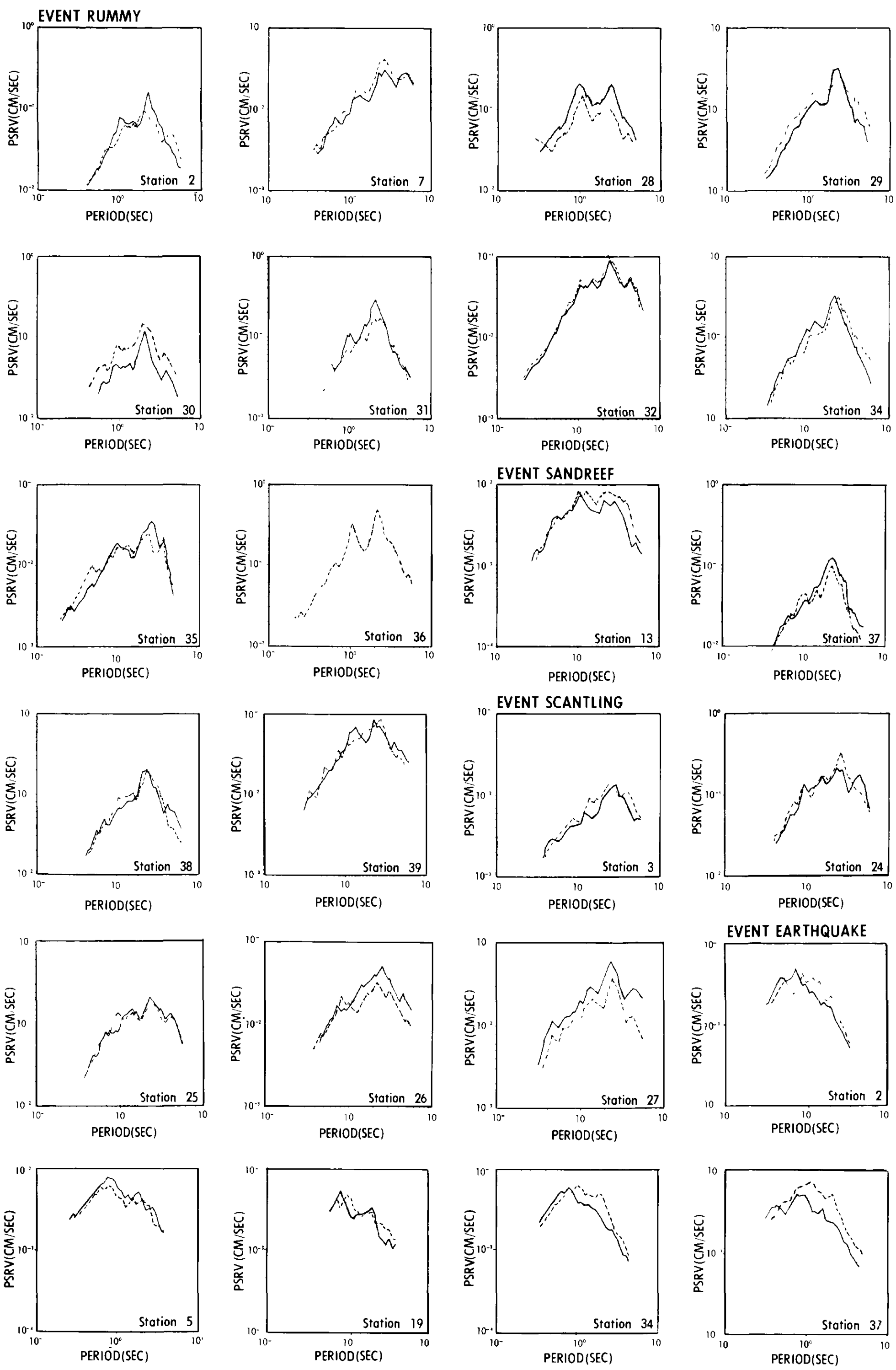


—— RADIAL COMPONENT

---- TRANSVERSE COMPONENT

SITE RESPONSE SPECTRA

SALT LAKE CITY



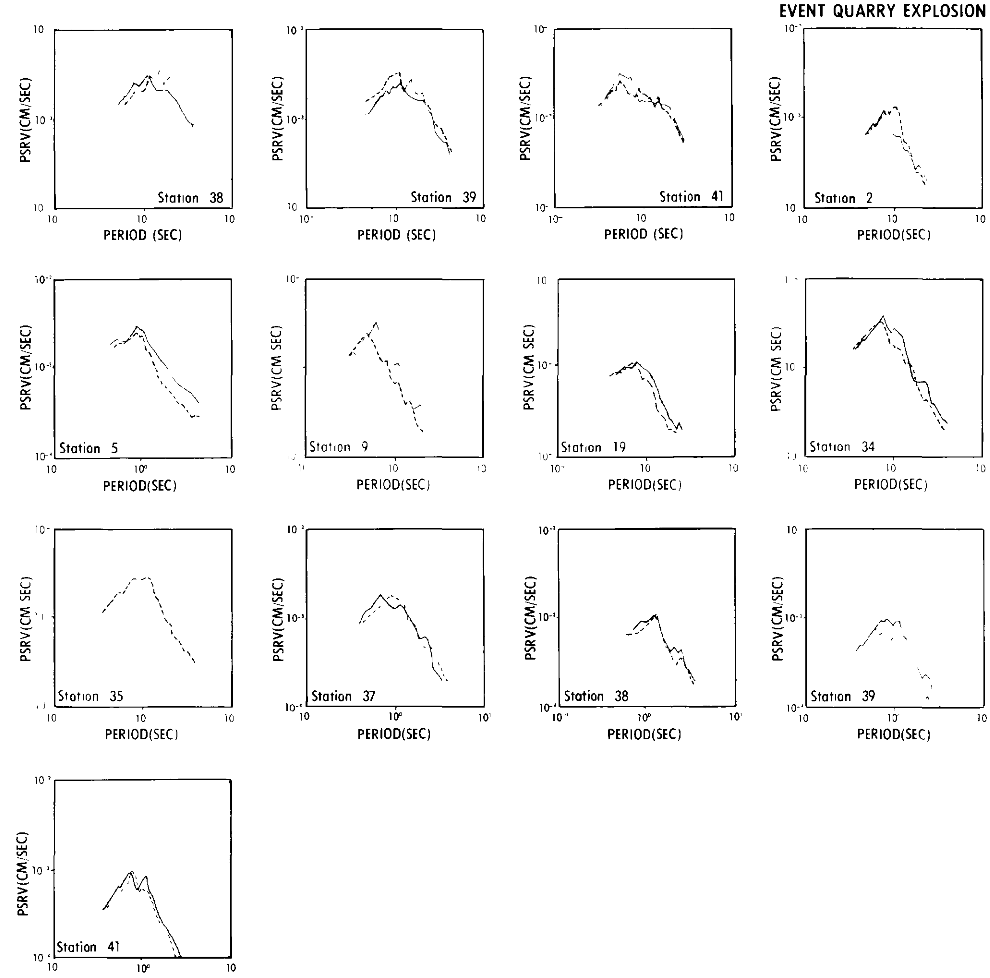
—— RADIAL COMPONENT

----- TRANSVERSE COMPONENT

SITE RESPONSE SPECTRA

SALT LAKE CITY

EVENT QUARRY EXPLOSION



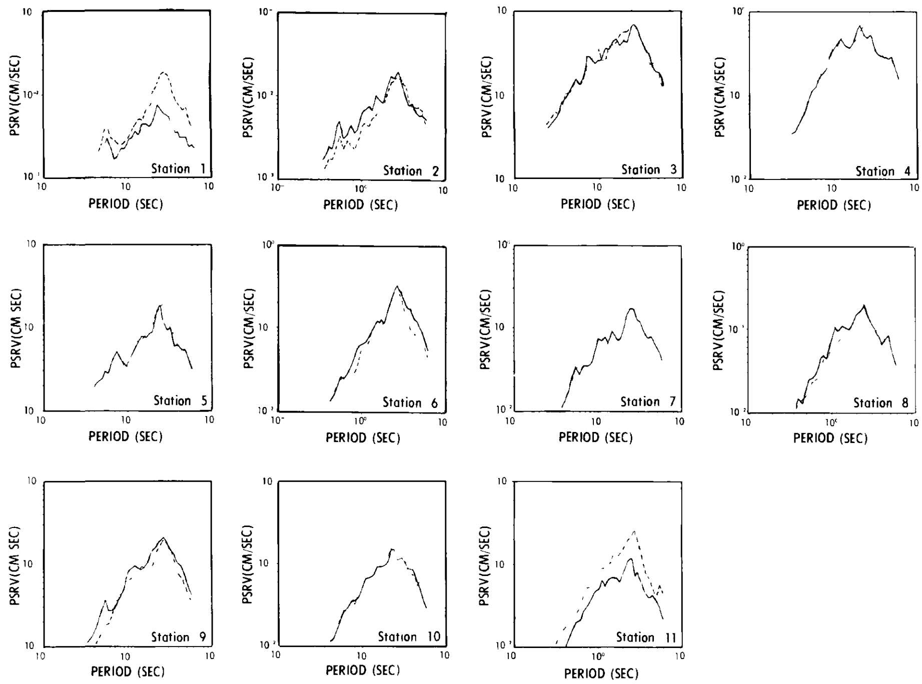
—— RADIAL COMPONENT

----- TRANSVERSE COMPONENT

SITE RESPONSE SPECTRA

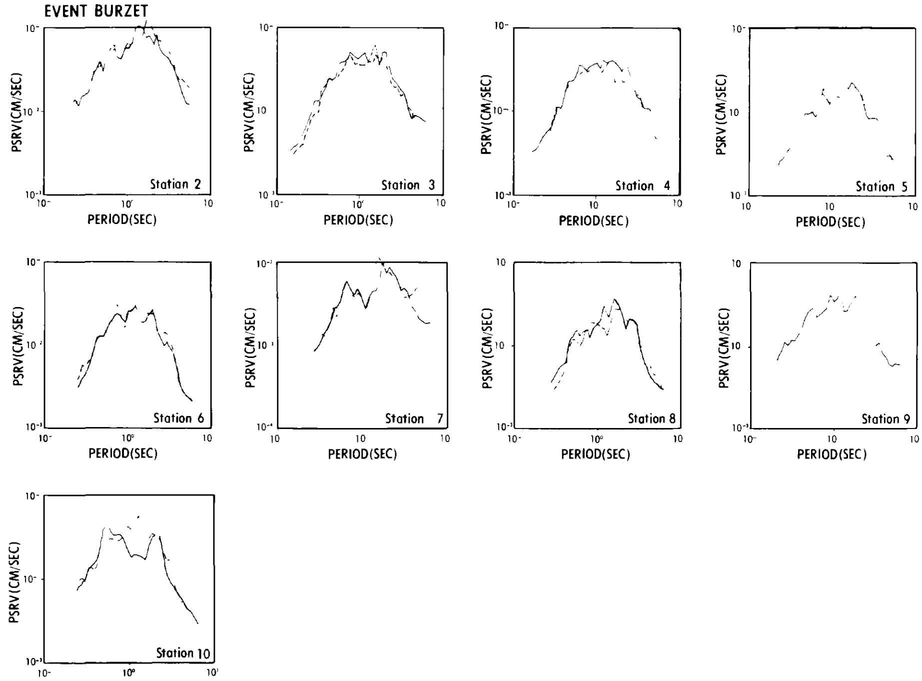
PROVO

EVENT REBLOCHON



CEDAR CITY

EVENT BURZET



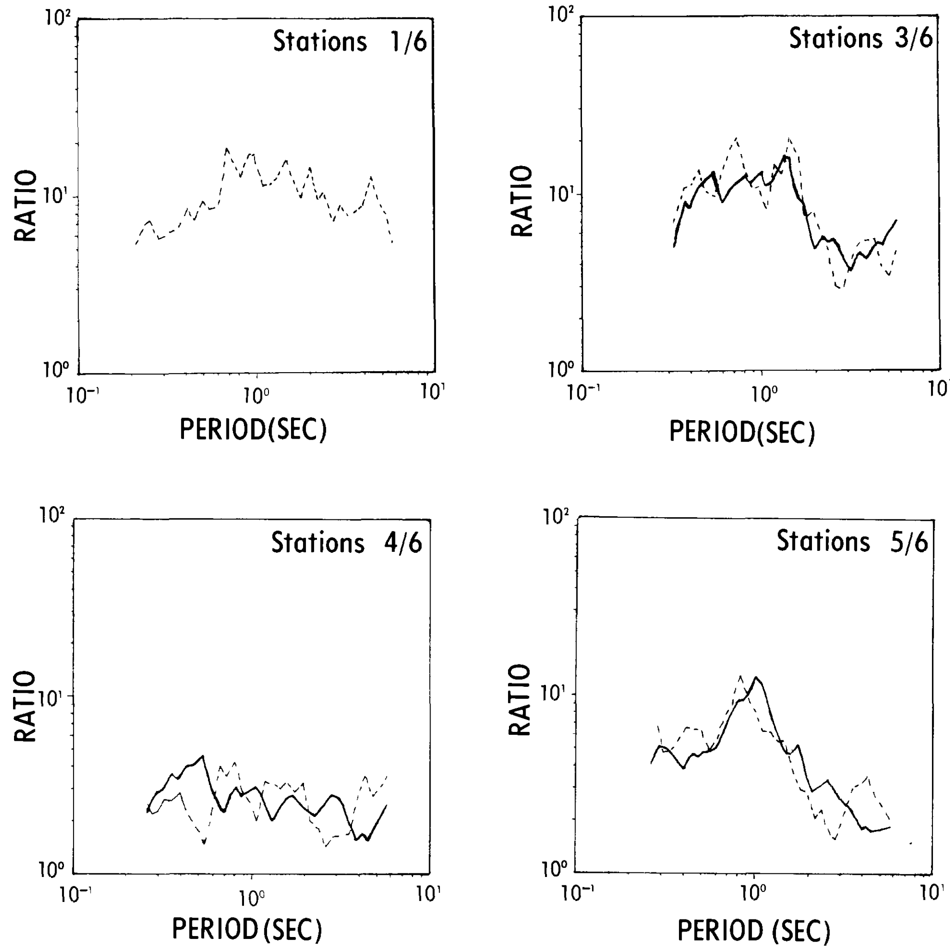
—— RADIAL COMPONENT

---- TRANSVERSE COMPONENT

APPENDIX C

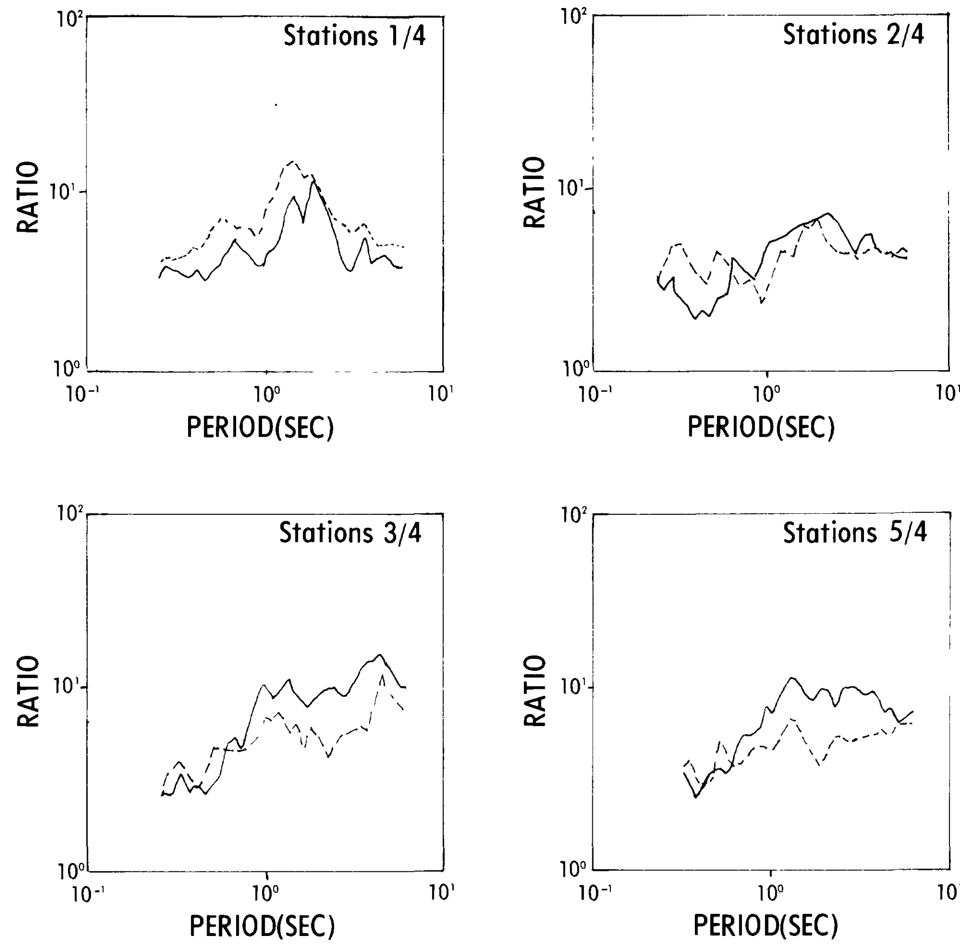
Site transfer functions arranged according to recording area.

LOGAN
EVENT SHEEPSHEAD



— RADIAL COMPONENT
---TRANSVERSE COMPONENT

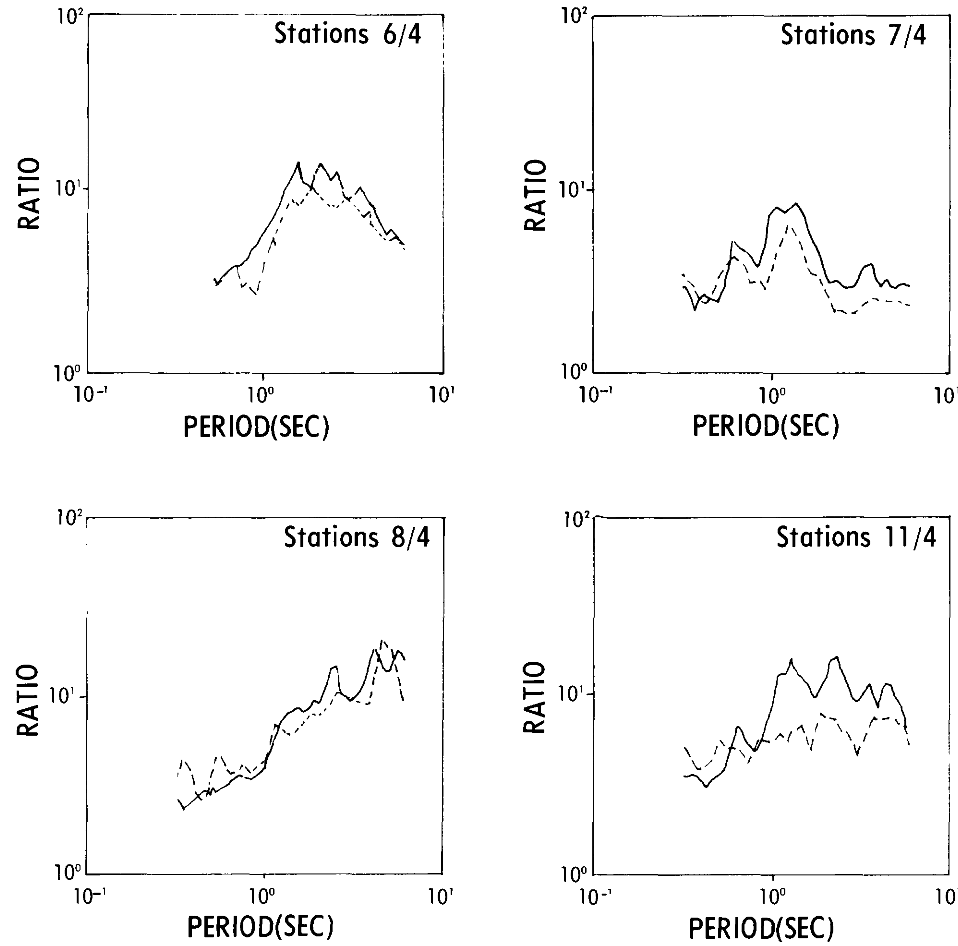
OGDEN
EVENT LOWBALL



—— RADIAL COMPONENT
- - -TRANSVERSE COMPONENT

OGDEN

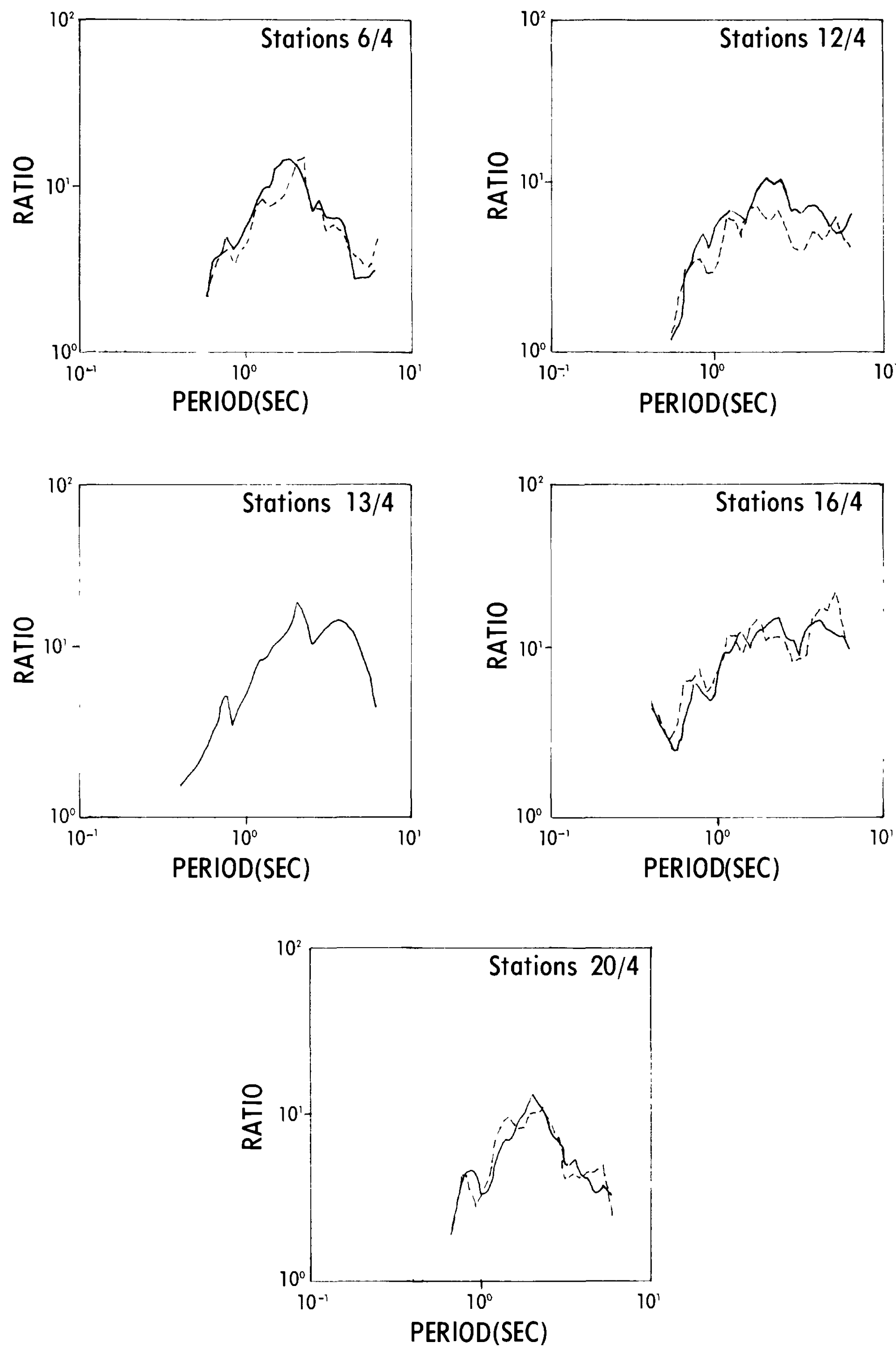
EVENT LOWBALL



—— RADIAL COMPONENT
- - -TRANSVERSE COMPONENT

OGDEN

EVENT PANIR

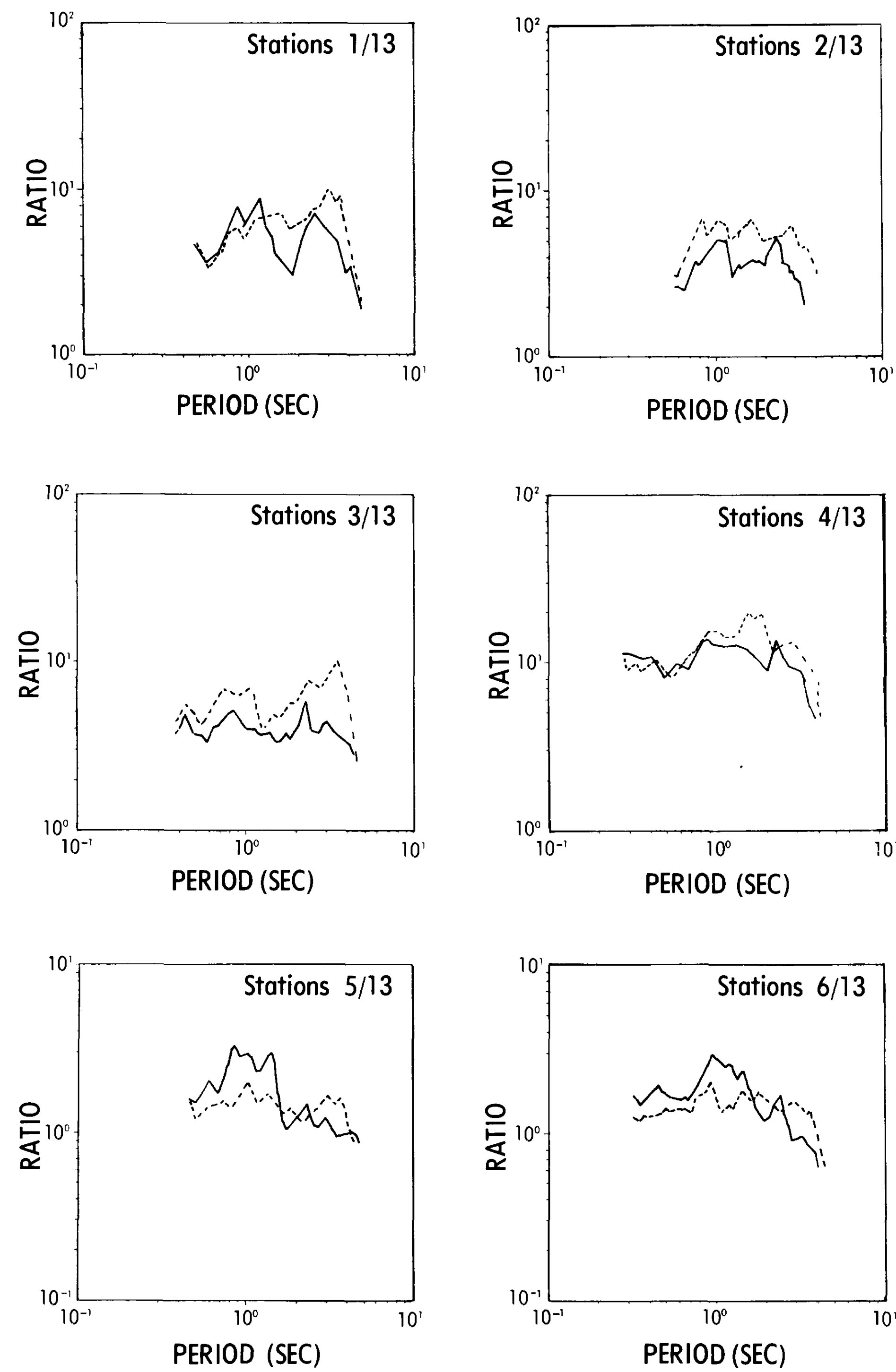


—— RADIAL COMPONENT

- - -TRANSVERSE COMPONENT

SALT LAKE CITY

EVENT BANON

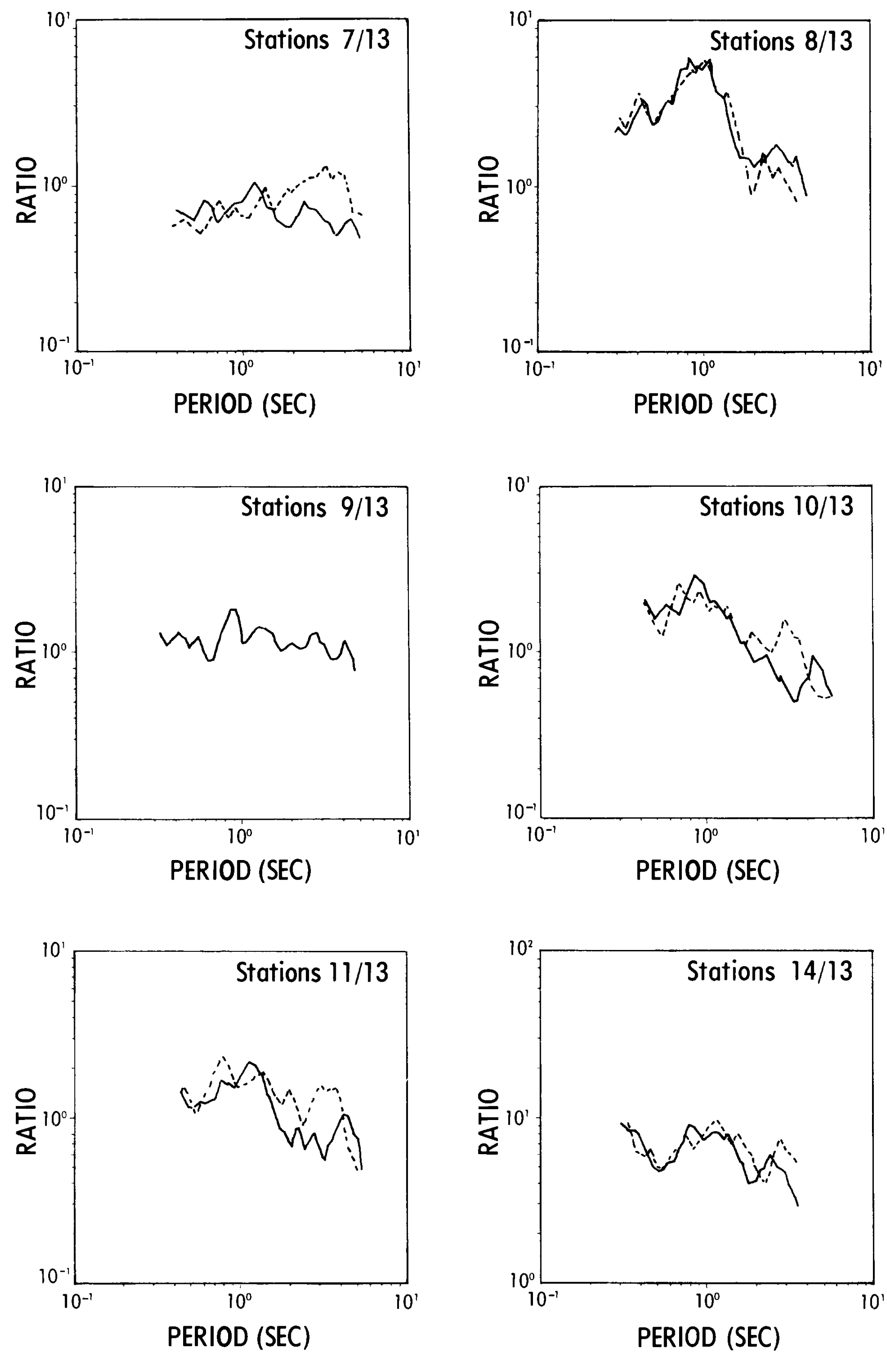


—— RADIAL COMPONENT

----TRANSVERSE COMPONENT

SALT LAKE CITY

EVENT BANON

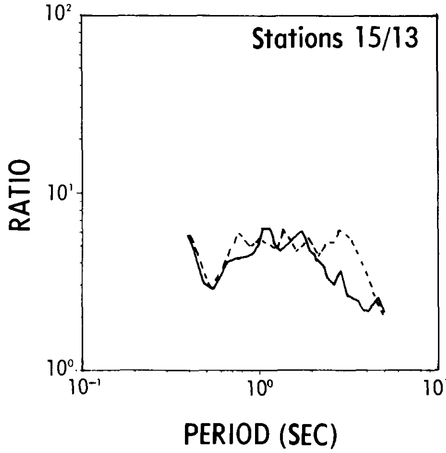


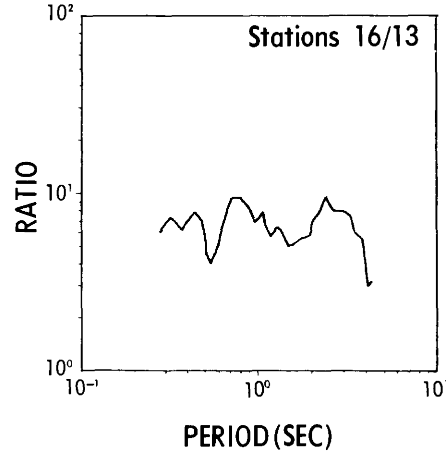
—— RADIAL COMPONENT

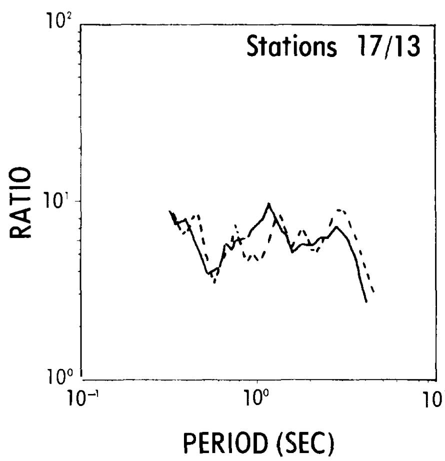
---- TRANSVERSE COMPONENT

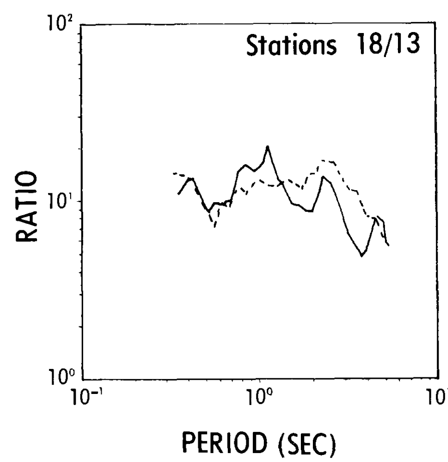
SALT LAKE CITY

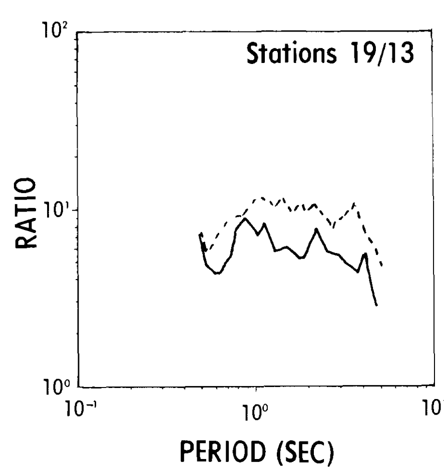
EVENT BANON





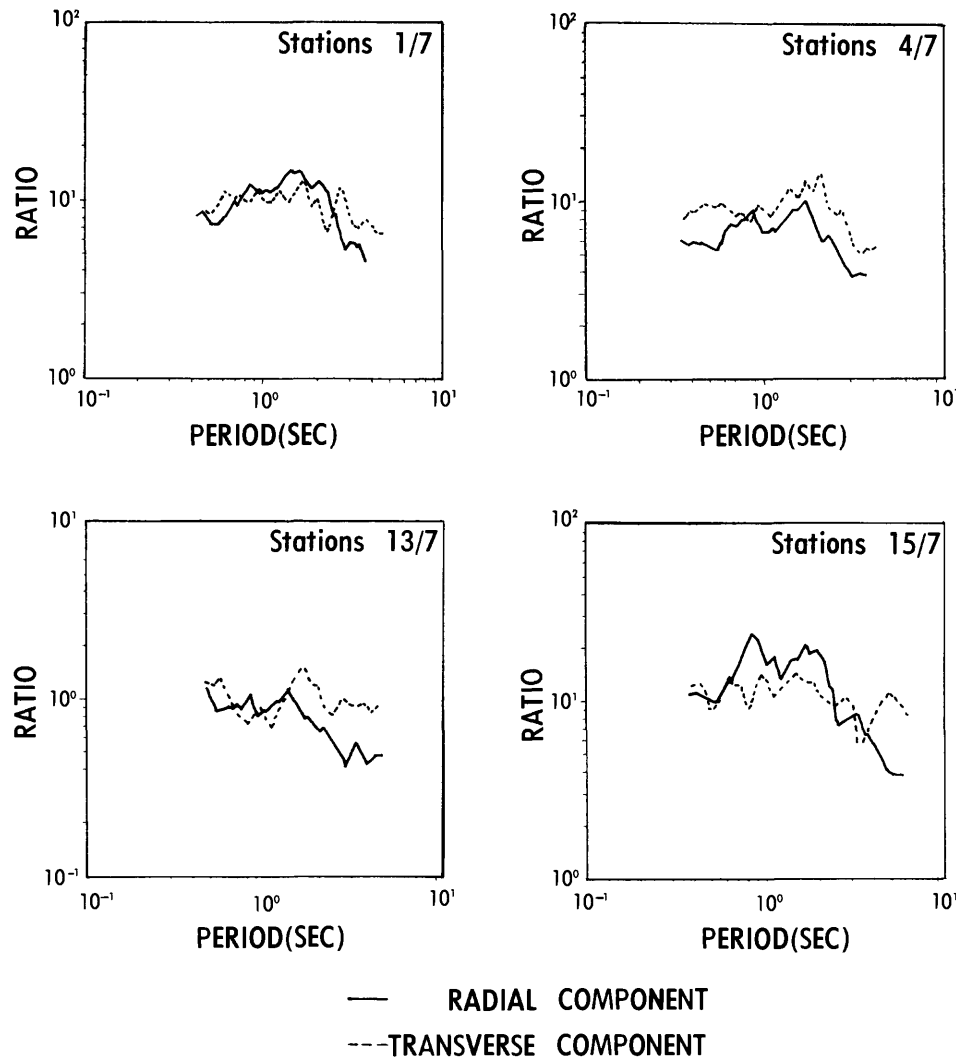






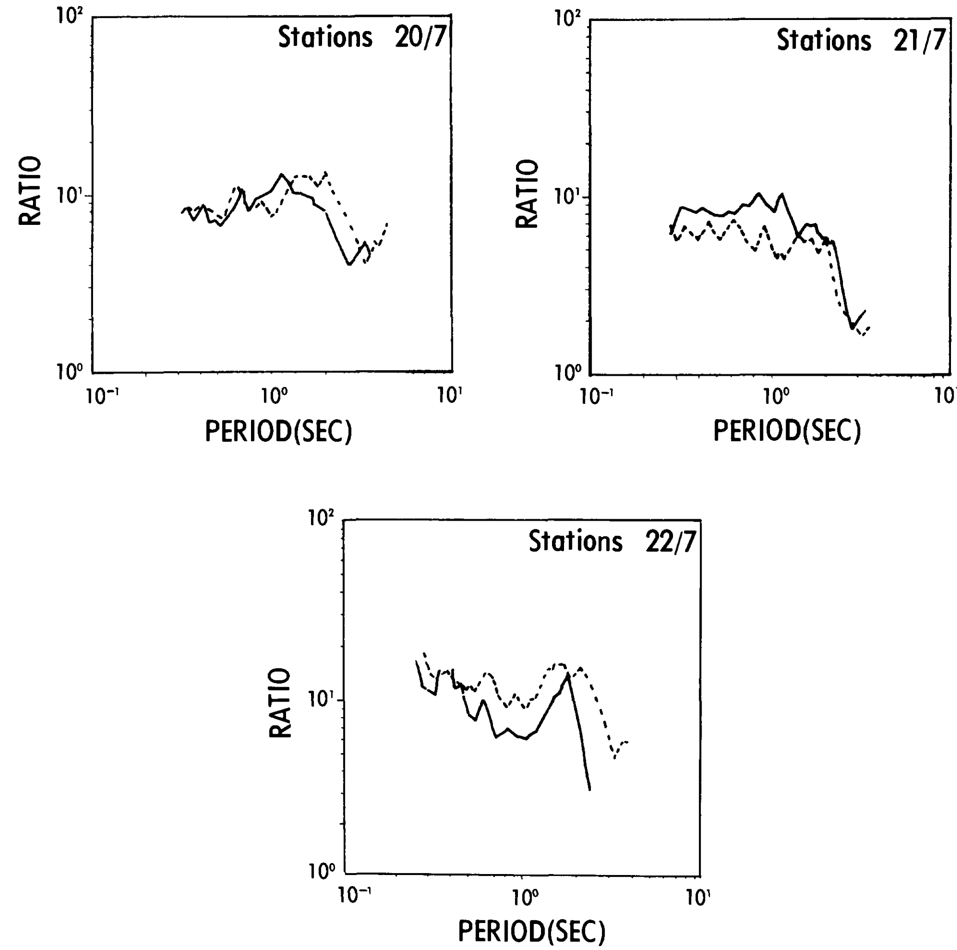
—— RADIAL COMPONENT
- - - TRANSVERSE COMPONENT

SALT LAKE CITY
EVENT BULKHEAD



SALT LAKE CITY

EVENT BULKHEAD

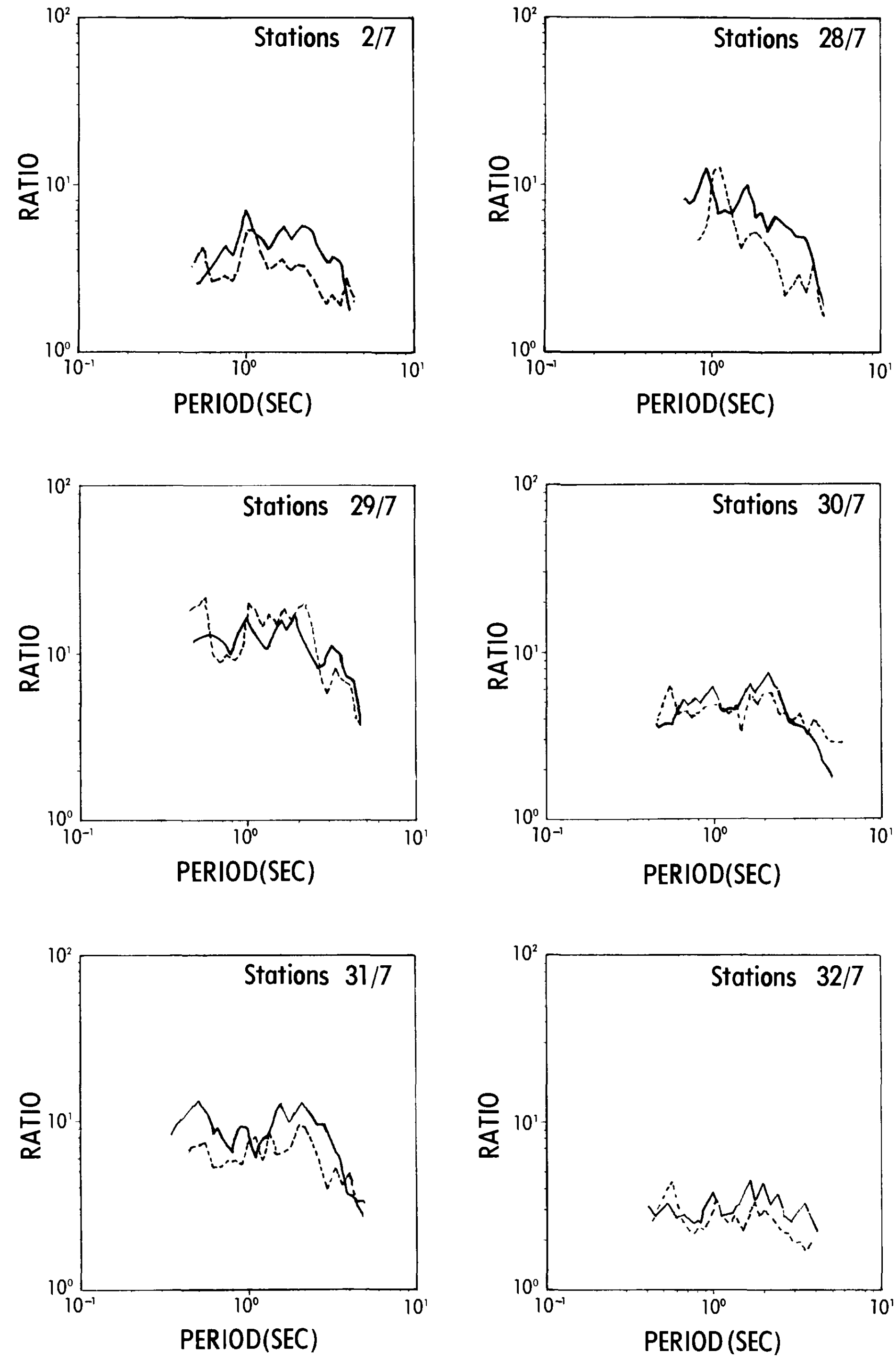


— RADIAL COMPONENT

---TRANSVERSE COMPONENT

SALT LAKE CITY

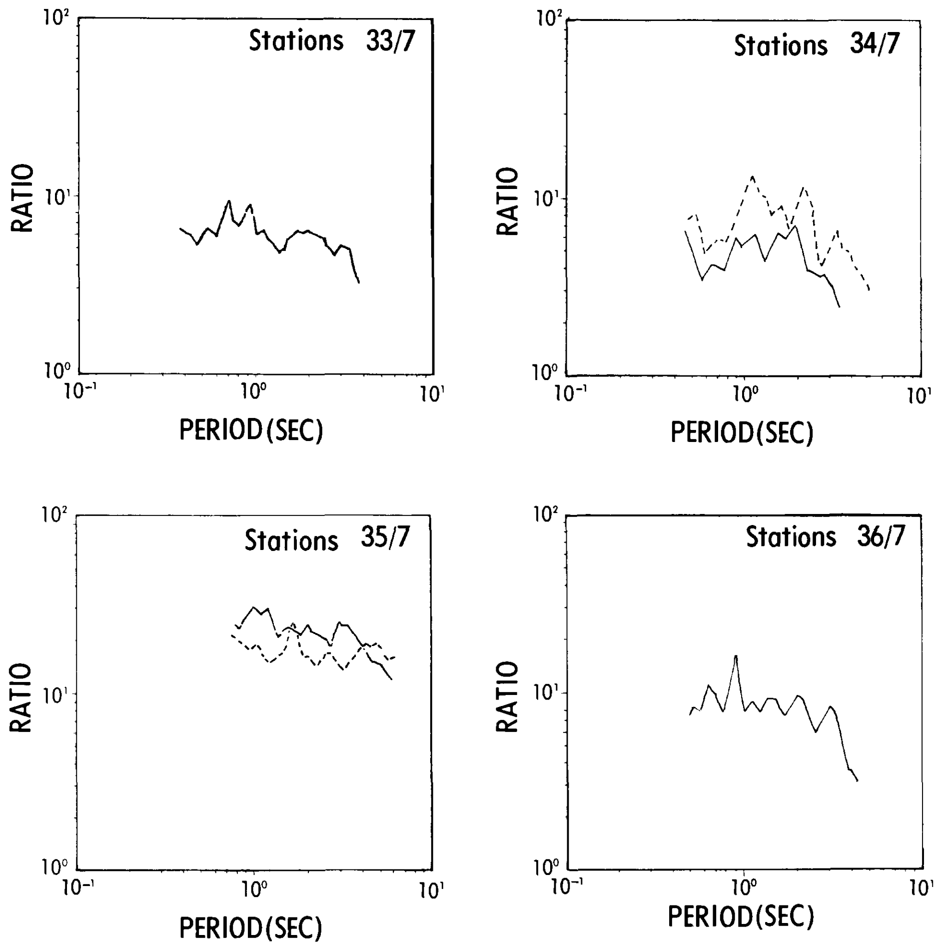
EVENT DRAUGHTS



—— RADIAL COMPONENT
---- TRANSVERSE COMPONENT

SALT LAKE CITY

EVENT DRAUGHTS

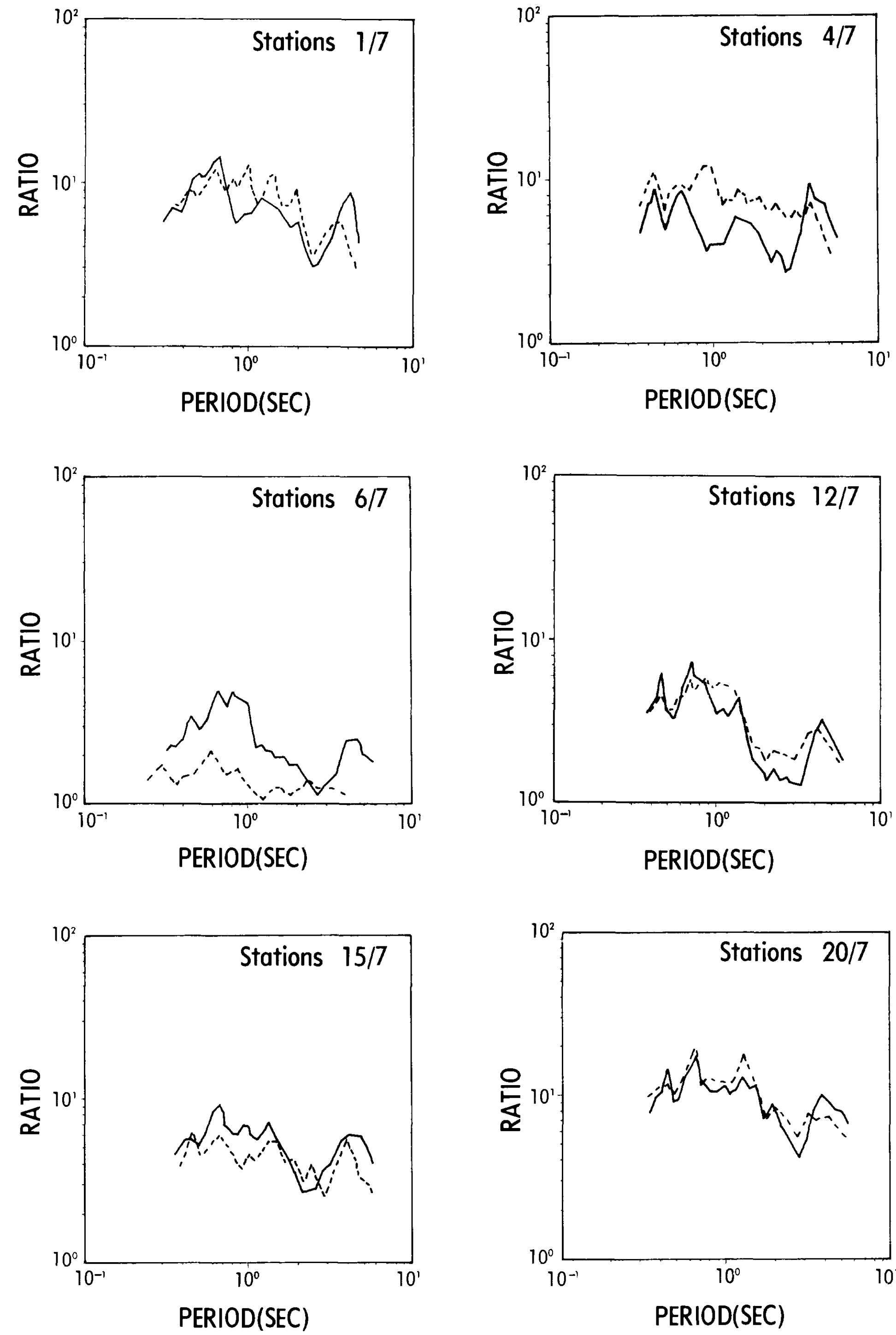


— RADIAL COMPONENT

---- TRANSVERSE COMPONENT

SALT LAKE CITY

EVENT MARSILLY

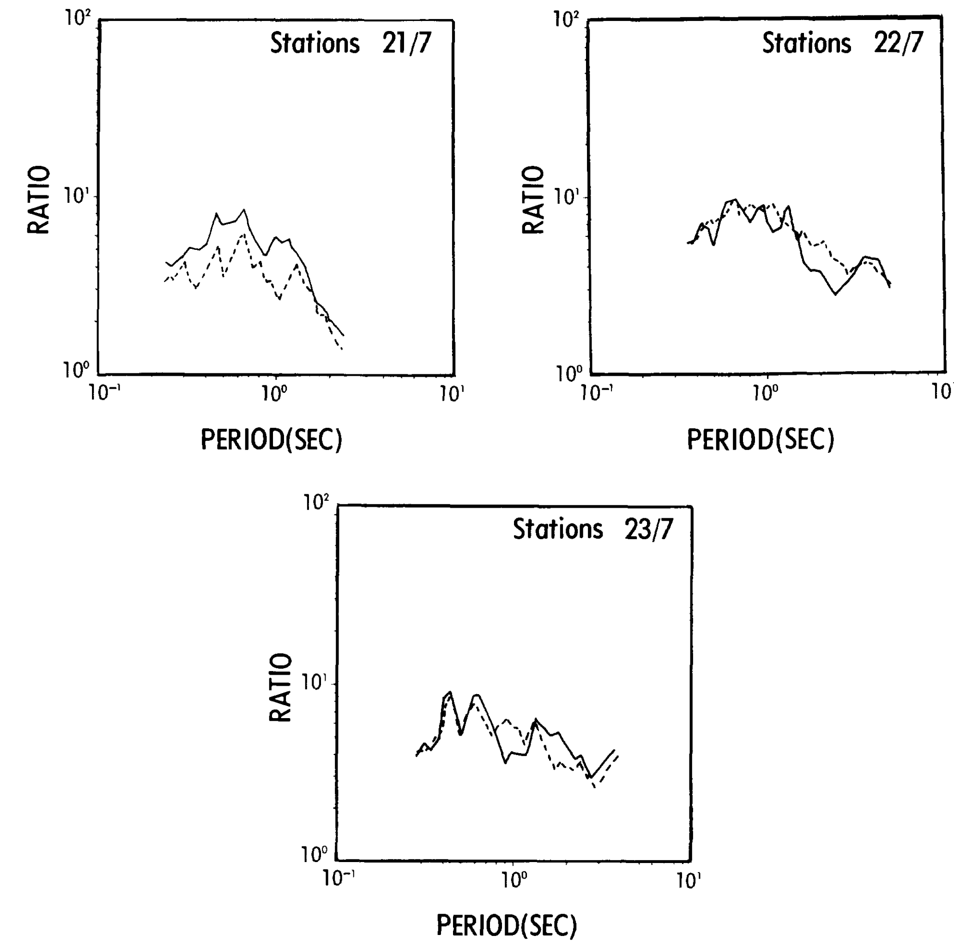


—— RADIAL COMPONENT

- - - - TRANSVERSE COMPONENT

SALT LAKE CITY

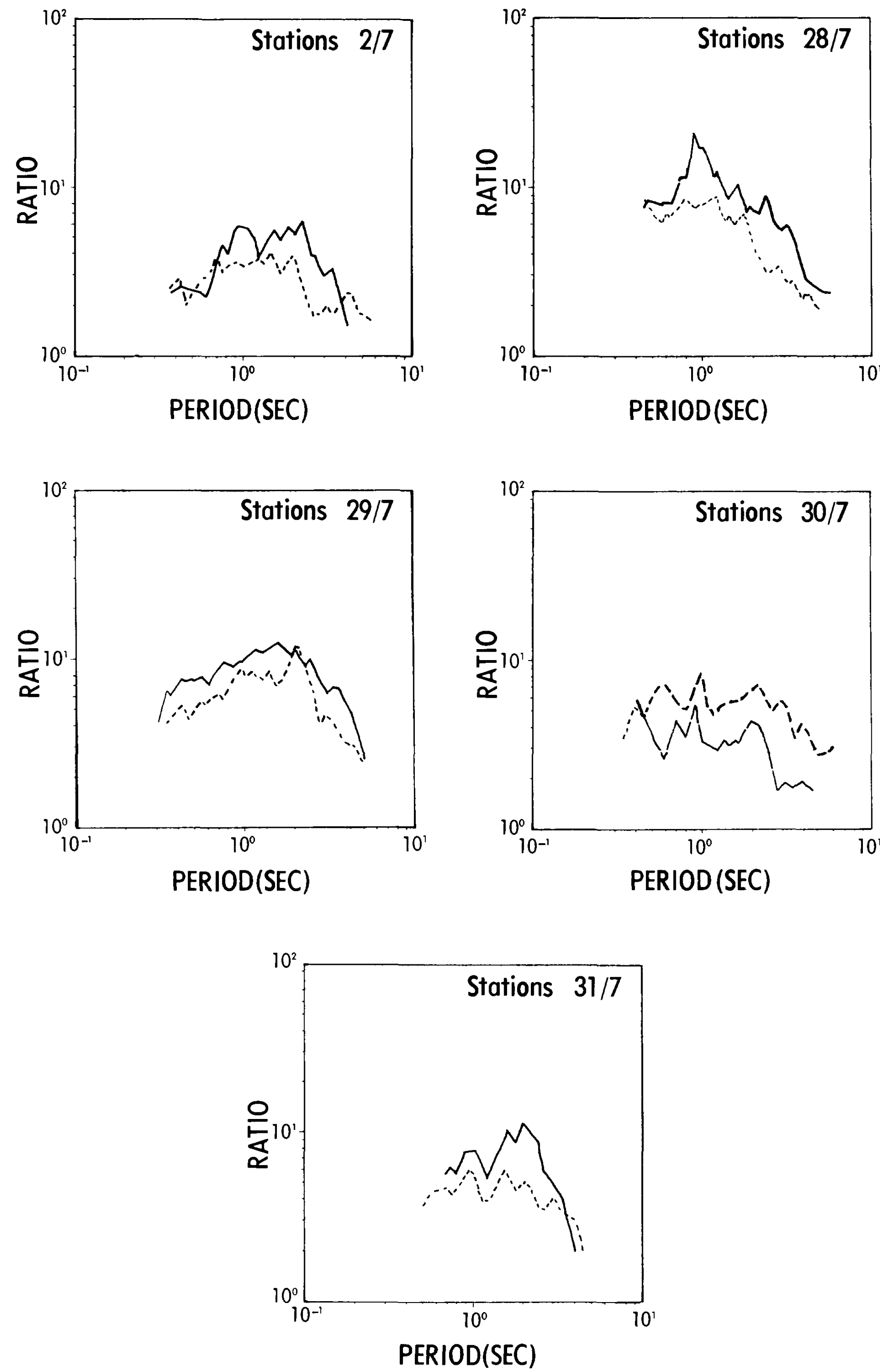
EVENT MARSILLY



—— RADIAL COMPONENT
----TRANSVERSE COMPONENT

SALT LAKE CITY

EVENT RUMMY

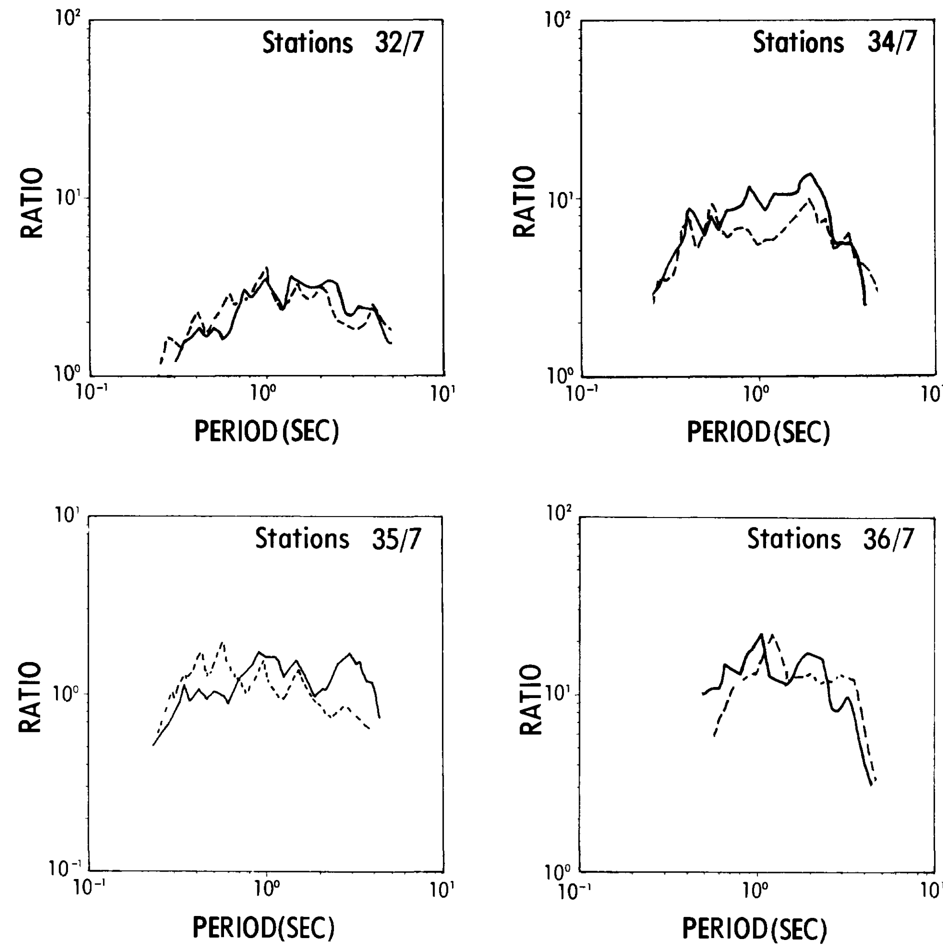


—— RADIAL COMPONENT

---- TRANSVERSE COMPONENT

SALT LAKE CITY

EVENT RUMMY

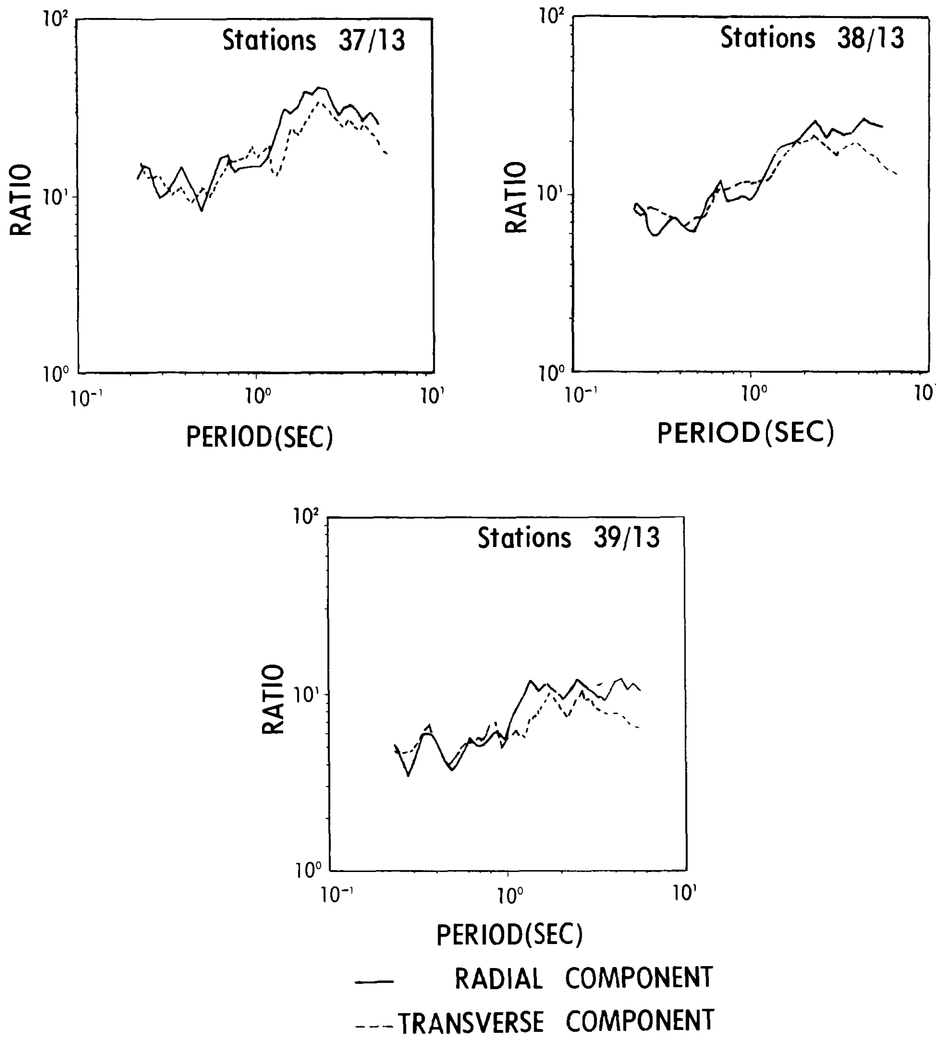


— RADIAL COMPONENT

---TRANSVERSE COMPONENT

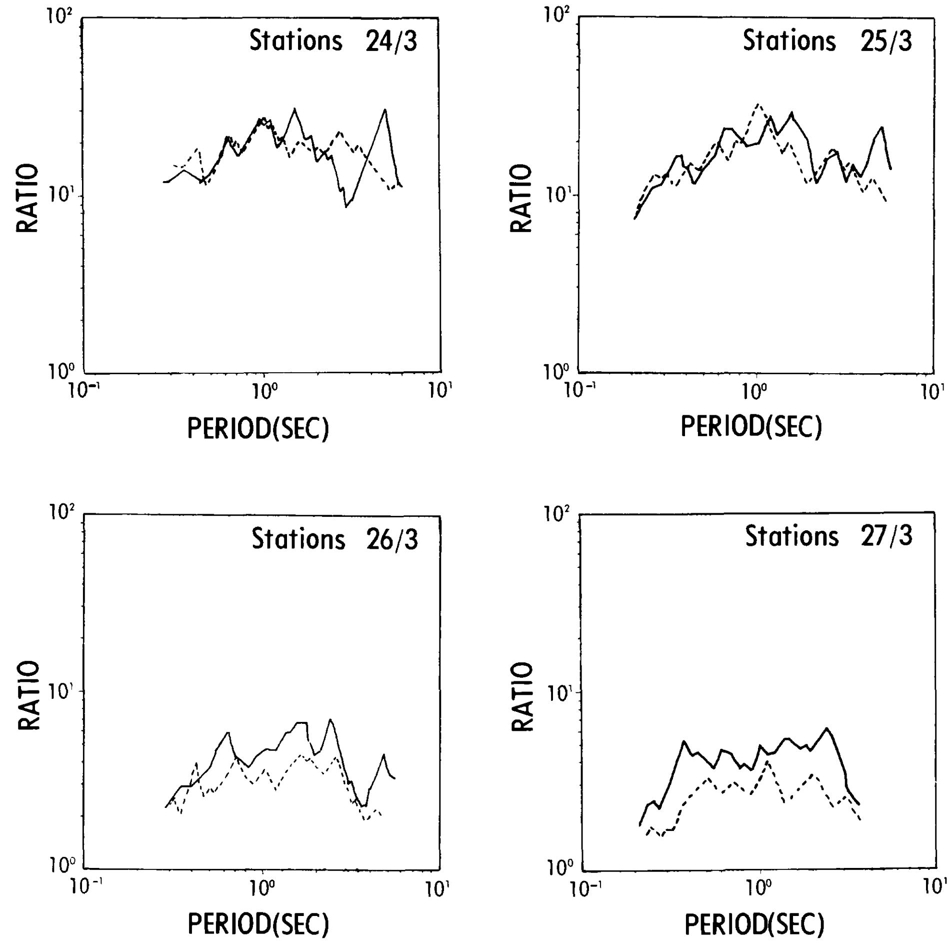
SALT LAKE CITY

EVENT SANDREEF



SALT LAKE CITY

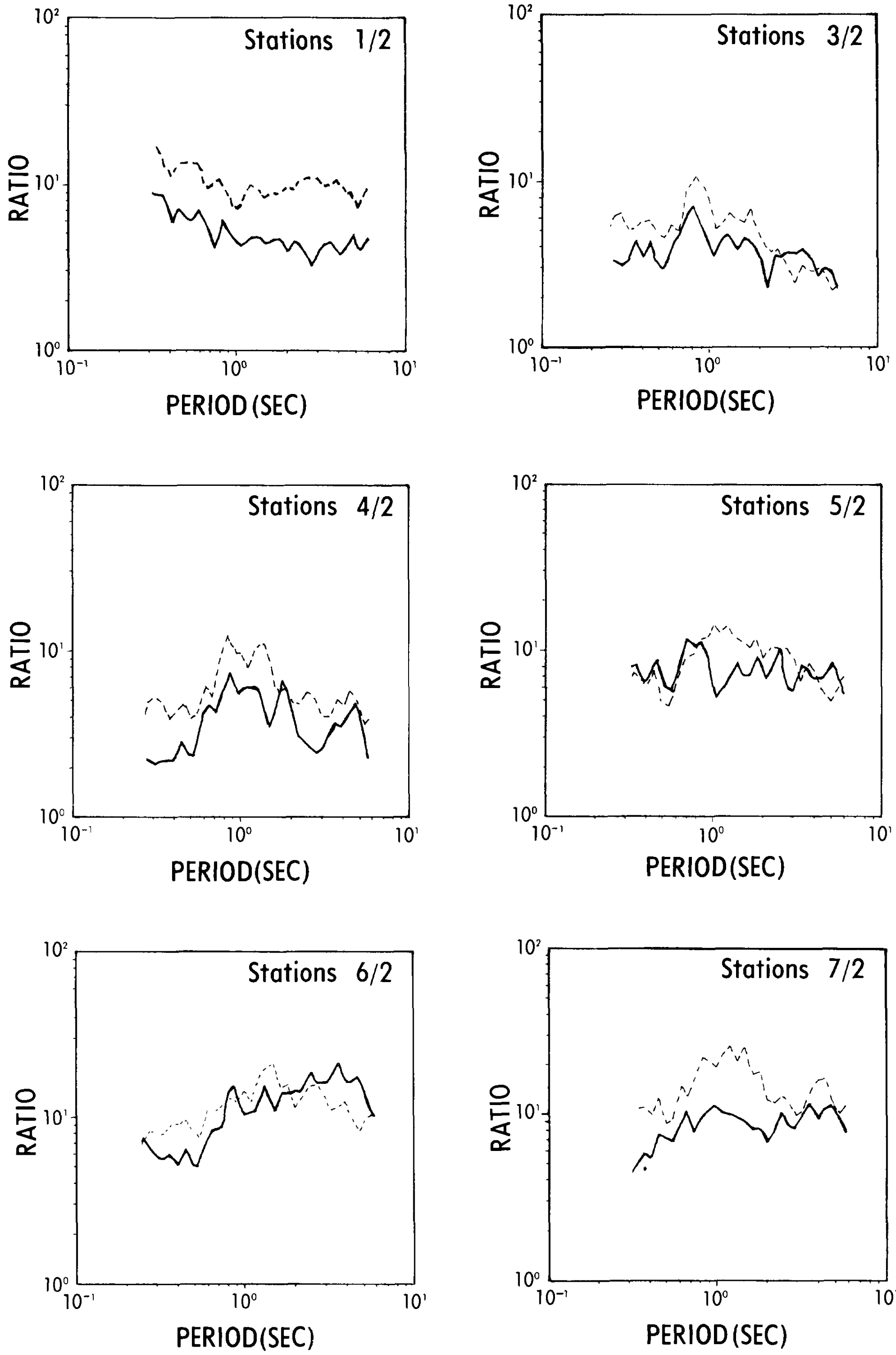
EVENT SCANTLING



— RADIAL COMPONENT

---- TRANSVERSE COMPONENT

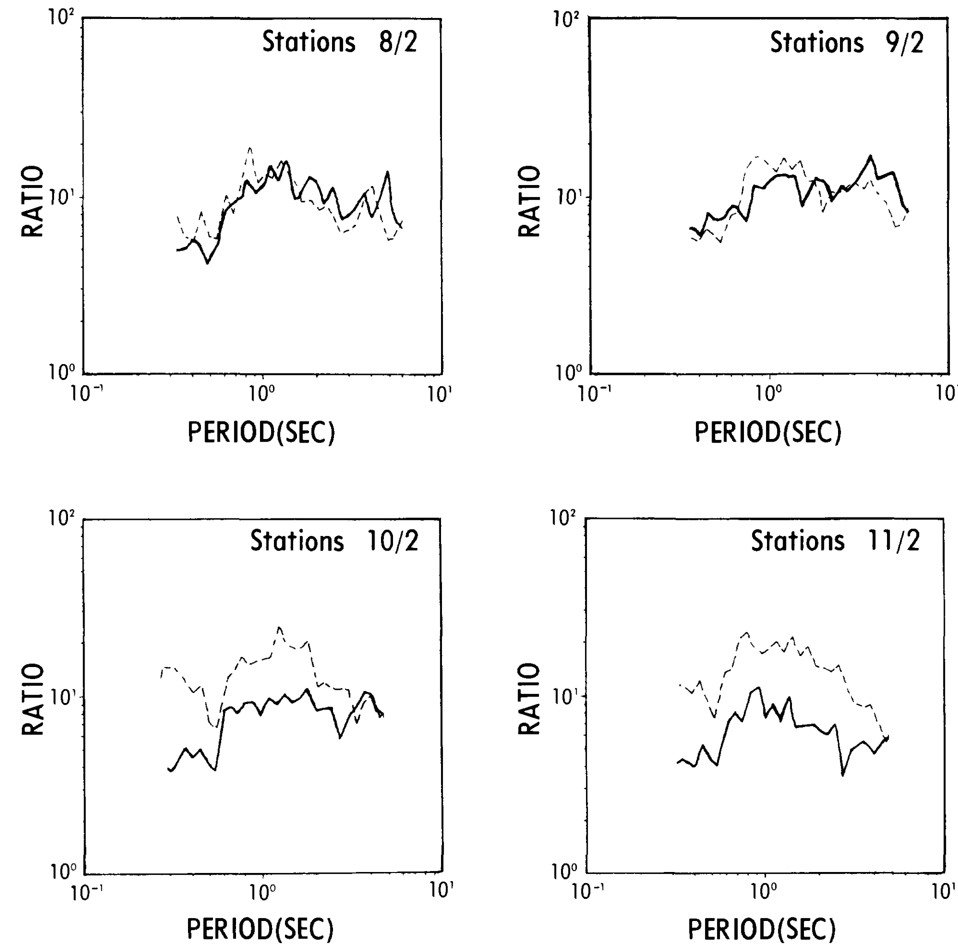
PROVO
EVENT REBLOCHON



—— RADIAL COMPONENT
---- TRANSVERSE COMPONENT

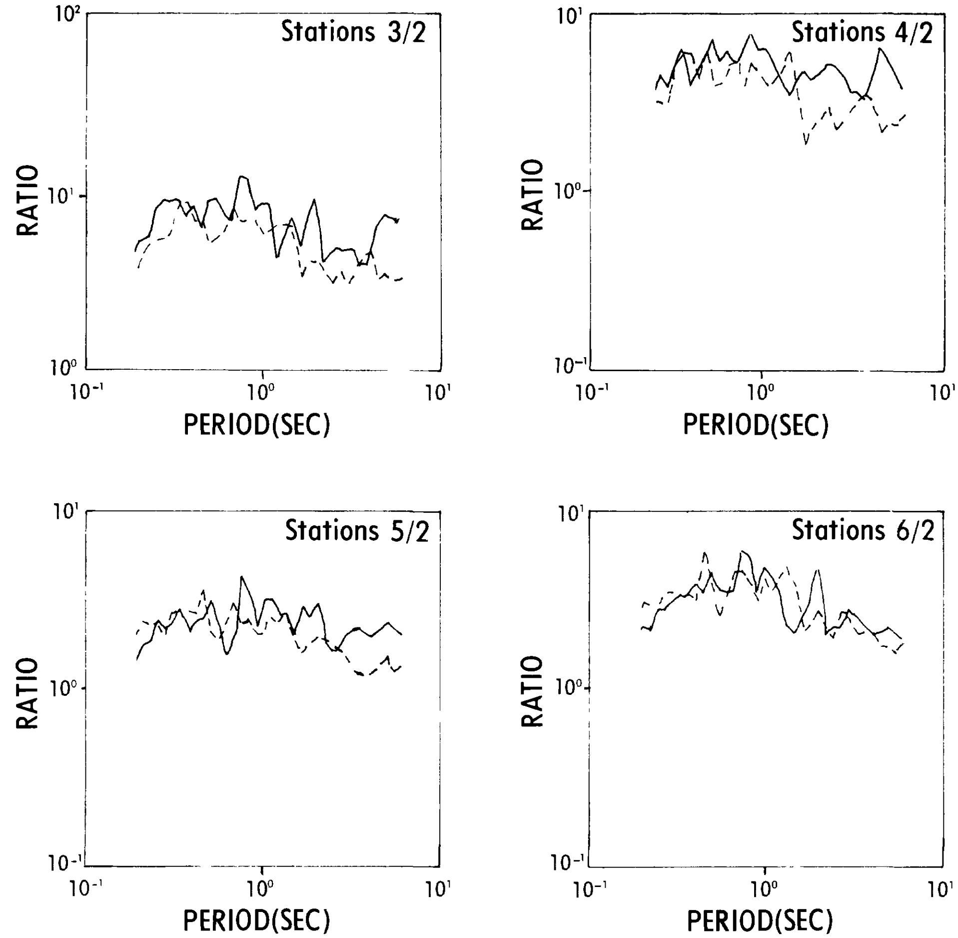
PROVO

EVENT REBLOCHON



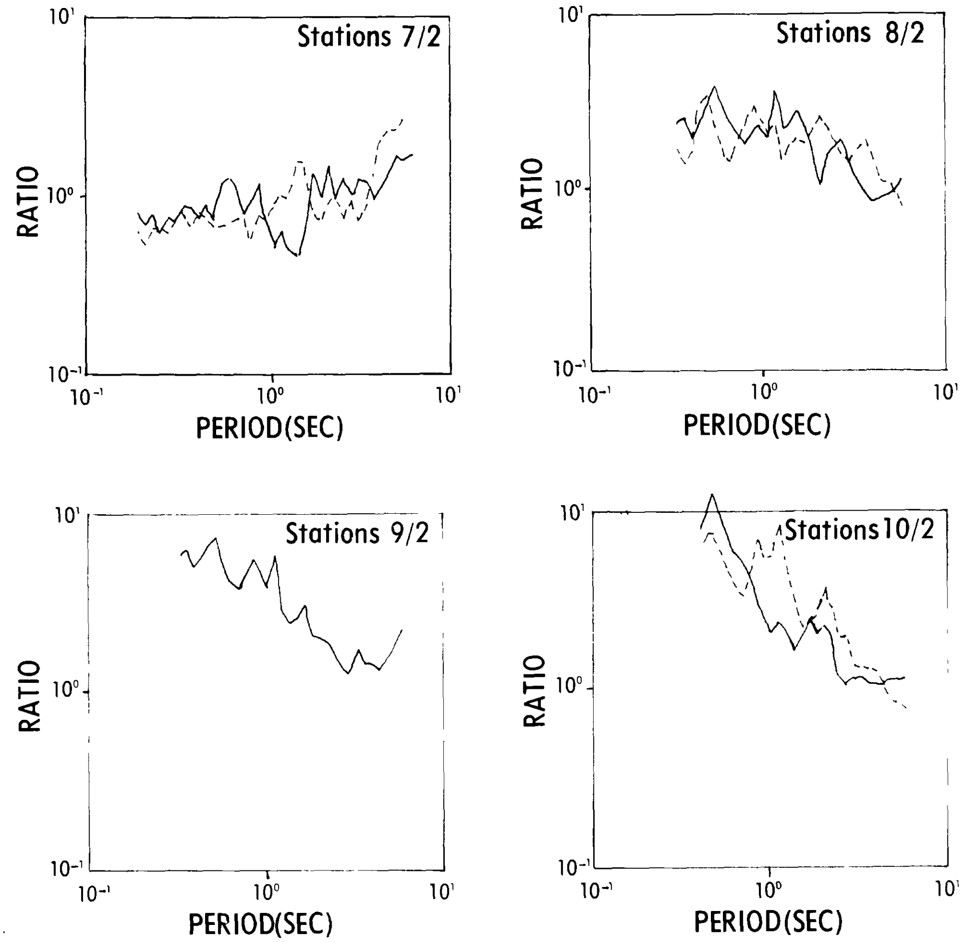
—— RADIAL COMPONENT
---- TRANSVERSE COMPONENT

CEDAR CITY
EVENT BURZET



—— RADIAL COMPONENT
- - -TRANSVERSE COMPONENT

CEDAR CITY
EVENT BURZET



—— RADIAL COMPONENT
- - -TRANSVERSE COMPONENT

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