EARTHQUAKE DATA FOR THE UTAH REGION

January 1, 1984 to December 31, 1985

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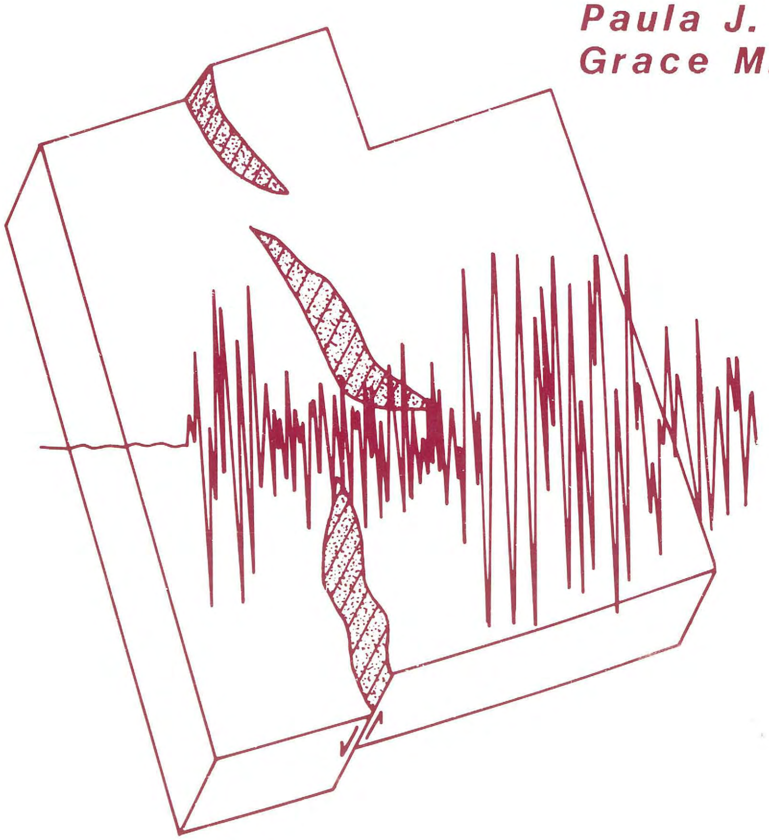

UNIVERSITY OF UTAH SEISMOGRAPH STATIONS
DEPARTMENT OF GEOLOGY AND GEOPHYSICS
UNIVERSITY OF UTAH

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December 1985

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CONTENTS

ILLUSTRATIONS

TABLES

PREFACE

This report continues a modern series of special publications begun by the University of Utah Seismograph Stations in 1979 (Arabasz et al., 1979) when a revised compilation was presented of all available earthquake data for the Utah region from 1850, the date of publication of the first newspaper in Utah, through June 1978. Subsequent publications cover the period July 1978-December 1980 (Richins et al., 1981) and the period January 1981-December 1983 (Richins et al., 1984b). This report extends the published record of earthquake activity in the Utah region through the years 1984 and 1985.

Although seismographic recording at the University of Utah's Salt Lake City campus began as early as 1907, instrumental surveillance of local earthquakes effectively dates from 1962 when the first three stations of a Utah network began continuous operation. The term "University of Utah Seismograph Stations" (UUSS) originally implied the small group of earthquake-recording installations of the 1960's, but now refers to an organizational entity. In effect, the UUSS is a research, educational, and public-service group that forms an integral part of a larger seismological research and teaching program within the Department of Geology and Geophysics of the University of Utah.

The earthquake information in this report was made possible by financial support from a number of organizations and agencies. During the 1984-1985 period, the most significant support for the operation of the University of Utah seismic network—and for associated earthquake research—was provided by the Earthquake Hazards Reduction Program of the U.S. Geological Survey, by the State of Utah, and by the U.S. Bureau of Reclamation. This includes: U.S. Geological Survey Contract Nos. 14-08-0001-21856, 14-08-0001-21857, 14-08-0001-21983, and 14-08-0001-A0265; and U.S. Bureau of Reclamation Contract Nos. 2-07-40-S2051, 5-PG-40-05190, and 6-PG-40-05650. Partial support for operation of the University of Utah's Worldwide Standardized Seismograph Station at Dugway, Utah, was provided by the U.S. Geological Survey, Branch of Global Seismology and Geomagnetism.

A key factor contributing to successful earthquake surveillance in the Utah region is the cooperation received from various seismological groups in the recording and location of local and regional earthquakes. UUSS directly records continuous seismic data from seismographic stations operated by: 1) the U.S. Geological Survey, Branch of Global Seismology and Geomagnetism, Golden, Colorado; 2) the U.S. Geological Survey, Branch of Geologic Risk Assessment, Golden, Colorado; 3) the Idaho National Engineering Laboratory, Idaho Falls, Idaho; 4) Ricks College, Rexburg, Idaho; and 5) Snow College, Ephraim, Utah. Also, seismic arrival-time data are kindly provided upon request for stations operating in southeastern Utah by Woodward-Clyde Consultants of San Francisco, California.

We sincerely thank all the individuals and organizations whose efforts, encouragement, cooperation, and financial assistance make possible the ongoing earthquake research and seismic network operations reflected in this report. We thank all the members of the seismology research group at the University of Utah for their contributing efforts—especially J.K. Whipp for extensive work maintaining and repairing the University of Utah seismic network, J.A. Barlow and L.B. Burnett for help in preparing this report, and R.B. Smith for his supportive involvement. We also thank R. Clothier for operating station PTI on a volunteer basis. Parts of this report are adapted from earlier UUSS publications, to which W.D. Richins made substantial contributions.

Salt Lake City, Utah
July 1986

Walter J. Arabasz
Director, UUSS

Ethan D. Brown
Senior Staff Seismologist

INTRODUCTION

The purpose of this report is to summarize data compiled by the University of Utah Seismograph Stations (UUSS) for local earthquakes in the Utah region during the period January 1, 1984 through December 31, 1985. The term "Utah region", as used in this report, signifies the rectangular area extending from latitude 36°45'N to 42°30'N, and from longitude 108°45'W to 114°15'W. This report is basically a continuation of previous catalogs of earthquake hypocentral and magnitude data presented in UUSS publications Earthquake Studies in Utah, 1850 to 1978 (Arabasz et al., 1979), Earthquake Data for the Utah Region July 1, 1978 to December 31, 1980 (Richins et al., 1981), and Earthquake Data for the Utah Region January 1, 1981 to December 31, 1983 (Richins et al., 1984b).

Since 1974, the UUSS has operated a modern telemetered network of high-gain short-period seismic stations in the Intermountain region. During 1974-1980, data from this network was centrally recorded at the University of Utah in Salt Lake City, primarily on 16-mm analog film recorders (Develocorders). On January 1, 1981, a computer system (described elsewhere in this report) provided by the U.S. Geological Survey for network recording became fully operational and the analog film recording was discontinued. In December 1985, the USGS network consisted of 81 stations, 27 of which were funded and maintained by other agencies. Local earthquake coverage extends throughout most of Utah—with a focus on the densely-populated Wasatch Front area—southeastern Idaho, and western Wyoming (Figure 1). Earthquake data for the region of Yellowstone National Park are reported separately (see Smith et al., 1986). In January 1981, central recording of the University of Utah seismic network was fully converted from analog film recording to computerized on-line digital recording (Richins et al., 1984b).

The heart of this report is a catalog of instrumentally located earthquakes for the Utah region during 1984 and 1985. Background information relevant to technical details of the catalog is provided in the preliminary sections. We refer the uninitiated reader to the earlier publication Arabasz et al., (1979) for more general background—either for understanding the seismological information or for better perspective on Utah earthquake activity.

The Appendices represent updated summaries that were begun in the 1979 issue of this series. They include abstracts from a selection of pertinent University of Utah graduate theses and a bibliography of selected seismological publications resulting from research at the University of Utah during the period of this report.

STATION DATA AND INSTRUMENTATION

The current seismic network recorded by the UUSS (see Figure 1) consists of 81 short-period vertical stations, 27 of which are operated and maintained by other agencies. Essential information for each station is summarized in Tables 1 and 2. Stations GMU and HVU have three short-period components. Station DUG operates as part of the World Wide Standardized Seismograph Network (WWSSN), and it has six short-period components (three components with low and high gain) telemetered to the University of Utah. All stations are centrally recorded at the University of Utah. The network has average station spacings of 15 to 35 km in north-central Utah, and 30 to 100 km in central and southwestern Utah. Six temporary stations in the Salt Lake Valley (inset, Figure 1) were added to the network during 1985 to provide additional coverage in that area.

The instrumentation in the current UUSS network is illustrated in the block diagram in Figure 2. Data from each seismometer are telemetered via telephone, microwave, and/or radio data transmission lines to a central recording facility located on the University of Utah campus in Salt Lake City. The standard instrumentation at each field site consists of a vertical seismometer with a natural frequency of 1.0 Hz, an amplifier/voltage controlled oscillator (VCO) package, a 100-milliwatt radio transmitter, a 9 db gain directional Yagi antenna, and interfacing electronics powered by air-cell batteries or solar electric panels. The central recording facility incorporates a bank of discriminators, an IRIG time code receiver, 12 drum recorders, and a PDP 11/34 computer.

At each field site, the seismometer acts as a transducer to convert ground motion to an electrical signal, which is amplified and converted into a frequency-modulated (FM) audio tone within the amplifier/VCO unit. Eight FM center frequencies ranging from 680 to 3060 Hz are in use with a 340 Hz separation between center frequencies and an individual fixed bandwidth of 250 Hz. Typically, data from several field sites are transmitted via VHF radio link in the 160-174 MHz range to a receiver site where up to eight data channels are multiplexed and transmitted to the University of Utah campus via additional VHF radio links and/or voice-grade telephone lines. At the recording site, each FM seismic signal is demodulated by a discriminator and the resulting amplified seismometer signal is routed to a multiplexed analog-to-digital (A/D) converter in the PDP 11/34 computer. A program in the PDP 11/34 continuously monitors all the seismic signals. When the occurrence of an earthquake is detected, the digitized signals are recorded on magnetic tape for the duration of the earthquake. In addition, 20 seismic signals are recorded on the drum recorders to provide a continuous visual record.

Figure 3 illustrates the response characteristics of the entire telemetered system from seismometer (Mark Products L4C or Geotech S13) to the input of the A/D converter. The complete system gain ranges from 1.0 x 10^6 counts/cm/sec to 8.0 x 10^6 counts/cm/sec. The gain for a particular station is determined according to the level of ground noise at the site.

UUSS Network
December 1985

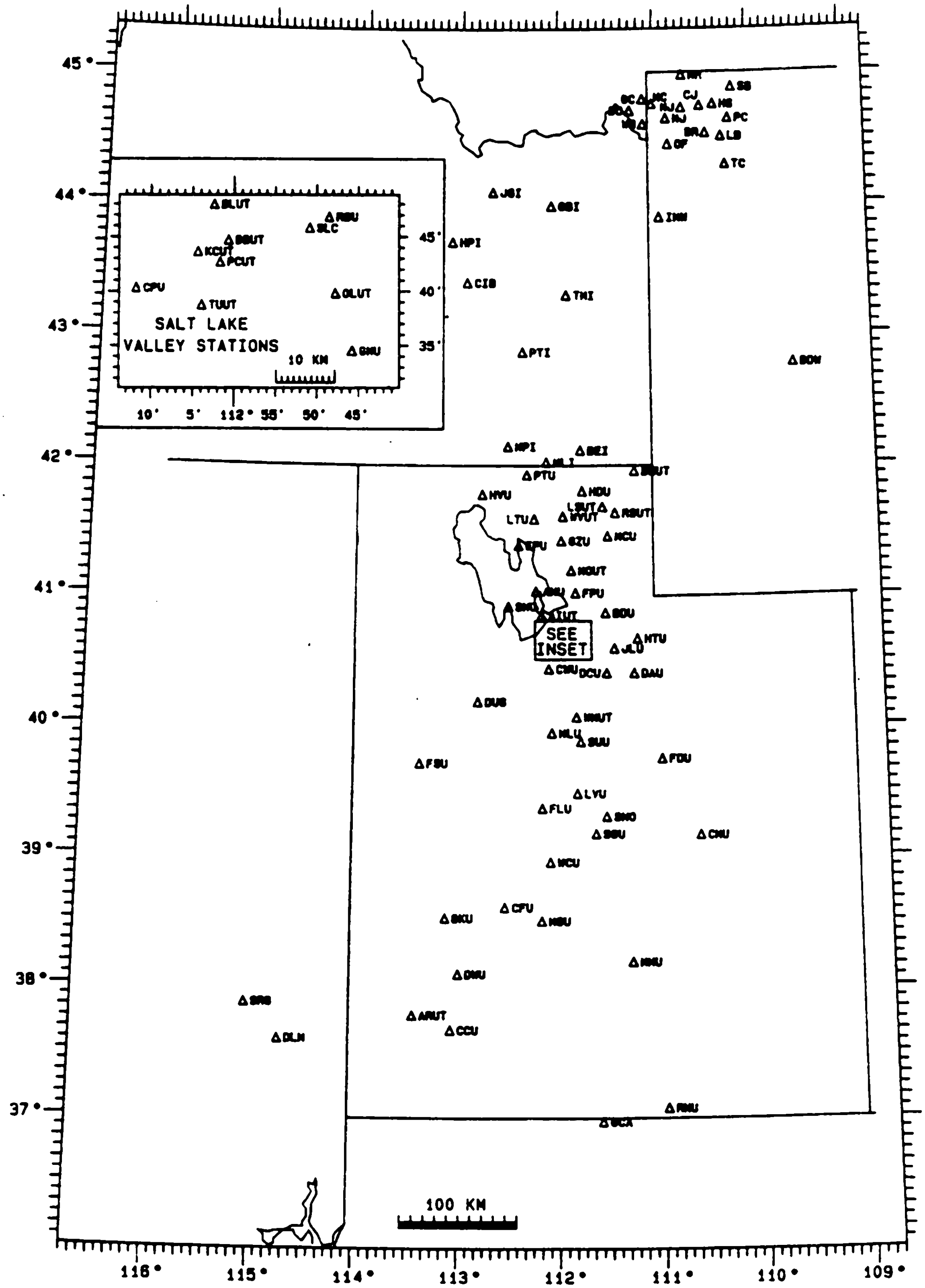


Figure 1

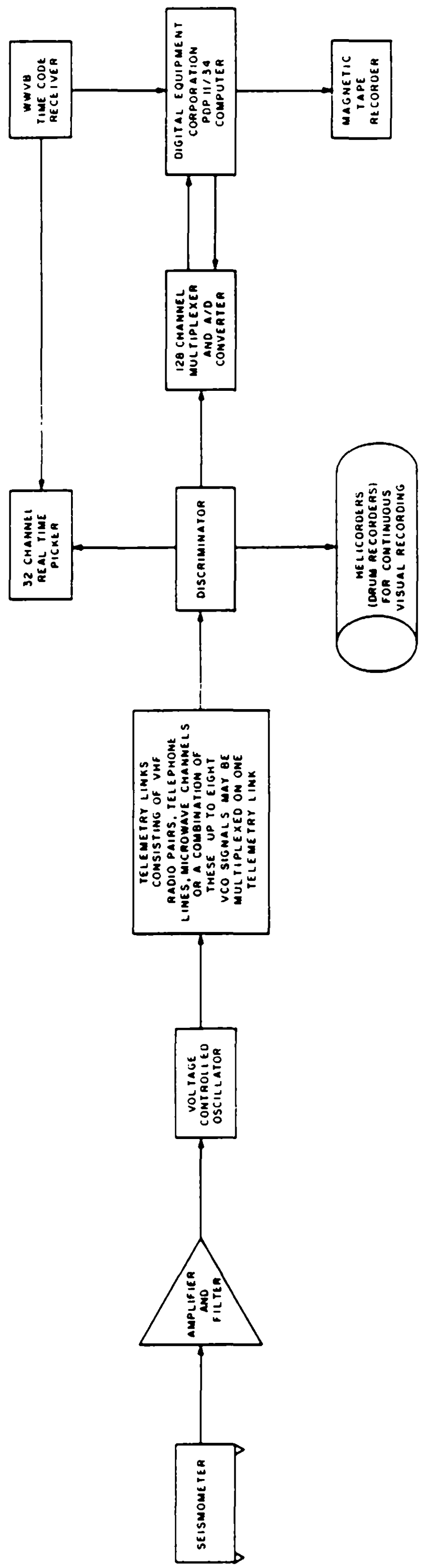
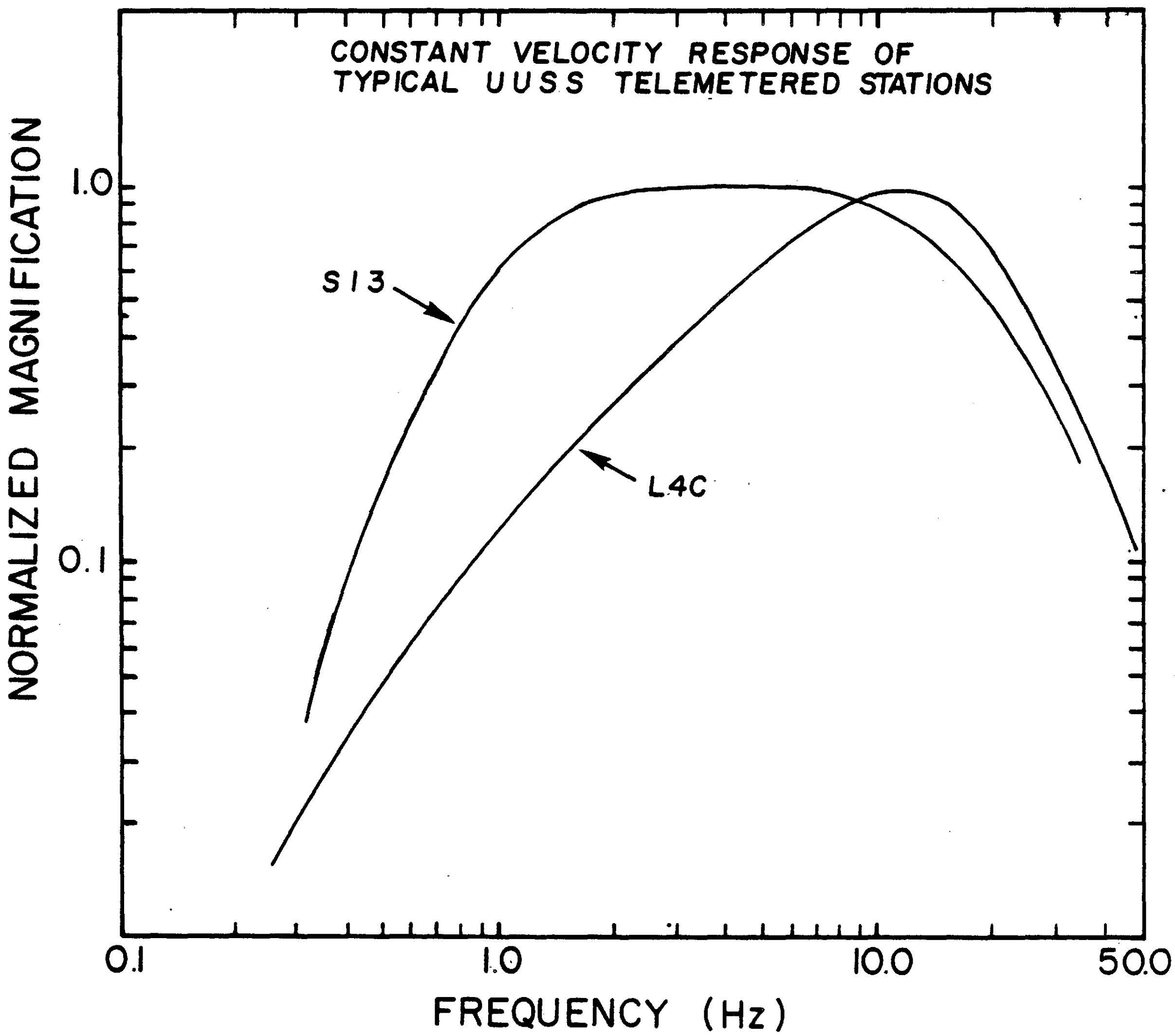

SEISMOMETER
AMPLIFIER AND FILTER
VOLTAGE CONTROLLED OSCILLATOR
TELEMETRY LINKS CONSISTING OF VHF RADIO PAIRS, TELEPHONE LINES, MICROWAVE CHANNELS OR A COMBINATION OF THESE UP TO EIGHT VCO SIGNALS MAY BE MULTIPLEXED ON ONE TELEMETRY LINK
DISCRIMINATOR
HELICORDERS (DRUM RECORDERS) FOR CONTINUOUS VISUAL RECORDING
32 CHANNEL REAL TIME PICKER
128 CHANNEL MULTIPLEXER AND A/D CONVERTER
WWVB TIME CODE RECEIVER
DIGITAL EQUIPMENT CORPORATION PDP 11/34 COMPUTER
MAGNETIC TAPE RECORDER

Figure 2



CONSTANT VELOCITY RESPONSE OF
TYPICAL UUSS TELEMETERED STATIONS
NORMALIZED MAGNIFICATION
1.0
0.1
S13
L4C
0.1
1.0
10.0
50.0
FREQUENCY (Hz)

Figure 3

Station siting is constrained by several factors including accessibility (especially difficult during winter months), requirements for unobstructed line-of-sight radio transmission, exposure of competent bed rock if available, difficulty in obtaining land permits, and the need to effectively cover seismically active areas of Utah. Economic factors also govern the variable station spacing within the network.

Table 1

OPERATING STATIONS, DECEMBER 1985

Code	Station Name	N-Lat	W-Long	Elev (m)	Date Open**
ANU	Antelope Island, UT	41°02.38'	112°13.90'	1353	11/75
AIUT	So.Antelope Island, UT	40°51.35'	112°10.53'	1334	04/83
ARUT	Antelope Range, UT	37°47.28'	113°26.42'	1646	12/80
BBUT	Bumble Bee, UT	40°44.73'	112°00.67'	1291	07/85
BLUT	Baily Lake, UT	40°48.02'	112°02.40'	1286	10/85
BDU	Big Dutch Hollow, UT	40°52.45'	111°32.04'	2198	09/74
BDW	Boulder, WY*	42°46.57'	109°34.10'	2190	06/77
BEI	Bear River Range, ID	42°07.00'	111°46.94'	1859	10/74
BKU	Beaver Lake Mts., UT	38°32.11'	113°07.61'	1859	12/80
BMUT	Black Mt., UT	41°57.49'	111°14.05'	2243	10/79
CCU	Cedar City, UT	37°40.52'	113°04.11'	1775	12/68
CFU	Cove Fort, UT	38°37.13'	112°32.32'	2012	03/77
CIB	Cedar Butte, ID*	43°24.07'	112°56.51'	1611	03/81
CMU	Cedar Mt., UT	39°10.28'	110°37.16'	2332	06/78
CPU	Coon Peak, UT	40°40.34'	112°11.78'	2377	11/74
CWU	Camp Williams, UT	40°26.75'	112°06.13'	1945	10/74
DAU	Daniels Canyon, UT	40°24.75'	111°15.35'	2771	11/74
DCU	Deer Creek Res., UT	40°24.82'	111°31.61'	1829	11/74
DLM	Delmar Mts., NV*	37°36.35'	114°44.33'	1730	03/80
DUG	Dugway, UT	40°11.70'	112°48.80'	1477	05/62
DWU	Dry Willow, UT	38°06.32'	112°59.85'	2270	09/82
EPU	E. Promontory, UT	41°23.49'	112°24.53'	1436	09/75
FDU	Ford Ridge, UT	39°45.41'	110°59.40'	2975	03/78
FLU	Fools Peak, UT	39°22.69'	112°10.23'	1950	09/81
FPU	Francis Peak, UT	41°01.58'	111°50.21'	2816	09/74
FSU	Fish Springs, UT	39°43.35'	113°23.48'	1487	06/79
GBI	Big Grassy Butte, ID*	43°59.25'	112°03.80'	1561	12/81
GCA	Glen Canyon. AZ*	36°58.42'	111°35.58'	1339	12/76
GMU	Granite Mt., UT	40°34.53'	111°45.79'	1829	08/70
GZU	Grizzly Peak, UT	41°25.53'	111°58.50'	2646	11/81
HDU	Hyde Park, UT	41°48.27'	111°45.89'	1853	03/75
HPI	Howe Peak, ID*	43°42.68'	113°05.90'	2597	03/81
HTU	Hoyt Peak, UT	40°40.52'	111°13.21'	2576	11/74
HVU	Hansel Valley, UT	41°46.78'	112°46.50'	1609	11/76
IMW	Indian Meadow, WY*	43°53.82'	110°56.35'	2646	08/80
JGI	Juniper Gulch, ID*	44°05.56'	112°40.61'	1657	02/80
JLU	Jordanelle, UT	40°36.11'	111°26.95'	2304	09/81
KCUT	Kersey Creek, UT	40°43.66'	112°04.37'	1288	08/85
LSUT	Lucky Star, UT	41°41.09'	111°33.45'	2225	11/79
LTU	Little Mt., UT	41°35.51'	112°14.83'	1585	09/74
LVU	Levan Peak, UT	39°29.50'	111°49.60'	2530	01/78
MCU	Monte Cristo Peak, UT	41°27.70'	111°30.45'	2664	12/74

OPERATING STATIONS, DECEMBER 1983 (Continued)

Code	Station Name	N-Lat	W.Long	Elev (m)	Date Open**
MLI	Malad Range, ID	42°01.61'	112°07.53'	1896	10/74
MMU	Miners Mt., UT	38°11.91'	111°17.66'	2387	10/80
MOUT	Mount Ogden, UT	41°11.94'	111°52.73'	2743	09/80
MSU	Marysvale, UT	38°30.80'	112°10.45'	2141	11/75
NLU	North Lily, UT	39°57.29'	112°04.50'	2036	08/81
NPI	N. Pocatello Valley, ID	42°08.84'	112°31.10'	1640	04/75
OLUT	Mount Olympus, UT	40°39.83'	112°47.76'	1646	01/86
PCUT	Pear Courtright, UT	40°42.72'	112°01.68'	1295	08/85
PTI	Pocatello, ID	42°52.22'	112°22.21'	1670	10/84
PTU	Portage, UT	41°55.76'	112°19.48'	2192	12/76
RBU	Red Butte Canyon, UT	40°46.85'	111°48.50'	1676	06/74
RMU	Rainbow Bridge, UT*	37°04.56'	110°58.20'	1536	11/81
RSUT	Red Spur, UT	41°38.31'	111°25.90'	2682	10/79
SGU	Sterling, UT	39°10.97'	111°38.60'	2365	10/78
SLC	Salt Lake City, UT	40°45.83'	111°50.87'	1423	04/62
SNO	Snow College, UT*	39°18.86'	111°32.28'	2446	10/81
SNU	Stansbury North, UT	40°55.43'	112°30.60'	1378	05/78
SRG	Seaman Range, NV*	37°52.93'	115°04.08'	1645	03/80
SUU	Santaquin Canyon, UT	39°53.32'	111°47.50'	1987	08/74
TMI	Taylor Mt., ID*	43°18.33'	111°55.09'	2179	12/76
TUUT	Thad Utley, UT	40°38.77'	112°03.92'	1573	11/85
WCU	Willow Creek, UT	38°57.88'	112°05.40'	2714	01/78
WMUT	West Mountain, UT	40°04.60'	111°50.00	1981	08/81
WVUT	Wellsville, UT	41°36.61'	111°57.55'	1828	08/79
YPBR	Bridge Bay, YNP*	44°32.20'	110°26.37'	2383	12/83
YPCJ	Canyon Village, YNP*	44°44.63'	110°29.85'	2426	12/83
YPDC	Denny Creek, YNP*	44°42.57'	111°14.38'	2025	12/83
YPGC	Grayling Creek, YNP*	44°47.77'	111°06.39'	2075	12/83
YPHS	Hot Springs Basin, YNP*	44°45.33'	110°21.24'	2621	12/83
YPLB	Lake Butte, YNP*	44°30.68'	110°16.32'	2565	12/83
YPMC	Maple Creek, YNP*	44°45.56'	111°00.37'	2073	12/83
YPMH	Mammoth Hot Springs, YNP*	44°58.62'	110°41.12'	1781	12/83
YPMJ	Madison Junction, YNP*	44°38.90'	110°51.52'	2111	12/83
YPNJ	Norris Junction, YNP*	44°43.82'	110°41.58'	2290	12/83
YPOF	Old Faithful, YNP*	44°27.15'	110°50.48'	2260	12/83
YPPC	Pelican Cone, YNP*	44°38.84'	110°11.58'	2939	12/83
YPSB	Soda Butte, YNP*	44°53.04'	110°09.06'	2072	12/83
YPTC	Trail Creek, YNP*	44°17.79'	110°13.92'	2360	12/83
YPWB	West Yellowstone, YNP*	44°36.35'	111°06.05'	2310	12/83

* Station operated by other agency and recorded by UUSS.

**Date open indicates beginning of data recording at University of Utah

Note: Each station has a vertical-component short-period seismometer. Stations GMU and HVU are three-component stations. Station DUG is a six-component station (three high-gain, three low-gain) Station DUG is a World-wide Standardized Seismograph Station.

Table 2

DISCONTINUED STATIONS, DECEMBER 1985

Code	Station Name	N-Lat	W-Long	Elev(m)	Open	Closed
ETU	E. Traverse Mts., UT	40°28.64'	111°50.67'	1884	07/74	11/83
GRCI	Grant Creek, ID*#	43°58.00'	113°59.35'	2341	11/83	4/84
HID	Hamer Butte, ID*	43°57.78'	112°09.83'	1527	12/76	10/81
JECI	Jemson Cabin, ID*#	44°22.33'	114°11.05'	2135	11/83	8/84
KDUT	Kidman Hollow, UT	41°43.28'	112°01.75'	1829	10/78	6/85
LBUT	Lower Brown's Hole, UT	41°18.58'	111°43.90'	1768	08/78	05/81
LGUI	Leaton Gulch, ID*#	44°31.78'	114°04.55'	2538	11/83	8/84
LWA	Lower Mag Wash, UT*	38°29.32'	112°51.71'	1817	02/81	02/82
MCPI	Mackay Peak, ID*#	43°54.02'	113°42.27'	2902	11/83	8/84
PBU	Perry Basin, UT	41°28.09'	112°00.58'	1625	09/75	11/81
PCY	Pole Canyon, UT*	38°20.07'	112°54.15'	2033	02/81	01/82
RVUT	Riverside, UT	41°50.30'	112°15.55'	1951	09/79	10/81
SAU	Saltair, UT	40°49.18'	112°04.38'	1283	03/74	04/82
SHUT	Spring Hollow, UT	41°43.80'	111°41.13'	2716	11/81	08/83
SURI	Summit Reservoir, ID*#	44°18.35'	113°28.95'	2324	11/83	8/84
WHU	Wild Horse, UT	39°22.83'	112°10.19'	1993	10/74	09/81
WICI	Willow Creek, ID*#	44°10.46'	113°53.13'	2088	11/83	8/84
WMU	West Mountain, UT	40°05.30'	111°49.36'	2054	12/73	08/81
YNJ[1]	Norris Junction, YNP*	44°43.82'	110°41.58'	2290	09/81	11/81
YPGV	Grant Village, YNP*	44°22.85'	110°32.72'	2430	12/83	10/85
YPMC[1]	Maple Creek, YNP*	44°45.56'	111°00.37'	2073	11/80	11/81

*Station operated by other agency and recorded by UUSS

#Stations installed by the U.S. Geological Survey following the October 28, 1983 M_s7.3 Borah Peak, Idaho, earthquake.

Note: "Open" and "Closed" in this table indicate the period for which seismic data are on file at the University of Utah.

[1]YPMC was used alternately with YNJ from September 1981 until November 1981.

DATA PROCESSING AND ANALYSIS

General Procedure

During the period of this report, seismic network data were chiefly recorded on digital tape using the PDP 11/34 computer system operating in an event detection mode. The on-line recording system is closely modeled after the CEDAR system designed by C. Johnson (1979). The current code was written at the University of Washington by A. Bittenbinder. The system is currently capable of recording 128 channels of digital data, including time code, in a multiplexed format on tape. Prior to January 1984 the recording capacity of the system was 64 channels.

Tapes written by the on-line PDP 11/34 system are read onto a PDP 11/70 computer for analysis and eventual archival of the seismic data. Software developed primarily by S. Malone, A. Bittenbinder and D. Leaver at the University of Washington was adapted to the UUSS PDP 11/70 system for routine earthquake analysis. The following steps summarize the analysis process:

1) Demultiplexing and scanning. Data tapes from the PDP 11/34 system are demultiplexed (a software process that separates the multiplexed 64 or 128 channel data into individual data files) and scanned to identify seismic events of interest. Scanning is accomplished by visually examining trace data from individual stations displayed on either a Versatec printer/plotter or a Tektronix graphics terminal.

2) Timing. Events provisionally identified as local earthquakes within the UUSS network are timed as accurately as possible (with reading errors less than about ±0.1 sec for the best data) using the computer program "PING". This routine uses the Tektronix interactive graphics terminals to display seismic trace data from individual stations. Each channel may be scaled in either time or amplitude, band-pass filtered to reduce site or transmission noise, and saved or deleted from the archive file at the option of the analyst. Arrival times and total signal duration can be read using the terminal cursor controls. These data are automatically stored on disk. A time code trace is used to establish absolute timing.

3) Location procedure. The computer program HYPOINVERSE (Klein, 1978) is used for earthquake location as described in the next section. The hypocentral solution for each event is analyzed by a geophysicist and checked for errors. Arrival times having large residuals are re-timed. Additional data are sought for events having a poor spatial distribution of stations. Poor hypocentral solutions are reprocessed and checked for remaining errors. Small earthquakes (magnitude < 1.5) that cannot be reliably located are deleted.

4) Data archival. Seismic trace data as well as arrival times, signal durations, first motions, location, origin time, and magnitude information are archived on digital tape for each local earthquake processed.

5) Elimination of blasts and check for completeness. Located seismic events identifiable as blasts are deleted. To ensure that all data are accounted for, final data files are correlated with preliminary scanning lists, felt earthquake lists, press releases, and the U.S. Geological Survey publication Preliminary Determination of Epicenters.

6) Magnitude check. Available Wood-Anderson seismograms are examined and read for all earthquakes with local magnitude greater than 2.7.

7) Final processing. A final batch run on the computer is made of all data to create a catalog summary of hypocentral information.

Earthquake Location Techniques

The computer program HYPOINVERSE (Klein, 1978) was used to locate earthquakes in the Utah region for the January 1984 through December 1985 time period. This program determines hypocenters by minimizing differences between observed and computed travel-times using a generalized inverse (singular value decomposition) technique. Computed travel-times are calculated by assuming a trial hypocenter and then finding the appropriate ray path through a horizontally layered velocity model back to each station.

Two velocity models were used in order to approximate the transition in crustal structure across Utah from the Basin and Range province on the west to the Middle Rocky Mountains-Colorado Plateau on the east. A third velocity model was used to model crustal structure for stations in the southeast/central Idaho-western Wyoming area.

The first model, informally designated the "Wasatch Front model," was applied to all stations west of 111°W longitude and south of 42.5°N latitude, with the exception of GCA and MMU. The model was determined by seismic refraction profiling (Keller *et al.*, 1975) south of Salt Lake City along the Basin and Range-Colorado Plateau transition zone using local quarry blasts. A 7.9 km/sec halfspace at 42 km depth has been added in order to fit observed travel time data from earthquakes at distances greater than about 250 km (Pechmann *et al.*, 1984). The model is specified by:

Layer	Depth (km)	P-Velocity (km/sec)
1	0 to 1.4	3.4
2	1.4 to 15.5	5.9
3	15.5 to 25.4	6.4
4	25.4 to 42.0	7.5
5	42.0+	7.9

The second model, informally designated the "Colorado Plateau model," was applied to all stations east of 111°W longitude and south of 40°N latitude plus GCA and MMU. This model is modified from Roller (1965) and is specified by:

Layer	Depth (km)	P-Velocity (km/sec)
1	0 to 1.5	3.4
2	1.5 to 27.5	6.2
3	27.5 to 40.0	6.8
4	40.0 to 80.0	7.8
5	80.0+	7.9

The third model, informally designated the "southeast Idaho model," was applied to all stations north of 42.5°N latitude. This model was determined for analysis of the 1983 Borah Peak, Idaho sequence using data from several seismic refraction profiles near Mackay, Idaho (Richins et al., 1985).

Layer	Depth (km)	P-Velocity (km/sec)
1	0 to 1.1	4.8
2	1.1 to 6.5	5.6
3	6.5 to 18.0	6.2
4	18.0 to 40.0	6.8
5	40.0+	8.0

Reliable S-wave arrival times for stations less than 75 km from the epicenter were used in addition to P-wave arrival times whenever possible, with an empirically determined ratio of 1.74 for V_p/V_s corresponding to a Poisson's ratio of 0.25. S-wave arrivals prove particularly helpful in controlling locations near or slightly outside the boundaries of the network. Corrections for elevation were made to a datum level of 1500 m (above mean sea level) using the angle of incidence and the near-surface velocity of 3.4 km/sec for P-waves and 1.95 km/sec for S-waves. Some corrections are as large as 0.3 sec for P-waves. Empirical station delays were not applied to the data set due to the large geographical area involved.

Magnitude Estimation

Magnitude estimates for earthquakes in the Utah region are based directly or indirectly on the Richter local magnitude (M_L) scale. We refer the reader to Griscom and Arabasz (1979) for a critical evaluation of local magnitude in the Utah region, and for the technical basis of the following discussion.

For the larger earthquakes in this catalog, local magnitude was determined directly from measurements of peak amplitude on standard Wood-Anderson-type seismographs operating at Dugway and Salt Lake City, Utah, using Richter's original definition:

$$M_L = \log A - \log A_o$$

Here, A is the maximum trace amplitude recorded for a given earthquake at a given distance, and log A_o is a distance correction taken from Richter (1958). The Wood-Anderson instrument operating at Dugway is a true Wood-Anderson torsional seismograph built to the original specifications. The instrument at Salt lake City is an electronically simulated Wood-Anderson. When available, magnitude esimates from both horizontal components at each of the two stations were averaged to obtain the M_L value for the earthquake. If measurements from only one of the two Wood-Anderson stations were available, the M_L value was averaged with a coda magnitude (M_C) calculated from the total signal duration measured on paper records from the Benioff short-period vertical seismograph at Dugway. The relation used was:

$$M_C = -4.26 + 2.79 \log\tau + 0.0026\Delta$$

where τ is the total signal duration in seconds measured from the P-wave onset and Δ is the epicentral distance in kilometers. Using this equation, the standard error of magnitude estimation compared to M_L values determined directly from Wood-Anderson amplitude measurements is $\pm$ 0.28. Magnitudes from Wood-Anderson records and duration measurements on the Dugway Benioff are indicated by a "W" in the earthquake listings.

Wood-Anderson magnitudes cannot be determined for most earthquakes in Utah because Wood-Anderson instruments are operated at relatively low gains. Magnitudes for the majority of the earthquakes in this catalog were estimated from signal durations measured from digital recordings of the telemetry stations. These magnitudes were calculated using the equation

$$M_C = -3.13 + 2.74 \overline{\log\tau} + 0.0012\overline{\Delta}$$

were $\overline{\log\tau}$ is the average logarithm of total signal duration in seconds (measured from the P-wave onset) and $\overline{\Delta}$ is the average epicentral distance in kilometers. This equation was originally determined by calibration of duration measurements from 16 mm Develocorder film records against Wood-Anderson local magnitudes. Preliminary evaluations indicate that this equation yields reasonable magnitude estimates when applied to signal durations from the digital data. Signal durations for some earthquakes were problematical because the computer stopped recording before the end of the seismic signal. Research on refined methods of magnitude determination using the digital data is currently under way.

It is important to note compelling evidence that coda-magnitude scales cannot justifiably be extrapolated below about M_L = 1.5 without special calibration (Bakun and Lindh, 1977; Suteau and Whitcomb, 1979). Thus, magnitudes below 1.5 listed in this catalog should be interpreted only as indicating relatively small size.

Quality and Completeness of Data

The quality of hypocenter locations is governed by many factors and should be considered when assessing earthquake hazards, comparing relative seismicity of various parts of Utah, associating earthquakes with mapped faults, and in other applications of these data. The accuracy (difference between actual and calculated locations) is limited by systematic errors such as inadequate velocity models, possible consistent misidentification of phases, and systematic station delays (dependent on the local geology beneath the site). Accuracy can be evaluated using data from explosions where the origin time and location is known. Precision (a measure of the ability to recalculate the same location, which determines the reliability of seismicity patterns) is affected by random timing errors and the use of a variety of station subsets. Precision can be estimated for each earthquake using standard statistical methods in the location routine, HYPOINVERSE (Klein, 1978).

For each earthquake located, four parameters that relate to the quality of the solution (NO, GAP, DMN, and RMS; see Data Explanation, Page 37) are listed. HYPOINVERSE (Klein, 1978) also calculates lengths in kilometers and orientations of the three mutually perpendicular principal axes of a confidence ellipsoid. The earthquake hypocenter has a statistical probability of 32 to 95% (depending on user specified program options) of lying within the region described by the confidence ellipsoid. Hence, the smaller the ellipsoid, the better the estimate of the location. The ellipsoid is a function of the random reading error, the array geometry used to locate each earthquake, and the velocity model. The calculation assumes that the only source of error is random reading error, thus it is a measure of the precision of each earthquake hypocenter. The RMS residual listed for each solution is primarily a measure of systematic errors including the incompatibility of velocity models, misinterpretation of phases, and consistent but uncorrected station delays. Generally, if the hypocenter is well-surrounded by stations (as determined by a small value for GAP), the number of arrival times used (NO) is greater than 5, and the velocity model is well known, then RMS is a measure of the correctness of phase identification and timing.

Explosions from many quarries, particularly in north-central Utah along the Wasatch Front, are routinely recorded. Accurate locations of several blasts from the Keigley quarry, the Bingham Canyon Copper mine, and the Devil's Slide quarry (see detailed information on individual quarries, below) have been compared with our instrumental locations. The comparisons suggest an accuracy of approximately ± 1 km for well-recorded earthquakes. Using well-recorded earthquakes, Kastrinsky (1977) estimated epicentral errors for earthquakes located on the Wasatch Front during 1975-1976 (using 30 stations) at ± 2.0 km. Depth determinations are judged to be reliable to within ± 2.0 km if DMN (the distance to the closest recording station) is approximately equal to or less than the depth. An asterisk next to the depth is used in the earthquake catalog to indicate events with poor depth control, i.e., earthquakes that do not have a recording station within 10 km of the epicenter or within a distance to the epicenter of twice the depth.

The catalog is estimated to be systematically complete above magnitude (M_L) 1.5 in north-central Utah, above magnitude 2.5 in central and southwestern Utah, and above magnitude 3.0 in southeastern Utah and the eastern Uinta Basin. Magnitudes are judged to be accurate to within ± 0.3 magnitude units. Some earthquakes listed are multiple events where seismographs record two or more events in rapid succession, which often precludes locating both events.

Blasting in the Utah Region

Blasting for mining, road and dam construction, seismic exploration, and military ammunition disposal is common in the Utah region. Most of these blasts are too small for an epicenter calculation and are automatically excluded from the catalog. Nevertheless, locatable blasts are recorded regularly from a number of mines in the region. Known sites of active blasting operations during the last several years are listed in Table 3 and shown in Figure 4. Events identified as blasts by contacting individual blasting operations and/or correlation with known blasting areas and the time of day of frequent blasting have been removed from the earthquake catalog. Blasting data is kept, however, for analysis in special studies (see Smith *et al.*, 1980). Note that some blasts may still be included in the catalog.

Table 3

UTAH BLASTING SITES

Site Name	N-Lat	W-Long
Bingham mine	40°31.00'	112°08.00'
Blackmesa	36°30.00'	110°20.00'
Carr Fork	40°33.00'	112°12.00'
Desert Mound	37°42.00'	113°16.00'
Devils Slide	41°03.00'	111°33.00'
Diamond Mountain	40°37.50'	109°30.00'
Dolomite Mine	40°42.00'	112°35.00'
Dugway	40°07.50'	112°52.50'
Elkol Mine	41°44.00'	110°37.00'
Georgia Pacific	38°55.00'	111°53.00'
Ireco	40°14.00'	112°18.00'
Iron Mountain	37°39.00'	113°22.00'
Keigley	40°01.00'	111°18.00'
Lakeside Mountain	40°54.00'	112°50.00'
Lakeside	41°13.00'	112°52.00'
Parleys Canyon	40°43.00'	111°46.00'
Pelican Point	40°05.55'	111°52.31'
Providence Canyon	41°41.00'	111°44.00'
Skull Point	41°40.00'	110°32.00'
Thiokol	41°35.00'	112°25.00'
Tooele	40°30.00'	112°28.00'
Topaz Mine	39°42.00'	113°13.00'
US Gypsum	38°53.00'	111°55.00'
Mercur Mine	40°18.54'	112°12.32'
Western States	39°31.49'	113°00.23'

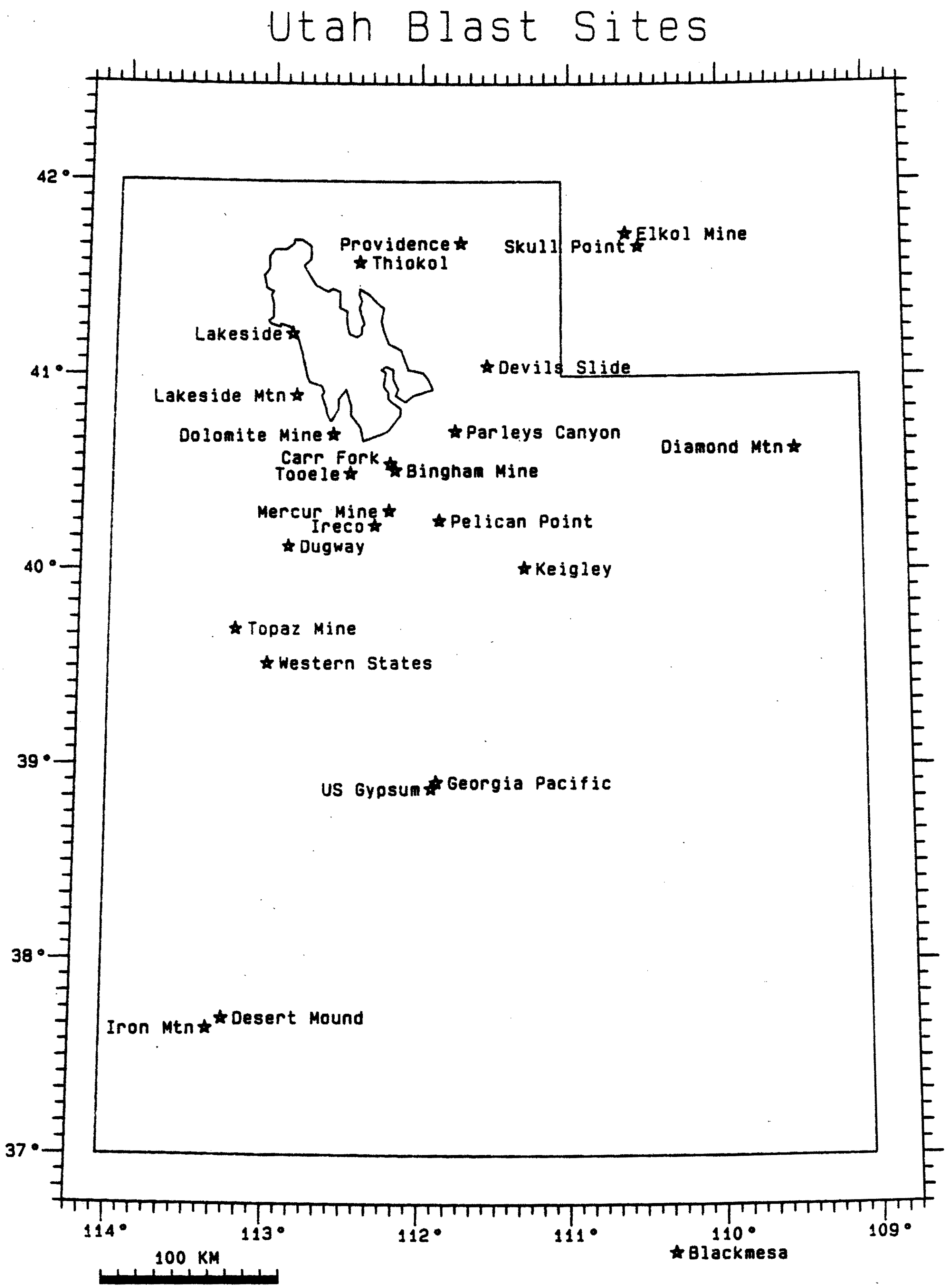

Utah Blast Sites
42°
41°
40°
39°
38°
37°
114°
113°
112°
111°
110°
109°
100 KM
Providence
Thiokol
Skull Point
Elkol Mine
Lakeside
Devils Slide
Lakeside Mtn
Dolomite Mine
Parleys Canyon
Diamond Mtn
Carr Fork
Tooele
Bingham Mine
Mercur Mine
Ireco
Pelican Point
Dugway
Keigley
Topaz Mine
Western States
US Gypsum
Georgia Pacific
Iron Mtn
Desert Mound
Blackmesa

Figure 4

OVERVIEW OF SEISMICITY

Recent publications by the UUSS have examined detailed characteristics of seismicity in Utah. Earthquake data for the time period 1850 through June 1978 is presented in Earthquake Studies in Utah: 1850 to 1978 (Arabasz et al., 1979), earthquake data for July 1978 through December 1980 is presented in Earthquake Data for the Utah Region July 1, 1978 to December 31, 1980 (Richins et al., 1981), and earthquake data for January 1981 through December 1983 is presented in Earthquake Data for the Utah Region January 1, 1981 to December 31, 1983 (Richins et al., 1984b). Selected bibliographies of UUSS Publications are available in the above volumes for the respective time periods. Publications after 1983 are listed in Appendices of this volume.

Annual maps of seismicity in the Utah region for 1984 and 1985 are shown in Figures 5 and 6. For reference, a generalized fault map is included as Figure 7. A total of 855 earthquakes were located during the report period in the Utah region including 24 felt shocks (see Page 61) and 11 earthquakes of magnitude 3.0 or greater (see Table 4). The largest shock was one of magnitude 3.7, which occurred on August 16, 1984, 70 km north of Richfield near the Wasatch Fault. This earthquake was felt in Levan, Gunnison, Ephraim, Manti, and other nearby communities. Other significant aspects of earthquake activity shown in Figures 5 and 6 include (from north to south):

1) A continuation of activity near Soda Springs, Idaho (approximately 42°20'N latitude, 111°30'W longitude). Twenty-six events occurred over this two-year report period. There was a slightly higher rate of seismicity in 1985 than in 1984 (an average of 0.8 events/month in 1984, 1.3 events/month in 1985; see Figure 8). The largest event in this cluster has a magnitude of 3.2, and occurred on April 5, 1985. A study of seismicity in this area was done by Richins et al. (1983).

2) Clusters of events along the Utah-Idaho border, north of the Great Salt Lake, which include late aftershocks of the magnitude 6.0 Pocatello Valley earthquake of March 1975 (see Arabasz et al., 1981) and activity in Hansel Valley. A total number of 208 events occurred here during the report period. Seismicity in 1984 and early 1985 is characterized by four periods of swarm activity in February 1984, October 1984, January 1985, and September-October 1985 (see Figure 9). There is also a period of quiescence in March and April of 1984, following the first swarm. The average rate of activity during 1984 and January, 1985 is 9.9 events/month. Through the remaining part of 1985 activity is more constant, with an average of 7.2 events/month.

3) Continued activity in a north-south zone between 5 and 30 km east of Logan and Ogden, including one felt earthquake of magnitude 2.9 on October 21, 1985.

4) Clusters of earthquakes within a 50-km radius of Price, predominantly related to extensive underground coal mining. The largest event in this area occurred on June 27, 1985, with a magnitude of 3.0. The rate of activity is nearly constant throughout the report period, with

an average rate of 5.75 events/month (Figure 10). The spatial occurrence of events, however, changes over the report period. A shift of activity from an area about 45 km southwest of Price to areas east and north of Price between 1984 and 1985 is apparent in Figures 5 and 6. A space-time plot along the line A - A' in Figure 11 shows activity in the southwest during 1984 diminishing early in 1985 (Figure 12). Concurrent with the decrease of activity in the southwest, activity increases towards the northeast and continues through the end of the study period. The cessation of activity in the southwest correlates with a shut-down of mines in that area (due to a fire at the Wilberg mine). The increase of activity in the northeast may reflect increased production in the northeastern coal mines. For detailed studies of mining-related seismicity in Utah see Smith _et al._ (1974), McKee and Arabasz (1982), McKee (1982), and Williams (1986).

5) Scattered activity within a broad north-south trending zone between Salt Lake City and Richfield, Utah, in the general vicinity of the southern Wasatch fault.

6) Scattered small earthquakes throughout southwestern Utah in a broad NE-SW trending belt encompassing the Elsinore, Tushar, Sevier, and Hurricane fault zones between Richfield and Cedar City.

7) Three events near St. George including two small felt earthquakes (magnitudes 2.2 and 2.5) on November 25, 1984.

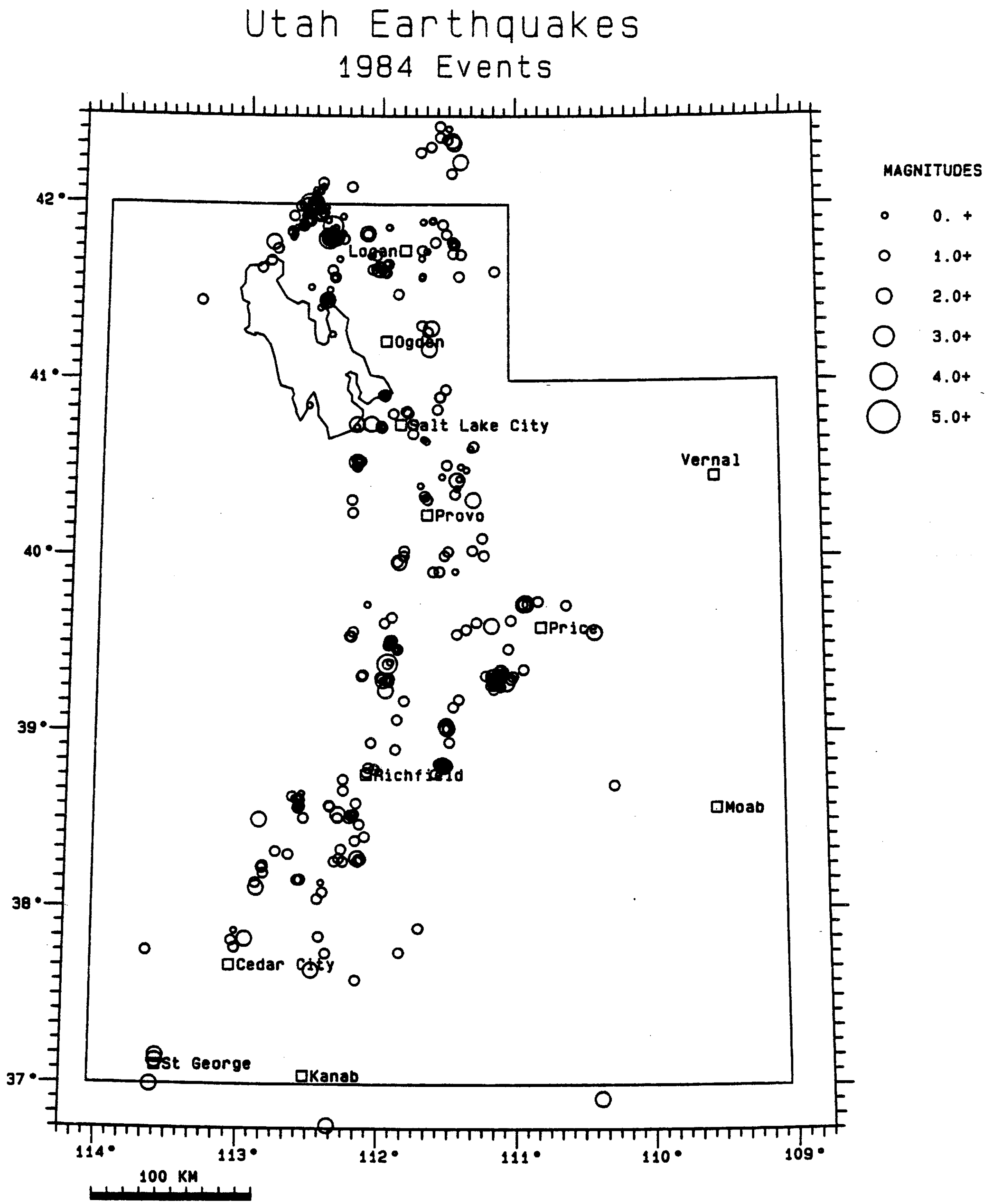
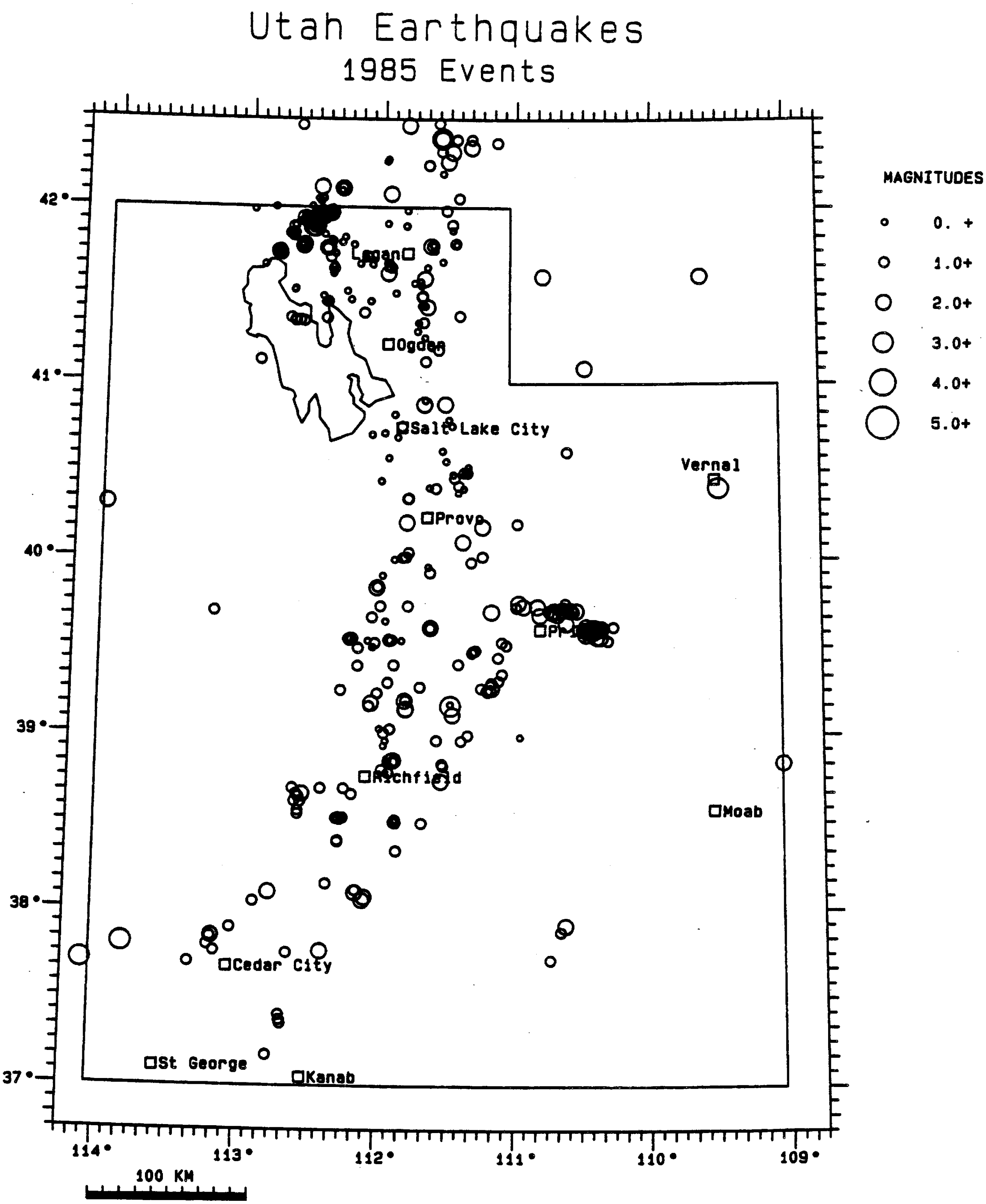
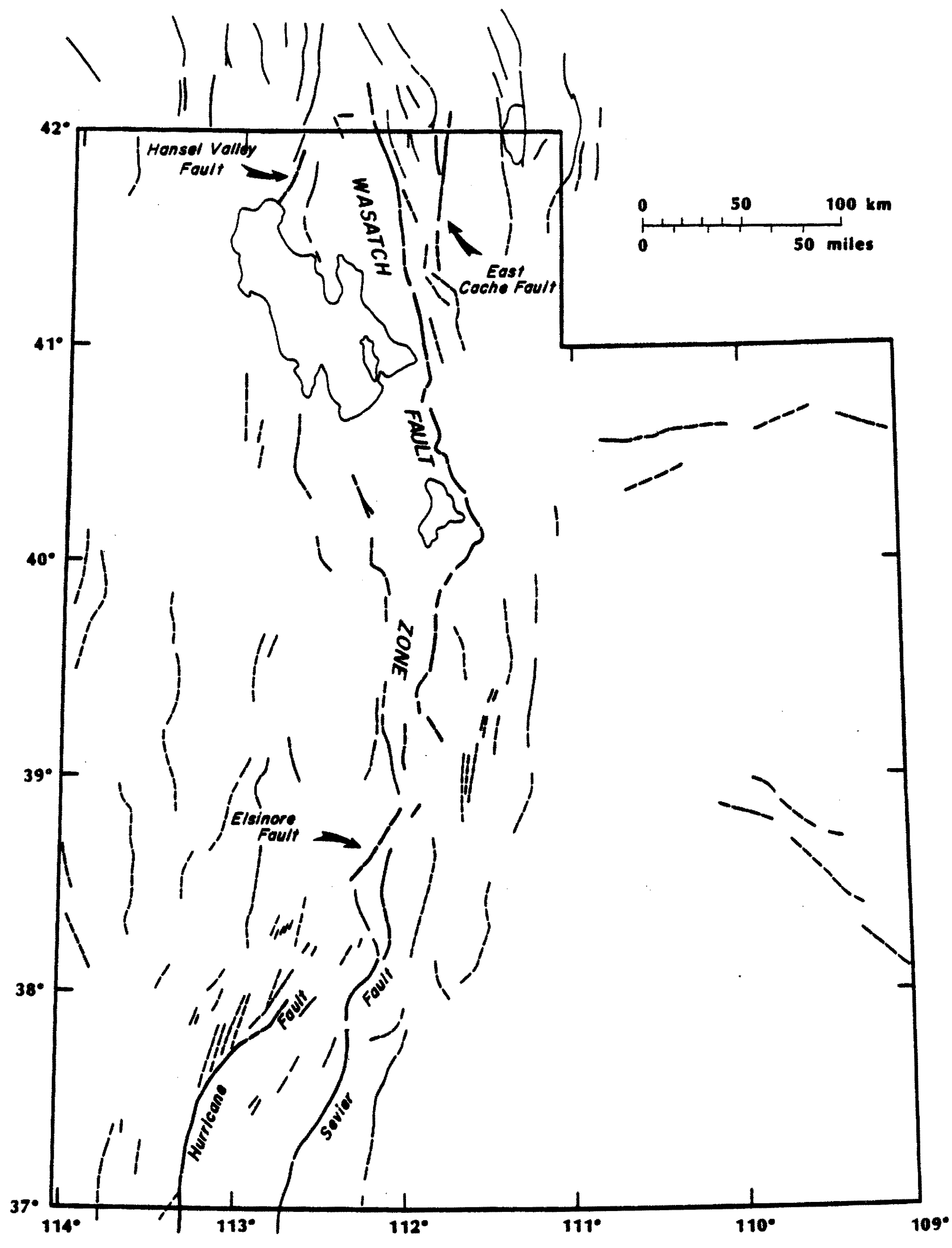

Utah Earthquakes
1984 Events
MAGNITUDES
0. +
1.0+
2.0+
3.0+
4.0+
5.0+
Logan
Ogden
Salt Lake City
Vernal
Provo
Price
Richfield
Moab
Cedar City
St George
Kanab
42°
41°
40°
39°
38°
37°
114°
113°
112°
111°
110°
109°
100 KM

Figure 5



Utah Earthquakes
1985 Events
MAGNITUDES
0. +
1.0+
2.0+
3.0+
4.0+
5.0+
42°
41°
40°
39°
38°
37°
114°
113°
112°
111°
110°
109°
Logan
Ogden
Salt Lake City
Vernal
Provo
Richfield
Moab
Cedar City
St George
Kanab
100 KM

Figure 6



GENERALIZED MAP OF YOUNG FAULTS IN UTAH

Figure 7

Soda Springs Area

42 deg 10' - 42 deg 30', 111 deg - 112 deg

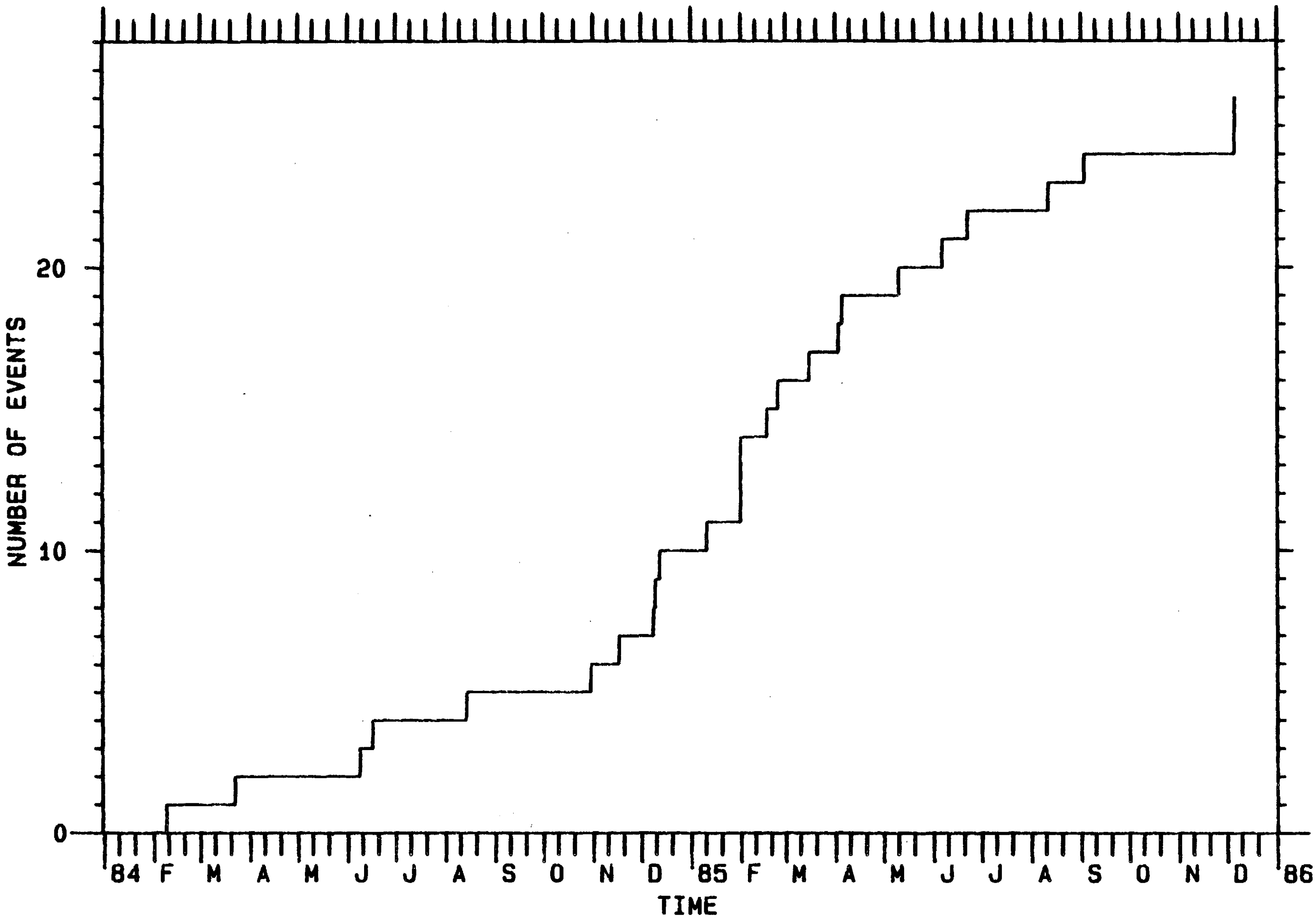


Figure 8

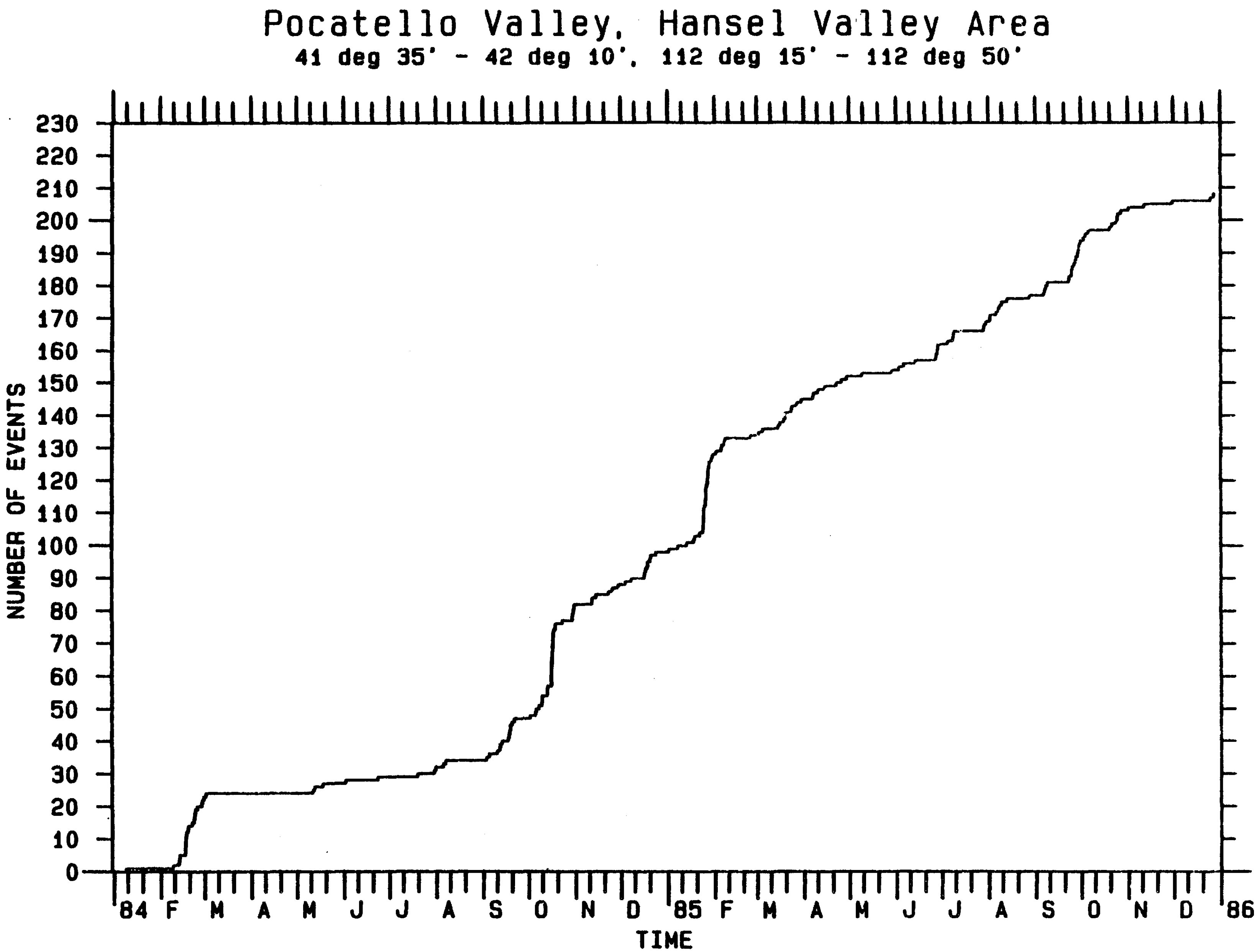

Pocatello Valley, Hansel Valley Area
41 deg 35' - 42 deg 10', 112 deg 15' - 112 deg 50'
NUMBER OF EVENTS
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
'84 F M A M J J A S O N D '85 F M A M J J A S O N D '86
TIME

Figure 9

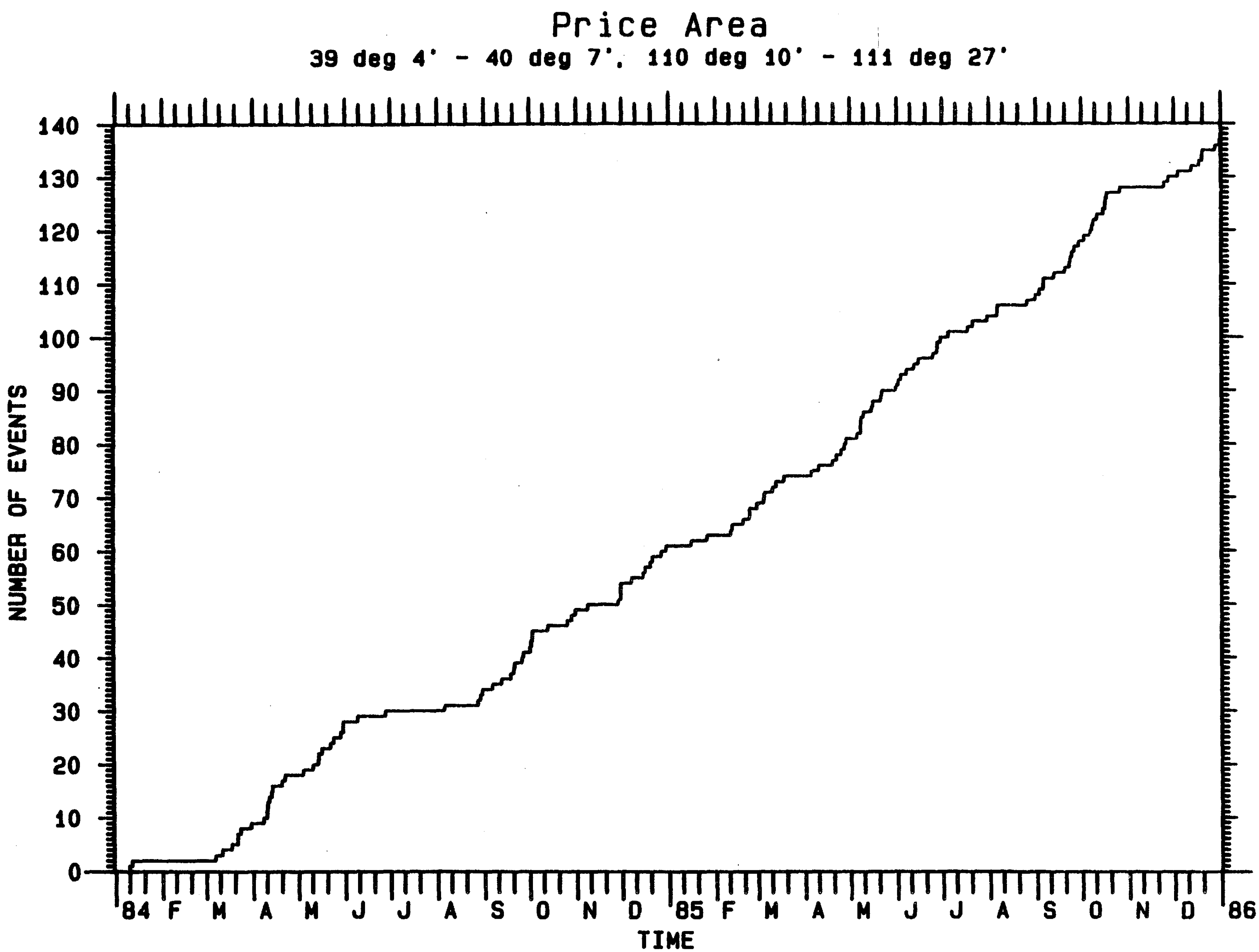

Price Area
39 deg 4' - 40 deg 7', 110 deg 10' - 111 deg 27'
NUMBER OF EVENTS
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
84 F M A M J J A S O N D 85 F M A M J J A S O N D 86
TIME

Figure 10

Price Area Events

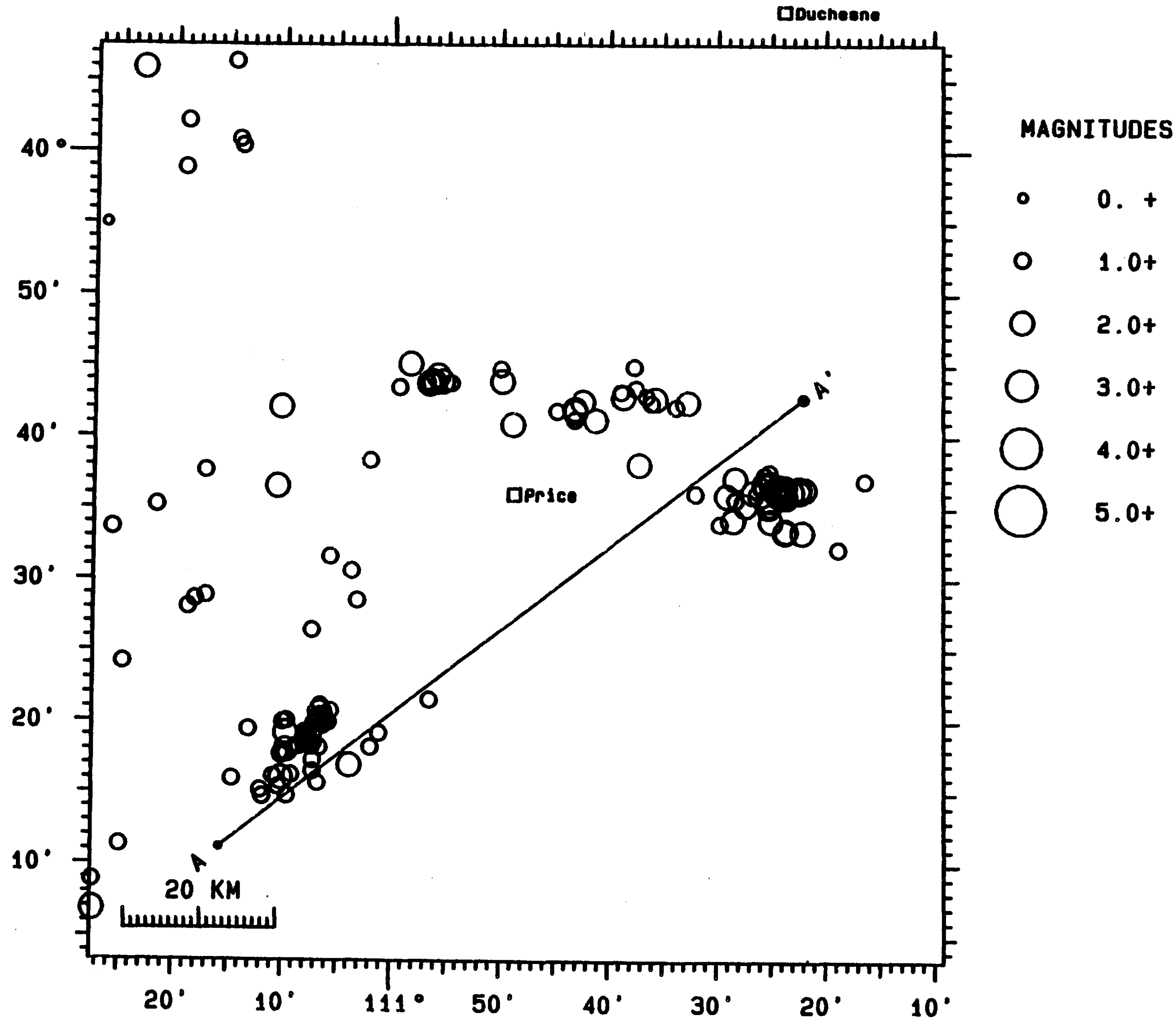
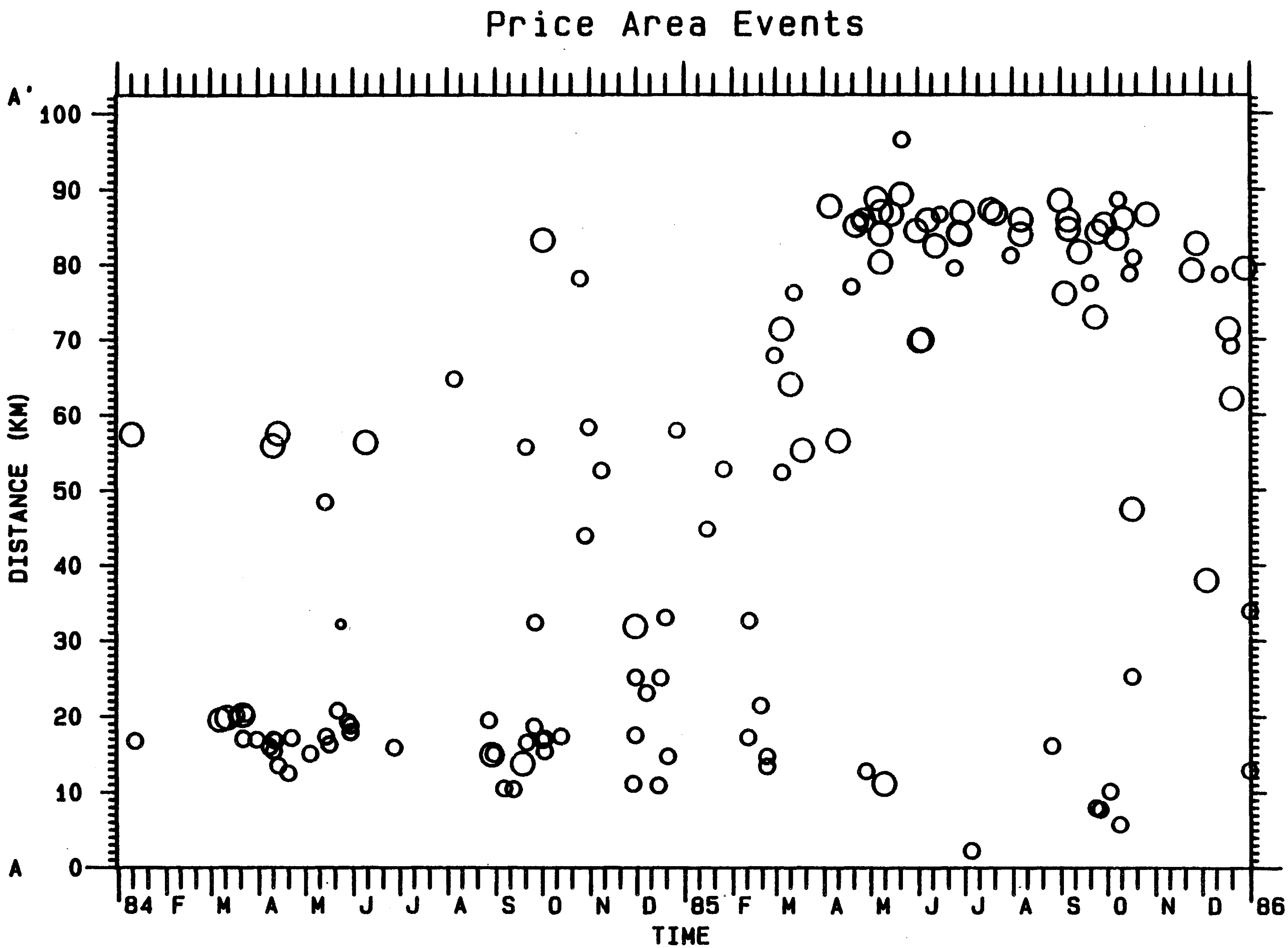


Figure 11



Price Area Events
A'
A
100
90
80
70
60
50
40
30
20
10
0
DISTANCE (KM)
84 F M A M J J A S O N D 85 F M A M J J A S O N D 86
TIME

Figure 12

Table 4

UTAH REGION EARTHQUAKES: 1984-1985, MAGNITUDE 3.0 AND LARGER

yr	date	orig	time	lat-n	long-w	depth	mag	no	gap	dmn	rms
84	512	1520	4.41	42- 0.15	112-33.11	3.6*	3.0W	38	130	20	0.28
84	806	2230	38.66	41-52.53	112-22.38	2.1	3.0W	26	92	7	0.35
84	816	1419	21.71	39-23.50	111-56.16	6.1*	3.7W	12	95	34	0.33
84	1015	2323	56.53	41-48.27	112-24.10	4.1*	3.4W	25	81	15	0.17
85	118	1543	13.34	37-42.48	114- 6.47	2.1*	3.1W	9	167	56	0.16
85	126	1508	6.71	41-53.43	112-31.80	2.0*	3.6W	30	109	17	0.24
85	127	1046	49.60	41-53.40	112-32.21	1.5*	3.3W	33	109	18	0.25
85	405	543	26.79	42-23.43	111-34.27	4.5*	3.2W	30	162	35	0.29
85	611	721	45.12	39- 9.93	111-28.21	0.1*	3.0	8	169	15	0.42
85	619	1745	49.72	37-48.45	113-49.30	6.9*	3.0W	15	140	67	0.42
85	627	1036	29.53	39-33.50	110-23.74	0.6*	3.1	21	234	47	0.43
85	1007	2033	40.07	40-24.41	109-29.90	20.6*	3.0	22	214	148	0.35

number of earthquakes = 12

* indicates poor depth control
W indicates Wood-Anderson data used for magnitude calculation
see page 37 for data explanation

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EARTHQUAKE DATA FOR THE UTAH REGION

(Explanation)

The following data are listed for each event:

1. Year (YR), date and origin time in Universal Coordinated Time (UTC). Subtract seven hours to convert to Mountain Standard Time (MST).

2. Earthquake location coordinates in degrees and minutes of north latitude (LAT-N) and west longitude (LONG-W), and depth in kilometers. "*" indicates poor depth resolution: no recording stations within 10 km or twice the depth.

3. MAG, computed local magnitude for each earthquake. "W" indicates Wood-Anderson records were used.

4. NO, number of P and S readings used in solution.

5. GAP, largest azimuthal separation in degrees between recording stations used in the solution.

6. DMN, epicentral distance in kilometers to the closest station.

7. RMS, root-mean-square error in seconds of the travel-time residuals:

$$RMS = [\Sigma_i (W_i R_i)^2 / \Sigma_i (W_i)^2]^{1/2}$$

where:

R_i is the observed minus the computed arrival time for the i-th P or S reading,

W_i is the relative weight given to the i-th P or S arrival time (0.0 for no weight through 1.0 for full weight).

UTAH EARTHQUAKES: JAN 1984 - DEC 1985

yr	date	orig	time	lat-n	long-w	depth	mag	no	gap	dmn	rms
84	101	630	2.43	38-28.75	112- 8.03	15.6	1.7	8	129	5	0.28
84	105	925	10.90	38-12.11	112-49.50	0.5*	2.0	11	140	18	0.81
84	105	929	13.12	38-14.22	112-49.77	1.7*	1.4	9	98	20	0.24
84	105	1600	43.35	38-14.07	112-50.35	3.9*	1.3	9	133	19	0.36
84	107	133	18.85	40-43.86	111-59.56	6.8*	1.6	20	47	16	0.24
84	107	137	42.72	40-44.40	111-59.73	4.3*	1.3	21	50	16	0.29
84	108	159	7.15	39- 2.39	111-30.55	0.4*	2.7W	25	89	19	0.41
84	108	323	9.20	39- 1.53	111-30.08	0.2*	2.0	14	90	21	0.45
84	108	727	9.69	38-34.75	112-34.16	0.7	1.8	13	106	5	0.37
84	108	744	45.57	38-14.74	112-49.86	0.4*	1.4	10	132	21	0.25
84	108	1422	48.27	38-34.27	112-34.71	1.7	1.6	10	109	6	0.45
84	109	407	51.10	37-46.64	113- 1.60	0.7*	1.7	8	126	11	0.68
84	109	411	36.88	37-49.07	113- 2.95	6.0*	1.5	7	191	32	0.31
84	109	505	13.89	41-59.86	112-30.37	1.4*	1.0	13	134	16	0.39
84	109	1412	17.01	39-14.40	111-56.96	0.1*	2.2	25	93	27	0.32
84	109	2153	36.32	39-44.34	110-55.84	1.6	2.3	18	177	5	0.30
84	110	657	50.30	39- 1.44	111-29.68	0.2*	1.9	13	92	21	0.33
84	111	529	1.28	38-16.03	112-15.11	0.7*	2.0	9	148	28	0.47
84	111	954	57.33	38-31.95	112-11.79	1.2	1.9	8	127	2	0.22
84	111	1512	8.78	38-17.15	112-16.75	3.9*	1.5	7	157	26	0.32
84	111	1742	39.09	39-18.34	111- 7.41	7.0*	1.5	6	143	45	0.33
84	117	1257	59.96	38-20.23	112-15.89	7.1*	1.1	5	149	21	0.31
84	117	1848	50.23	38-30.90	112-32.34	7.0*	1.6	10	115	31	0.34
84	117	1909	52.75	38-36.93	112-34.17	6.1*	1.0	7	208	36	0.27
84	119	1219	6.61	38-37.50	112-34.60	1.0*	1.5	8	210	37	0.46
84	206	700	51.97	41-30.89	112-23.35	9.4	0.7	9	179	13	0.17
84	208	1413	33.78	42-19.58	111-38.09	6.8*	1.1	8	304	52	0.14
84	209	514	9.12	41-44.90	112-47.18	7.1*	1.6	10	245	43	0.29
84	213	6	42.71	41-52.93	112-35.15	3.9*	0.9	8	250	22	0.18
84	213	729	22.61	41-53.70	112-35.20	3.7*	0.6	7	250	22	0.12
84	213	1253	35.07	42- 0.21	112-29.38	2.2*	0.9	12	178	15	0.31
84	217	524	18.96	41-52.61	112-35.67	3.2*	1.1	19	116	18	0.21
84	217	544	15.48	41-53.22	112-36.17	2.5*	0.6	10	142	18	0.13
84	217	546	22.64	41-52.50	112-36.84	3.9*	0.6	12	142	17	0.22
84	217	754	50.35	41-52.48	112-35.83	2.9*	0.6	8	137	18	0.26
84	217	815	48.15	41-53.24	112-36.23	3.1*	0.5	9	143	18	0.13
84	217	1449	46.09	41-58.83	112-25.57	3.7*	0.4	8	207	10	0.08
84	217	1847	14.20	41-52.66	112-35.60	2.5*	1.0	12	136	18	0.17
84	218	105	47.11	40-48.86	111-47.71	7.3	1.1	16	103	3	0.26
84	218	1608	14.15	41-52.96	112-36.24	0.8*	0.8	12	141	18	0.14

UTAH EARTHQUAKES: JAN 1984 - DEC 1985

yr	date	orig	time	lat-n	long-w	depth	mag	no	gap	dmn	rms
84	219	356	28.49	41-52.82	112-35.81	4.3*	1.3	15	139	18	0.21
84	219	1537	37.28	38-44.03	112-15.20	3.6*	1.3	7	155	25	0.32
84	220	1116	47.39	38-49.12	111-30.24	1.7*	1.2	10	104	42	0.42
84	220	1356	20.71	38-34.54	112-34.97	1.1*	1.7	13	105	36	0.42
84	221	1248	5.67	42- 0.63	112-31.92	2.1*	0.8	9	145	15	0.09
84	222	417	30.03	38-48.74	111-30.48	3.0*	1.6	13	102	42	0.48
84	222	2308	16.97	41-53.22	112-36.30	2.4*	0.6	9	143	18	0.13
84	223	311	34.82	41-53.29	112-36.10	2.9*	0.8	9	143	18	0.18
84	223	921	25.55	41-53.80	112-36.26	2.9*	0.4	8	146	19	0.15
84	223	1410	25.15	41-52.97	112-35.87	2.6*	0.6	11	140	18	0.17
84	223	2039	44.71	38-49.00	111-32.62	3.9*	1.2	8	110	41	0.30
84	225	346	25.63	41-53.10	112-36.12	2.5*	0.5	11	142	18	0.19
84	227	323	42.81	40-44.00	111-59.35	1.2*	1.6	19	62	16	0.25
84	228	338	29.17	42- 0.82	112-30.58	2.5*	0.5	11	137	14	0.19
84	228	1015	35.61	41-50.72	112-40.75	6.4	1.0	10	153	10	0.20
84	229	905	57.33	41-49.66	112-39.82	3.2*	0.8	7	138	10	0.36
84	301	1956	1.68	41-50.27	112-41.56	9.8	1.0	13	155	9	0.27
84	302	2154	55.11	41-28.20	112-23.96	1.8	1.2	15	132	8	0.29
84	306	715	58.54	41-31.72	112-31.78	6.3*	0.8	11	178	18	0.18
84	306	1254	57.09	41-27.84	112-24.54	4.1	1.7	14	141	8	0.19
84	306	1256	56.89	41-27.04	112-25.64	7.5	1.1	15	156	6	0.28
84	306	2130	48.64	39-16.94	111- 3.81	14.1*	2.0	16	101	40	0.44
84	310	1345	6.69	40-36.76	111-20.08	13.3	0.8	5	313	9	0.13
84	311	1108	43.27	39-20.19	111- 6.42	0.1*	2.0	18	101	45	0.47
84	311	2058	50.10	38-19.49	112-44.28	14.7*	1.4	11	92	33	0.46
84	313	129	24.08	38-56.58	112- 3.19	7.0	1.7	16	63	4	0.40
84	313	449	25.67	38-48.62	111-29.95	4.2*	1.6	9	103	43	0.48
84	314	2301	20.97	41-15.64	112-21.94	1.9*	0.8	13	164	14	0.34
84	315	819	30.29	40-37.48	111-18.67	10.9	1.0	14	200	11	0.24
84	316	1214	46.01	38-16.13	112- 8.65	4.0*	1.4	9	161	27	0.40
84	317	932	6.74	40-31.20	111-30.55	6.4	1.1	18	90	10	0.28
84	317	1335	53.61	39-20.24	111- 6.25	9.0*	1.9	11	102	45	0.38
84	320	1257	9.11	41-27.46	112-25.27	4.9	1.0	11	150	7	0.20
84	321	706	5.67	41-25.42	112-25.89	13.4	0.9	17	160	4	0.39
84	321	1119	30.58	39-20.64	111- 6.53	0.1*	2.9W	24	102	37	0.51
84	321	1725	24.24	39-18.66	111- 7.45	12.9*	1.9	12	96	46	0.50
84	322	1216	33.27	42-22.86	111-34.00	6.6*	1.4	15	192	34	0.22
84	323	338	35.50	41-17.85	111-37.62	1.7*	2.1	24	189	32	0.26
84	323	648	32.38	41-10.69	111-38.60	3.8*	2.2	22	182	23	0.26
84	323	1400	27.14	39-19.97	111- 5.77	8.5*	1.9	13	103	44	0.45

UTAH EARTHQUAKES: JAN 1984 - DEC 1985

yr	date	orig	time	lat-n	long-w	depth	mag	no	gap	dmn	rms
84	326	1036	54.90	40-27.19	111-32.62	3.7	0.5	6	145	4	0.07
84	330	1322	37.22	39-18.63	111- 7.49	0.1*	1.9	13	96	46	0.49
84	401	4	32.76	40-14.96	112-11.86	5.5*	1.4	15	96	23	0.29
84	402	1318	2.33	41-27.01	113-20.71	8.6*	1.8	25	186	59	0.30
84	403	532	21.46	38-38.18	112-37.27	1.8	1.5	10	129	7	0.43
84	406	1026	47.90	38-35.59	112-34.41	1.6*	1.8	11	104	35	0.41
84	406	1031	58.05	38-34.85	112-34.19	1.8*	1.7	15	106	35	0.45
84	406	2201	46.19	38-37.27	112-35.45	14.6*	1.8	10	100	38	0.28
84	407	1913	41.83	39-20.06	111- 9.59	8.1*	1.9	13	114	44	0.50
84	409	2158	45.28	39-43.77	110-56.64	1.0	2.0	19	168	5	0.34
84	410	749	25.19	39-18.67	111- 7.54	6.3*	2.0	13	96	46	0.31
84	410	1103	8.65	39-18.25	111- 8.45	0.0*	1.8	10	118	45	0.21
84	411	1209	53.97	39-18.23	111- 7.30	7.2*	1.8	8	143	45	0.40
84	411	2004	28.77	40-24.13	111-42.07	3.0*	0.8	7	147	14	0.47
84	412	1537	56.30	39-43.70	112- 5.12	1.6*	0.9	17	119	25	0.29
84	413	228	12.02	39-43.92	110-55.41	0.2*	2.1	10	177	67	0.36
84	413	1201	59.88	39-17.75	111- 9.64	4.1*	2.0	19	91	43	0.48
84	414	1652	31.37	36-59.85	113-36.36	0.1*	2.1	14	215	89	0.41
84	415	2121	55.84	38-35.73	112-34.63	5.6	0.9	9	142	4	0.19
84	419	2251	36.17	39-16.25	111- 9.16	3.3*	1.8	11	112	43	0.50
84	421	2307	11.58	39-18.94	111- 7.59	6.3*	1.7	12	115	46	0.50
84	426	1537	35.26	38-56.77	111-29.04	18.3	1.5	7	181	29	0.42
84	428	1810	32.87	38-48.53	111-31.77	1.0*	1.7	14	101	42	0.44
84	428	1842	31.01	38-49.11	111-32.20	1.5*	1.2	9	101	41	0.29
84	428	1845	13.31	38-48.69	111-32.17	0.5*	1.6	16	99	42	0.37
84	429	1101	56.88	38-49.00	111-32.24	0.3*	2.0	20	99	41	0.42
84	429	1253	38.53	38-48.92	111-32.22	2.7*	1.5	9	99	41	0.27
84	430	1348	29.85	38-13.99	112-50.14	5.1*	1.3	7	134	20	0.11
84	502	1530	8.00	37-52.39	113- 1.71	6.9*	0.9	10	180	26	0.38
84	504	24	2.69	39-16.52	111- 7.20	7.4*	1.8	10	115	44	0.39
84	505	403	0.94	40-19.36	111-18.82	6.8	2.3W	20	196	11	0.30
84	505	2335	6.06	38-49.21	111-32.05	1.5*	1.8	19	100	41	0.43
84	509	1129	26.85	38-49.38	111-32.65	3.7*	1.1	14	98	40	0.34
84	510	813	3.14	39- 8.84	111-27.36	0.2*	1.9	18	85	16	0.34
84	511	810	22.50	42- 7.35	112-27.08	5.9*	1.1	10	234	23	0.17
84	512	1520	4.41	42- 0.15	112-33.11	3.6*	3.0W	38	130	20	0.28
84	513	403	38.61	38-32.08	112-10.70	2.4	0.7	8	106	2	0.15
84	513	1626	4.64	38-31.46	112-11.09	2.6	1.8	10	106	1	0.33
84	513	2026	42.96	40- 2.18	111-19.09	8.0*	1.2	9	241	42	0.31
84	513	2045	42.99	38-32.19	112-10.62	1.1	1.5	7	107	2	0.10

UTAH EARTHQUAKES: JAN 1984 - DEC 1985

yr	date	orig	time	lat-n	long-w	depth	mag	no	gap	dmn	rms
84	514	420	26.55	39-19.17	111- 7.64	4.4*	1.7	17	97	46	0.45
84	514	1431	43.78	38-30.92	112-12.45	2.1	1.3	10	92	2	0.28
84	515	2042	8.41	39-28.39	111-52.34	0.1	0.9	12	86	4	0.35
84	516	728	50.64	39-18.41	111- 7.86	5.1*	1.7	11	95	46	0.31
84	517	2203	37.95	42- 3.66	112-30.68	9.4*	0.9	13	164	21	0.23
84	519	1839	26.27	41-53.12	111-32.66	1.3*	1.2	15	208	20	0.45
84	521	2142	22.02	39-21.16	111- 6.49	3.0*	1.9	16	103	46	0.42
84	523	2358	57.50	39-54.99	111-26.54	7.1*	0.9	11	249	29	0.49
84	528	1328	31.80	39-20.03	111- 6.74	8.9*	1.9	11	101	46	0.38
84	528	1747	11.76	38-48.36	111-30.77	2.9*	1.4	10	102	43	0.47
84	529	1802	36.06	38-48.36	111-32.55	0.4*	1.8	9	99	42	0.34
84	530	631	16.70	39-19.13	111- 7.10	3.4*	1.9	17	98	46	0.42
84	530	632	50.34	39-19.95	111- 7.09	5.4*	1.5	17	99	46	0.37
84	530	1435	19.58	38-49.38	111-33.76	2.8*	1.4	10	97	40	0.26
84	530	1439	33.44	38-45.96	111-35.11	13.2*	1.5	12	150	46	0.24
84	530	1442	58.15	38-47.88	111-31.07	6.8*	1.7	10	180	44	0.34
84	530	2307	9.48	39-28.49	111-51.57	0.0	0.9	12	94	3	0.31
84	601	1202	14.54	39-17.89	111-58.15	2.2*	0.9	12	102	19	0.45
84	601	1227	6.52	38-54.33	111-52.49	0.2*	1.7	10	79	19	0.48
84	601	1231	11.91	40-19.34	112-12.23	4.1*	1.0	13	104	16	0.35
84	601	1233	54.01	39-17.87	111-58.01	5.0*	2.1	18	67	19	0.31
84	601	2318	37.22	41-35.11	112-21.07	6.3	1.6	25	107	8	0.29
84	602	26	33.05	41-50.02	112- 6.53	4.8*	2.2	26	60	20	0.26
84	602	35	16.20	41-49.87	112- 6.43	5.8*	1.6	28	61	21	0.27
84	602	404	33.67	41-34.90	112-21.16	4.7	1.0	13	193	8	0.20
84	602	910	45.22	39-58.25	111-51.81	0.2*	1.3	22	100	10	0.38
84	602	1352	34.17	39-58.13	111-51.28	0.1*	2.4W	34	62	10	0.28
84	603	1026	22.27	41-16.60	111-39.24	1.4*	1.0	19	130	23	0.24
84	607	1836	38.24	40- 0.26	111-49.28	3.2	1.2	10	122	8	0.39
84	607	2047	25.12	40- 2.06	111-49.04	1.1	1.4	17	85	4	0.36
84	608	916	50.48	42-14.45	111-24.82	0.6*	2.0	27	108	33	0.37
84	608	2152	21.61	39-43.96	110-56.42	1.4	2.6	23	169	5	0.30
84	609	349	29.36	36-45.91	112-20.92	1.7*	2.2	9	220	127	0.40
84	609	1448	41.95	39- 1.52	111-31.10	0.0*	1.4	12	167	20	0.31
84	610	1410	30.92	40-45.21	112- 4.08	1.2*	2.7	27	66	14	0.32
84	613	1743	6.21	41-44.37	111-41.76	1.1	1.3	18	162	9	0.35
84	614	1529	34.74	40-20.64	111-40.35	0.4*	1.0	10	125	14	0.36
84	615	2048	0.16	40-31.79	112- 9.75	1.3*	1.2	13	114	16	0.20
84	616	742	33.64	42-10.56	111-28.74	0.2*	1.3	12	278	25	0.48
84	617	27	56.62	40-55.00	111-58.85	2.0*	1.2	16	95	20	0.10

UTAH EARTHQUAKES: JAN 1984 - DEC 1985

yr	date	orig	time	lat-n	long-w	depth	mag	no	gap	dmn	rms
84	617	616	25.80	40-55.05	111-58.07	4.8*	1.1	15	86	16	0.25
84	617	901	13.42	40-54.84	111-58.25	3.3*	1.8	31	54	16	0.26
84	617	914	41.93	40-55.11	111-58.23	1.3*	1.4	22	54	16	0.29
84	617	1416	56.12	38-16.86	112- 8.00	1.5*	1.2	10	114	26	0.45
84	617	1618	17.88	40-55.04	111-58.65	3.5*	0.8	11	88	16	0.14
84	617	1706	56.98	40-54.64	111-58.14	1.4*	1.2	19	88	16	0.19
84	618	49	45.80	38-17.22	112- 8.79	2.0*	2.2	15	102	25	0.20
84	618	656	60.00	38-16.87	112- 7.27	7.1*	1.7	6	159	26	0.29
84	618	1155	42.06	40-41.84	111-45.49	3.0*	1.2	17	69	10	0.31
84	620	508	36.19	40-26.47	111-24.91	11.1	0.8	10	124	9	0.20
84	620	1559	29.17	40-32.47	112- 8.52	0.8*	1.6	19	143	15	0.29
84	622	7	36.79	38-24.61	112- 5.75	26.7	1.3	6	139	13	0.29
84	622	1650	31.25	40-19.84	111-40.79	3.0*	1.0	9	141	15	0.33
84	622	2212	48.49	39-28.38	111-51.89	0.0	1.2	13	93	3	0.20
84	623	642	52.88	41-52.04	112-21.15	2.0	0.7	7	214	7	0.14
84	623	2138	45.32	41-38.59	112- 0.77	0.6	1.5	19	67	5	0.40
84	624	256	43.60	40-55.33	111-58.75	2.3*	0.9	14	88	16	0.21
84	624	934	40.39	40-49.50	111-48.39	1.5	1.0	17	61	4	0.28
84	624	2149	59.11	41-38.38	112- 1.40	1.8	0.9	8	158	6	0.23
84	627	40	18.58	40-54.39	111-33.54	8.9	1.1	25	129	4	0.28
84	627	42	2.48	40-54.32	111-33.69	8.4	1.3	19	127	4	0.31
84	627	142	57.59	40-54.31	111-33.85	9.5	1.5	24	127	4	0.33
84	627	614	27.70	39-17.29	111- 7.21	2.4*	1.8	9	116	36	0.48
84	627	1711	12.91	41-42.28	112- 5.07	5.1*	0.7	7	140	14	0.07
84	627	2113	8.74	39-28.25	111-52.45	0.1	0.8	12	95	4	0.35
84	628	906	59.86	39-18.44	111-58.40	3.8*	1.6	16	96	18	0.18
84	628	909	54.86	39-18.87	111-59.22	2.1*	1.3	13	102	17	0.28
84	702	2024	20.77	40-33.01	112-10.32	1.3*	2.0	14	123	13	0.47
84	703	2047	17.32	40-32.44	112- 9.20	0.5*	1.9	18	110	15	0.21
84	704	202	59.79	40-39.26	111-39.59	2.3*	0.8	8	127	12	0.14
84	704	551	15.11	38-42.00	110-16.74	16.7*	1.5	11	286	60	0.20
84	704	1825	2.81	40-44.25	111-59.24	2.3*	0.7	11	115	15	0.23
84	705	1705	39.29	40-19.37	111-39.05	2.2*	1.4	10	149	14	0.40
84	707	1829	5.17	40-44.31	111-58.58	1.9*	0.6	15	114	14	0.30
84	708	2031	19.22	41-38.35	112-54.06	5.9*	1.2	11	270	18	0.26
84	711	2355	0.91	40-44.00	111-59.28	2.0*	0.6	9	117	16	0.10
84	714	847	9.97	40-39.84	111-40.70	1.8*	0.7	13	82	12	0.33
84	717	1701	9.70	41-47.10	111-35.95	12.1	1.0	9	190	13	0.31
84	719	1139	1.80	42- 0.41	112-34.21	1.7*	1.2	16	161	16	0.27
84	720	1500	59.18	40- 1.80	111-29.78	0.2*	1.9	14	100	42	0.43

UTAH EARTHQUAKES: JAN 1984 - DEC 1985

yr	date	orig	time	lat-n	long-w	depth	mag	no	gap	dmn	rms
84	720	1706	24.43	40-50.13	111-34.76	9.2	1.6	23	79	5	0.28
84	720	1722	22.04	40-32.58	112- 9.52	0.6*	2.0	21	97	14	0.26
84	726	1732	59.49	39-19.74	112- 6.98	1.0	1.5	12	108	7	0.33
84	727	1714	16.61	40-20.25	111-39.55	2.9*	0.4	4	266	14	0.11
84	730	710	46.52	40-21.28	111-26.77	1.5	1.4	6	116	9	0.26
84	730	711	22.34	41-48.44	112-21.68	0.5*	1.9	15	92	13	0.35
84	730	1152	22.38	38-47.53	112- 1.70	7.6*	1.5	12	133	19	0.31
84	730	1206	59.94	38-46.43	112- 5.03	4.2*	1.6	10	126	21	0.16
84	730	1353	15.63	38-48.03	112- 4.26	4.4*	1.4	10	125	18	0.19
84	731	758	58.10	41-48.56	112-20.55	2.5*	0.8	7	104	13	0.17
84	801	1806	58.94	39-19.56	112- 7.06	0.	1.9	15	108	7	0.57
84	801	2050	8.01	40-32.86	112- 9.44	1.1*	1.7	16	118	14	0.43
84	802	2342	33.62	37-50.40	112-25.11	1.4*	1.8	15	121	58	0.45
84	805	631	51.37	39-44.79	110-50.05	0.3*	1.6	16	188	13	0.31
84	805	834	50.57	41-57.09	112-26.68	1.5*	1.7	20	109	10	0.33
84	806	2230	38.66	41-52.53	112-22.38	2.1	3.0W	26	92	7	0.35
84	807	118	26.77	40-23.15	111-25.92	1.5	0.8	11	147	8	0.38
84	808	427	42.32	37-53.39	111-42.35	0.8*	1.9	7	246	80	0.36
84	808	1019	46.39	39-39.39	111-54.23	2.9*	1.0	11	120	19	0.35
84	809	1908	7.02	37-38.99	112-28.28	1.1*	2.5	12	154	68	0.33
84	809	2100	59.10	41-37.88	112- 1.15	0.2*	2.4	21	48	19	0.27
84	811	958	34.05	41-37.26	112- 1.58	0.4*	1.4	14	91	18	0.43
84	813	2015	5.67	42-17.67	111-42.72	12.7	1.6	8	261	20	0.21
84	814	1114	15.52	39-37.42	111-57.49	1.3*	1.4	21	69	18	0.28
84	814	2143	45.73	39-19.27	112- 7.44	1.3	1.9	14	110	7	0.34
84	816	1419	21.71	39-23.50	111-56.16	6.1*	3.7W	12	95	34	0.33
84	816	2026	10.37	39-23.48	111-56.00	6.8*	1.9	15	70	14	0.28
84	817	2159	24.60	39-24.04	111-54.88	5.6*	0.9	9	87	22	0.28
84	820	2259	6.37	40- 0.32	111-31.34	4.3*	1.4	16	95	26	0.35
84	823	1824	56.09	39- 4.44	111-51.88	3.0*	1.5	7	147	22	0.37
84	825	700	31.30	41-42.57	112- 2.35	5.2*	1.2	11	76	25	0.39
84	827	1330	20.78	39-19.72	111- 6.30	5.4	1.3	17	99	1	0.39
84	829	909	30.57	39-19.22	111- 9.69	0.1	2.7	28	116	5	0.42
84	829	1159	54.46	38-35.93	112- 9.51	1.4	1.7	14	125	9	0.40
84	830	836	12.48	41-46.42	111-27.49	4.5*	1.1	11	129	12	0.11
84	830	1025	27.57	39-18.25	111- 8.75	4.0	1.4	15	118	4	0.39
84	830	1102	57.24	41-46.39	111-27.80	5.2*	1.0	10	128	12	0.22
84	830	1836	40.48	41-46.52	111-27.31	1.9*	1.3	9	131	13	0.18
84	830	1846	20.91	41-47.11	111-28.15	1.9*	1.6	21	124	13	0.43
84	830	1900	45.79	41-42.99	111-24.44	19.9	1.0	11	166	8	0.40

UTAH EARTHQUAKES: JAN 1984 - DEC 1985

yr	date	orig	time	lat-n	long-w	depth	mag	no	gap	dmn	rms
84	830	2004	30.69	41-46.30	111-27.83	3.0*	1.1	9	127	12	0.20
84	830	2009	34.60	41-46.20	111-27.33	2.4*	0.9	10	131	12	0.27
84	902	1757	41.48	41-29.44	111-52.40	12.0*	1.1	15	78	30	0.26
84	903	121	1.81	41-37.52	112-22.19	3.5*	1.1	19	104	10	0.32
84	903	2208	46.57	38- 7.08	112-52.44	1.5*	2.5	16	83	52	0.46
84	904	2056	24.68	40-48.70	111-54.23	2.1	1.1	13	107	8	0.39
84	904	2230	2.88	39-28.46	111-51.87	0.3	1.5	16	49	3	0.34
84	904	2310	4.70	40-29.57	111-21.79	10.1	0.6	7	104	12	0.15
84	905	1225	29.50	40-45.03	112-10.51	1.6	2.3	35	82	8	0.39
84	906	402	10.54	39-14.77	111- 9.58	1.6*	1.7	11	128	33	0.51
84	907	312	26.79	38-32.14	112-17.23	0.7*	2.5	21	56	10	0.43
84	907	510	50.06	38-30.97	112-17.46	3.0*	1.7	9	143	10	0.29
84	909	2323	9.07	41-56.90	112-33.39	2.2*	0.5	7	144	19	0.15
84	911	1646	8.01	41-47.10	112-49.11	5.3	2.4	35	191	3	0.31
84	912	130	52.13	41-56.51	112-33.09	1.5*	1.0	11	140	18	0.30
84	912	329	31.65	39-16.16	111-10.85	0.1*	1.7	12	110	31	0.45
84	913	741	23.36	41-56.81	112-32.90	2.2*	1.1	11	140	18	0.24
84	914	209	39.57	38- 5.56	112-23.75	0.8*	1.4	7	119	50	0.17
84	914	604	53.22	41-44.07	111-39.73	10.4	0.8	12	101	10	0.35
84	914	1320	43.33	38-35.16	112-21.22	0.4*	2.0	16	83	16	0.42
84	917	1431	48.73	41-59.38	112-37.06	2.9*	1.1	6	175	19	0.25
84	917	2326	25.40	41-48.75	112-20.92	1.4*	1.2	18	78	13	0.35
84	918	723	1.63	39-18.01	111- 9.63	0.7*	2.1	13	119	32	0.48
84	918	749	57.55	41-41.33	112-19.08	5.6*	0.6	7	166	12	0.22
84	918	1758	42.18	40-30.58	112-10.20	6.7*	1.7	14	137	35	0.29
84	918	1845	5.47	41-48.57	112-20.89	1.2*	2.1	30	75	13	0.22
84	918	1901	44.31	41-48.58	112-21.23	3.0*	0.6	9	79	13	0.19
84	918	2153	10.85	41-27.20	112-23.18	1.7	0.6	9	123	7	0.31
84	919	635	46.22	41-27.49	112-25.81	1.5	0.7	7	203	7	0.10
84	919	1744	55.43	40-32.23	112-10.50	0.4*	2.3	28	106	35	0.33
84	919	2227	33.76	41-57.96	112-27.00	10.1	0.5	8	112	11	0.31
84	920	855	40.65	39-43.85	110-56.85	3.0	2.0	15	174	4	0.29
84	920	1707	10.29	39-34.43	112-11.25	1.5*	1.6	12	101	21	0.39
84	920	2137	6.25	39-18.27	111- 7.50	0.4*	1.5	11	113	35	0.33
84	921	1009	53.74	42- 5.99	112-13.85	1.5*	1.5	23	77	11	0.36
84	921	1138	58.85	41-48.85	112-20.02	2.3*	0.5	9	102	12	0.13
84	921	1608	33.22	41-24.74	112-27.53	12.3	0.8	8	246	4	0.23
84	922	548	6.63	41-52.14	111-56.75	10.5	0.9	20	66	16	0.20
84	923	906	58.24	41-35.50	111-25.31	0.2	1.4	15	187	5	0.40
84	924	1519	15.75	41-46.30	111-27.35	0.9*	1.1	20	131	12	0.36

UTAH EARTHQUAKES: JAN 1984 - DEC 1985

yr	date	orig	time	lat-n	long-w	depth	mag	no	gap	dmn	rms
84	925	1928	29.29	39-19.84	111- 7.09	5.4*	1.8	13	117	36	0.49
84	926	1418	1.82	39-28.56	111- 3.17	0.6*	1.9	12	232	45	0.27
84	926	1832	51.36	38-34.79	112-20.88	0.3*	1.9	13	84	16	0.41
84	926	2225	37.64	38-40.29	112-15.11	0.1*	1.4	13	82	18	0.27
84	928	1402	7.39	41-27.79	112-24.74	1.7	0.8	10	143	8	0.31
84	929	2044	14.88	41-27.56	112-25.13	1.4	0.6	8	195	7	0.20
84	929	2302	28.85	41-27.00	112-22.93	1.6	0.6	10	120	6	0.34
84	930	1125	49.71	41-27.48	112-25.08	1.8	0.3	12	194	7	0.20
84	930	1500	33.00	38- 3.27	112-25.92	0.1*	1.1	14	136	49	0.32
84	930	2046	31.74	41-27.32	112-24.57	0.0	2.8W	37	116	7	0.32
84	930	2207	1.34	41-27.64	112-24.64	1.5	1.2	11	142	7	0.20
84	1001	105	20.88	41-27.48	112-24.00	1.8	0.9	15	133	7	0.35
84	1001	308	27.77	41-27.87	112-25.22	1.9	0.9	10	195	8	0.20
84	1001	406	36.21	39-18.41	111- 7.34	7.8*	1.7	10	114	35	0.27
84	1001	2344	41.03	39-34.18	110-25.13	0.3*	2.2	15	239	47	0.32
84	1002	230	42.79	41-51.57	112-22.53	6.9	0.7	11	96	8	0.32
84	1002	1306	42.98	39-19.98	111- 9.96	0.3*	1.9	17	113	32	0.45
84	1002	1802	5.15	39-19.28	111- 7.91	3.3*	2.0	10	120	34	0.27
84	1003	2131	35.37	39-54.88	111-36.42	2.0*	1.6	18	80	16	0.33
84	1005	1138	58.19	42- 0.52	112-30.30	6.4*	2.0	31	124	15	0.23
84	1005	2105	49.06	42- 5.85	112-26.91	9.5	0.8	6	152	8	0.17
84	1006	1158	26.31	41-35.60	111-41.72	8.6	0.5	13	99	15	0.20
84	1007	1710	21.83	42- 4.86	112-28.07	7.1	0.4	8	131	8	0.19
84	1009	1446	13.76	41-48.61	112-23.69	3.0*	0.4	13	111	14	0.26
84	1009	1656	9.80	41-48.68	112-24.00	1.9*	1.6	17	82	14	0.20
84	1009	1949	37.54	41-56.00	112-40.08	3.3*	1.0	10	179	19	0.18
84	1011	614	55.18	38- 8.86	112-52.94	0.6*	1.7	13	159	11	0.40
84	1011	2114	30.63	40-30.62	111-24.17	3.9*	0.1	5	152	10	0.24
84	1012	327	8.56	39-32.75	112-12.04	6.2*	1.6	10	109	18	0.15
84	1012	2231	22.35	39-35.22	111-21.69	7.5*	1.3	5	146	51	0.28
84	1013	533	2.54	41-50.76	112-25.60	2.4*	0.2	6	146	12	0.12
84	1013	708	57.29	41-48.84	112-24.11	0.8*	1.0	12	93	14	0.15
84	1013	917	20.54	41-56.37	112-27.92	1.5*	1.3	16	111	11	0.32
84	1014	1733	43.31	40-44.10	112-10.51	1.8	0.8	15	131	7	0.33
84	1015	253	33.04	40-45.07	111-45.55	6.0	1.0	8	201	7	0.39
84	1015	2323	56.53	41-48.27	112-24.10	4.1*	3.4W	25	81	15	0.17
84	1015	2347	15.91	41-49.32	112-26.01	2.5*	0.4	10	113	14	0.24
84	1016	10	53.63	41-48.60	112-23.82	1.1*	0.9	21	94	14	0.40
84	1016	36	20.85	41-49.40	112-22.44	3.0*	0.3	6	255	12	0.18
84	1016	151	53.51	41-49.26	112-23.22	9.8	0.7	14	107	13	0.36

UTAH EARTHQUAKES: JAN 1984 - DEC 1985

yr	date	orig	time	lat-n	long-w	depth	mag	no	gap	dmn	rms
84	1016	218	38.46	41-48.75	112-23.87	3.4*	0.5	17	112	14	0.25
84	1016	349	45.82	41-48.38	112-23.74	3.0*	2.4	33	80	14	0.20
84	1016	1106	36.68	41-49.16	112-22.69	1.9*	1.0	14	92	13	0.33
84	1016	1306	39.88	41-54.33	112-34.05	1.5*	1.1	16	119	20	0.31
84	1016	1418	6.13	41-49.98	112-17.70	2.2*	0.7	9	91	10	0.38
84	1016	1420	1.13	41-48.83	112-24.06	1.4*	1.4	21	82	14	0.33
84	1016	2027	2.24	41-48.38	112-23.76	3.0*	0.4	8	113	14	0.29
84	1016	2301	34.48	41-48.98	112-23.60	5.7*	0.6	16	109	13	0.16
84	1016	2328	46.70	41-49.17	112-24.32	5.1*	0.6	14	110	13	0.20
84	1017	116	26.04	41-54.53	112-24.52	23.0	0.2	9	97	7	0.38
84	1017	220	52.21	41-48.96	112-23.88	5.1*	0.7	15	110	13	0.18
84	1017	320	15.47	41-54.75	112-33.68	1.7*	1.1	13	136	19	0.33
84	1018	531	51.70	42- 4.76	112-30.23	2.8	0.8	13	184	7	0.11
84	1018	1151	8.71	41-49.01	112-24.33	2.5*	0.4	12	111	14	0.19
84	1019	846	58.36	38-30.28	112-51.52	0.1*	2.1	18	106	59	0.47
84	1020	637	10.55	38-39.17	112-33.17	5.5	0.8	8	196	3	0.16
84	1020	1727	25.08	36-55.14	110-23.04	1.0*	2.0	7	273	131	0.42
84	1023	415	50.18	41-48.92	112-24.19	2.7*	0.6	13	124	14	0.33
84	1023	1355	34.51	37-35.64	112- 9.30	1.6*	1.8	8	190	93	0.36
84	1023	1717	6.73	37-45.08	111-50.64	1.0*	1.3	4	158	89	0.09
84	1025	1456	25.87	39-43.44	110-37.59	1.3*	1.5	11	233	31	0.37
84	1028	1611	39.90	39-38.35	111- 2.03	1.4*	1.4	7	231	70	0.43
84	1029	2152	22.48	41-48.22	112-17.13	2.4*	1.0	11	95	14	0.23
84	1029	2355	37.74	42- 4.36	112-28.13	2.2	0.7	12	123	9	0.37
84	1030	811	22.13	42-25.68	111-29.98	7.0*	1.0	10	176	41	0.28
84	1030	1107	54.91	41-59.69	112-29.33	2.2*	0.2	7	224	15	0.22
84	1030	2055	40.92	41-49.31	112-24.01	1.4*	1.4	16	90	13	0.36
84	1031	246	9.74	41-49.64	112-24.14	2.2*	0.3	10	128	13	0.19
84	1031	331	50.17	39-43.81	110-54.61	0.4*	1.6	14	230	77	0.30
84	1031	1358	46.46	41-43.28	111-28.03	2.0	1.3	13	126	8	0.21
84	1102	1816	25.11	40-56.93	111-31.17	6.4*	1.7	9	302	41	0.19
84	1104	1606	8.95	41-49.80	111-30.97	1.5*	1.1	18	103	16	0.26
84	1106	2358	49.53	38-16.07	112-18.75	2.6*	1.3	6	231	29	0.03
84	1107	719	37.93	41-36.78	111-58.03	4.5	1.2	18	66	0	0.24
84	1108	651	56.40	40- 0.44	111-14.01	0.8*	1.3	10	203	45	0.30
84	1109	2340	23.30	38- 8.84	112-24.38	22.1*	0.3	5	199	51	0.12
84	1110	228	58.20	41-37.02	111-58.70	1.2	1.8	20	39	1	0.27
84	1111	1130	56.14	38-23.20	112- 9.85	2.5*	1.1	9	142	14	0.13
84	1111	2040	2.61	41-48.51	112-22.60	7.2	0.5	11	81	14	0.44
84	1111	2045	3.90	41-48.20	112-24.69	15.4	1.4	16	86	15	0.36

UTAH EARTHQUAKES: JAN 1984 - DEC 1985

yr	date	orig	time	lat-n	long-w	depth	mag	no	gap	dmn	rms
84	1112	2120	58.12	41-54.05	111-41.48	11.3	0.7	13	97	12	0.25
84	1113	1020	39.47	39-17.92	111-56.24	4.9*	1.4	10	84	21	0.38
84	1114	1415	15.43	41-55.82	112-17.68	7.5	0.5	13	89	2	0.18
84	1117	212	40.94	42-22.00	111-30.72	9.8*	1.8	16	170	35	0.28
84	1118	1851	32.96	41-37.77	112- 4.09	3.9	1.4	16	52	9	0.27
84	1118	2113	28.29	41-38.68	112- 3.03	8.8	0.9	11	86	8	0.33
84	1119	831	15.54	40-51.48	112-31.94	9.1	0.4	16	171	7	0.29
84	1122	728	42.83	37-49.63	112-57.04	1.3*	2.1	15	171	19	0.38
84	1122	1838	30.11	41-51.96	112-38.81	2.3*	0.5	15	150	14	0.19
84	1125	1056	36.65	41-58.78	112-34.80	3.8*	0.1	7	159	19	0.07
84	1125	1406	50.74	37- 7.90	113-34.33	1.1*	2.5	12	203	73	0.46
84	1125	2124	21.90	37- 9.60	113-34.15	0.0*	2.2	11	204	70	0.50
84	1126	1937	43.76	37-44.73	112-22.29	1.3*	1.6	11	142	61	0.40
84	1127	2208	24.84	38-18.50	112-38.71	0.4*	1.4	10	102	35	0.19
84	1128	1242	11.38	39-19.46	111-13.14	14.0	1.9	7	224	27	0.21
84	1129	516	38.40	41-54.32	112-32.52	1.9*	1.2	20	129	18	0.21
84	1129	2359	47.71	39-18.17	111- 6.58	0.1*	1.6	13	232	36	0.39
84	1130	403	38.99	39-37.62	111-17.22	3.3*	1.4	13	130	40	0.43
84	1130	409	10.08	39-36.52	111-10.58	3.0*	2.0	12	172	22	0.34
84	1202	358	44.64	41-35.05	111-41.95	10.3	0.6	13	159	16	0.11
84	1202	456	24.06	39-29.81	111-55.47	3.2	0.9	14	64	8	0.39
84	1202	459	7.17	39-29.89	111-55.83	0.8	1.5	13	65	8	0.37
84	1202	1258	33.29	39-30.57	111-55.51	0.1	0.6	11	85	8	0.33
84	1202	1350	36.77	39-30.61	111-54.48	6.2	1.0	15	93	7	0.33
84	1202	2153	15.38	39-30.86	111-55.40	5.5	1.7	17	80	8	0.45
84	1203	1500	30.68	39-31.50	111-54.18	4.7	1.7	16	90	7	0.40
84	1203	2056	29.81	41-40.86	112-50.06	5.4*	1.3	14	240	12	0.21
84	1203	2216	2.53	39-31.50	111-55.17	1.6	1.4	15	86	8	0.35
84	1204	1356	56.57	41-54.60	111-37.16	4.4*	0.8	9	152	16	0.17
84	1205	1103	40.44	41-54.27	111-37.29	8.9	0.9	10	150	16	0.16
84	1206	357	44.60	41-39.86	111-57.49	3.6	0.8	9	88	6	0.15
84	1207	639	6.54	39-18.20	111- 1.90	0.1*	1.9	10	237	43	0.44
84	1207	2306	39.71	41-48.80	112-25.04	3.3*	0.5	12	113	15	0.41
84	1208	941	2.28	42-21.65	111-28.51	0.2*	2.3	30	83	37	0.36
84	1208	1128	12.83	39-17.80	111-56.20	0.3*	1.7	14	78	22	0.36
84	1208	1144	25.78	39-18.34	111-55.50	2.6*	1.3	8	90	22	0.09
84	1209	1155	16.70	39-17.43	111-55.77	2.4*	1.7	11	80	22	0.29
84	1209	1156	30.89	42-20.76	111-27.86	2.5*	2.0	24	91	36	0.40
84	1210	122	14.05	39-18.66	111-55.72	0.3*	1.5	9	90	22	0.39
84	1210	403	36.57	41-39.62	111-57.13	3.4	1.3	16	63	9	0.24

UTAH EARTHQUAKES: JAN 1984 - DEC 1985

yr	date	orig time		lat-n	long-w	depth	mag	no	gap	dmn	rms
84	1211	1535	50.10	37-45.41	113-39.29	0.1*	1.5	8	306	19	0.53
84	1211	2036	15.20	39-32.83	112-12.24	3.2*	1.6	11	103	19	0.38
84	1212	841	23.43	42-26.58	111-34.09	0.1*	1.5	18	264	40	0.47
84	1214	1943	6.31	39-33.65	111-25.77	1.4*	1.4	13	140	28	0.38
84	1215	1203	28.95	41-41.65	111-42.08	12.9	0.9	11	95	23	0.21
84	1216	432	28.08	39-19.19	111- 1.11	0.5*	1.7	12	227	44	0.24
84	1216	932	38.92	42- 1.74	112-30.57	1.2*	0.9	19	138	13	0.31
84	1216	1020	8.79	42- 1.98	112-30.57	6.2*	0.3	11	139	12	0.46
84	1216	1334	40.09	40-26.04	111-26.02	0.3	2.3	30	90	8	0.37
84	1217	718	36.29	41-56.80	112-33.63	3.2*	0.3	7	144	19	0.44
84	1218	603	21.52	41-57.50	112-28.47	1.8*	0.4	12	119	12	0.30
84	1218	648	46.85	41-56.82	112-28.08	3.6*	2.0	30	116	12	0.23
84	1219	1604	17.75	39-21.57	110-56.48	1.9*	1.6	7	139	34	0.54
84	1220	316	40.14	41-55.97	112-35.05	2.4*	0.3	12	149	21	0.23
84	1220	1041	50.62	42- 1.50	112-30.26	7.7	1.4	25	127	13	0.27
84	1221	106	28.83	39-15.69	111- 6.75	0.0*	1.7	9	233	37	0.38
84	1222	1804	19.54	38- 9.81	112-34.83	0.1*	1.9	11	177	37	0.30
84	1223	1924	48.93	41-37.19	111- 9.38	0.2*	1.8	19	139	22	0.38
84	1224	133	35.39	41-48.72	112-40.37	2.2	0.7	11	130	9	0.22
84	1224	2112	30.42	39-33.03	112-12.77	2.2*	1.4	10	147	19	0.40
84	1226	2107	17.30	40- 6.36	111-14.72	12.4*	1.0	11	244	34	0.43
84	1228	619	54.00	39-54.97	111-33.62	2.4*	1.3	11	153	19	0.32
84	1229	1255	11.95	39-10.86	111-48.79	0.1*	1.0	12	114	14	0.37
84	1229	1850	17.67	38- 9.89	112-33.58	0.1*	1.5	15	180	38	0.40
84	1230	250	59.28	39-11.34	111-24.90	23.9	1.8	6	192	17	0.49
84	1231	252	42.04	41-18.75	111-41.96	13.1	2.0	25	115	23	0.27
85	101	1811	16.08	42- 2.09	112-29.21	2.3*	0.6	14	126	12	0.19
85	103	948	25.90	39- 0.62	111-57.49	12.4	1.3	6	159	12	0.17
85	104	41	36.14	41-27.53	112-26.16	3.4	0.8	12	159	7	0.29
85	105	140	11.44	41-41.45	111-33.43	11.1	1.0	20	78	0	0.47
85	105	1930	48.17	41-43.34	112- 7.66	3.2	1.2	18	62	8	0.19
85	107	1447	28.38	41-48.13	112-19.15	1.8*	0.6	14	102	14	0.20
85	107	2051	40.57	38-57.97	111-23.43	14.1*	1.2	7	249	32	0.44
85	108	2211	15.29	41-27.72	112-26.51	2.2	0.5	11	210	8	0.15
85	109	1351	31.73	38-20.30	111-51.45	22.3	1.3	9	149	33	0.30
85	110	424	22.66	39-23.59	112- 9.18	2.5*	1.8	16	88	30	0.23
85	110	1626	55.36	42-23.07	111-27.38	6.6*	1.5	12	178	40	0.31
85	113	1240	2.45	41-54.77	112-36.38	3.9*	0.4	6	151	20	0.23
85	113	1625	56.15	38-37.27	112-36.01	3.3	1.1	10	119	5	0.41
85	114	813	8.19	40-29.48	111-21.46	8.5	1.1	19	106	12	0.28

UTAH EARTHQUAKES: JAN 1984 - DEC 1985

yr	date	orig	time	lat-n	long-w	depth	mag	no	gap	dmn	rms
85	114	858	7.97	40-29.13	111-22.13	9.4	0.9	13	100	12	0.24
85	114	2321	12.14	38-59.31	110-57.50	6.9*	0.6	6	144	35	0.28
85	115	1357	29.77	39-58.89	111-19.31	5.6*	1.8	21	125	37	0.20
85	116	48	8.30	41-15.52	111-41.20	5.6*	0.9	12	131	27	0.21
85	116	2213	52.92	40-36.87	111-32.71	13.9	0.7	8	121	8	0.22
85	116	2216	25.09	39-32.49	112-12.78	2.4*	1.5	11	134	18	0.33
85	117	1718	39.45	41-59.10	112-59.12	10.6*	0.6	10	282	28	0.25
85	117	2339	19.10	41-55.55	112-37.56	2.9*	0.6	11	161	20	0.18
85	118	1543	13.34	37-42.48	114- 6.47	2.1*	3.1W	9	167	56	0.16
85	118	1725	23.24	42- 0.07	112-49.66	6.7*	0.6	16	188	25	0.26
85	121	901	0.05	38-37.14	112-33.44	1.1	1.4	10	116	1	0.47
85	121	2214	37.74	41-55.17	112-31.76	2.4*	0.4	10	129	16	0.25
85	122	609	2.36	41-40.57	112- 5.18	3.6	0.5	14	90	6	0.28
85	122	1222	51.74	37-45.97	112-23.61	1.6*	2.0	12	198	60	0.39
85	122	1703	27.53	41-40.51	112- 5.23	3.7	0.4	13	90	7	0.36
85	123	56	17.39	38-38.97	112-34.43	5.1	1.0	10	191	4	0.38
85	124	30	53.64	41-57.50	112-26.52	1.5*	0.6	8	109	10	0.09
85	124	351	15.96	41-55.48	112-31.45	1.4*	0.9	16	116	16	0.42
85	124	1028	38.81	41-55.79	112-31.46	1.4*	1.3	20	117	16	0.39
85	124	1051	58.80	41-55.20	112-31.42	2.2*	0.6	15	126	16	0.26
85	124	1116	9.14	41-55.30	112-32.33	3.9*	1.0	8	131	17	0.18
85	124	1308	53.61	41-55.00	112-31.69	2.2*	0.7	13	127	16	0.26
85	124	1317	8.30	41-54.40	112-31.81	2.2*	1.2	14	126	17	0.33
85	124	1407	52.62	41-55.13	112-32.68	2.3*	1.1	11	133	18	0.20
85	125	1212	41.57	41-53.89	112-31.95	1.4*	1.5	23	125	17	0.32
85	125	1325	12.24	41-53.95	112-32.46	1.5*	1.2	19	127	18	0.28
85	125	2144	43.48	41-56.96	112-27.70	1.6*	2.4	31	113	11	0.30
85	125	2205	57.12	41-57.45	112-27.39	2.2*	0.3	6	128	11	0.33
85	125	2218	41.58	41-59.82	112-24.00	1.9	0.2	10	111	9	0.42
85	126	237	6.58	41-56.90	112-28.53	1.9*	0.9	14	118	12	0.18
85	126	326	5.08	40- 0.89	111-14.28	2.3*	1.8	14	144	35	0.27
85	126	1508	6.71	41-53.43	112-31.80	2.0*	3.6W	30	109	17	0.24
85	127	312	46.69	41-53.99	112-32.44	3.0*	0.5	7	127	18	0.30
85	127	536	10.38	41-53.69	112-32.24	2.3*	0.7	12	126	18	0.28
85	127	923	37.22	41-53.66	112-31.86	1.5*	1.1	17	111	17	0.39
85	127	1046	49.60	41-53.40	112-32.21	1.5*	3.3W	33	109	18	0.25
85	127	1531	2.81	41-54.02	112-32.16	1.9*	1.0	16	127	17	0.30
85	128	540	51.48	41-53.79	112-31.71	2.2*	0.7	13	123	17	0.25
85	128	546	37.57	41-53.66	112-32.16	2.4*	0.5	14	124	17	0.29
85	129	1623	30.98	41-52.76	112-31.91	1.4*	2.4	28	107	18	0.25

UTAH EARTHQUAKES: JAN 1984 - DEC 1985

yr	date	orig	time	lat-n	long-w	depth	mag	no	gap	dmn	rms
85	130	1109	10.13	41-45.98	112-25.87	2.8*	1.1	19	96	20	0.27
85	130	2341	57.84	41-29.81	111-42.36	4.9*	1.3	14	101	17	0.18
85	131	2005	48.38	42-15.98	111-59.03	2.2*	0.4	10	145	23	0.37
85	131	2016	42.55	42-16.35	111-58.85	0.1*	1.0	10	145	23	0.30
85	131	2106	20.41	42-15.72	111-59.40	3.8*	0.8	12	145	23	0.23
85	201	1436	12.77	41-56.79	112-32.45	1.8*	0.7	14	137	18	0.25
85	202	451	10.86	39-17.86	111-55.83	0.3*	1.4	17	76	22	0.44
85	204	634	53.53	41-54.10	111-29.14	11.1	1.1	16	118	21	0.22
85	205	50	25.17	41-58.06	112-24.44	3.2	2.2	26	100	8	0.26
85	205	1114	27.91	41-58.31	112-24.63	2.8	1.1	19	101	8	0.36
85	206	307	34.09	39-50.28	112- 1.11	3.1*	2.0W	30	50	13	0.29
85	206	355	59.31	39-50.54	112- 0.79	5.0*	1.3	11	78	13	0.23
85	206	1849	51.30	40-52.85	111-31.65	1.7*	2.4W	24	145	26	0.29
85	207	501	5.69	41-57.89	112-23.99	8.4	0.6	14	98	7	0.23
85	207	1518	46.77	41-58.20	112-24.41	6.6	1.7	17	99	8	0.17
85	207	2227	38.85	41- 7.86	112-54.86	4.3*	1.6	17	194	51	0.26
85	208	107	57.77	40-18.27	114- 1.38	6.4*	2.7W	28	101	84	0.45
85	209	1748	18.33	41-40.49	112-53.92	4.1*	0.9	12	260	15	0.25
85	210	1943	38.48	39-18.49	111- 7.12	0.0*	1.9	10	193	36	0.38
85	211	707	14.88	38-50.81	111-53.34	1.4*	1.5	9	114	21	0.32
85	211	721	53.47	38-51.03	111-52.07	6.3*	1.7	11	117	23	0.26
85	211	804	35.91	38-51.30	111-53.15	3.2*	2.3	14	107	21	0.44
85	211	834	35.68	38-51.06	111-54.25	1.0*	2.1	11	82	20	0.40
85	211	839	17.36	38-51.14	111-52.54	3.3*	2.0	12	116	22	0.38
85	211	841	22.62	38-51.14	111-52.87	1.4*	2.0	10	115	21	0.30
85	211	1943	3.42	39-31.64	111- 5.66	0.8*	1.8	9	168	27	0.28
85	214	338	10.24	38-39.70	112-11.10	1.9*	1.6	13	85	16	0.37
85	214	504	34.81	38-56.31	111-57.50	3.0*	0.8	8	158	11	0.24
85	215	24	27.56	40-29.83	111-21.10	12.5	0.4	8	174	12	0.23
85	215	1948	18.88	37-42.07	113-20.47	9.8	1.3	6	222	13	0.22
85	216	1618	29.94	38-57.98	111-56.77	9.5	1.0	9	99	12	0.34
85	217	927	11.87	42-23.11	111-20.50	10.5*	1.8	14	218	47	0.26
85	217	1421	56.18	37-45.94	113- 9.41	5.8*	1.0	9	134	12	0.26
85	218	1746	3.88	38-23.90	112-16.96	2.7*	1.2	8	139	65	0.18
85	218	2314	32.61	39-20.79	111- 5.57	0.7*	1.4	13	194	38	0.34
85	219	2107	7.20	40-47.53	111-29.97	9.9*	0.8	12	246	21	0.23
85	219	2207	10.21	39-33.14	112-12.38	0.4*	1.9	17	85	19	0.33
85	223	502	32.99	39-28.66	111-18.13	1.8*	1.5	12	184	27	0.23
85	223	509	37.24	39-28.09	111-18.75	8.9*	1.5	11	184	25	0.29
85	224	537	13.19	42-27.86	111-49.33	7.4*	2.7W	21	143	38	0.16

UTAH EARTHQUAKES: JAN 1984 - DEC 1985

yr	date	orig	time	lat-n	long-w	depth	mag	no	gap	dmn	rms
85	224	1554	11.89	41-53.89	112-32.91	3.0*	0.6	10	130	18	0.30
85	225	1645	53.62	37-52.61	110-39.20	2.2*	1.9	11	213	66	0.37
85	225	1718	31.97	37-54.78	110-37.10	1.3*	2.3	9	150	64	0.25
85	227	547	21.18	38-34.11	112-34.54	3.0*	1.6	9	137	35	0.49
85	228	155	1.18	39-41.84	110-44.84	1.3*	1.8	19	205	80	0.49
85	228	602	22.21	38-32.89	112-34.55	4.4*	2.0	13	108	35	0.47
85	301	2156	17.61	41-53.54	112-31.87	2.3*	0.9	12	123	17	0.35
85	304	1414	12.79	41-58.57	112-22.88	2.9	0.5	12	105	7	0.34
85	304	1800	21.82	39-42.51	110-42.47	0.3*	2.2	16	212	24	0.33
85	304	2036	58.87	40-26.60	111-59.71	2.2*	0.5	19	78	24	0.29
85	305	136	26.12	39-43.50	110-59.38	2.8*	1.6	15	205	65	0.39
85	306	1639	34.69	39-10.46	111-28.25	4.7*	0.4	7	190	14	0.41
85	307	810	51.15	38- 5.99	112- 9.02	0.9*	2.3	13	159	46	0.29
85	307	1002	3.91	38- 6.81	112- 8.98	5.1*	1.7	8	188	44	0.21
85	307	2354	28.60	39-29.97	112- 2.74	15.0	0.7	7	139	17	0.24
85	310	1220	3.07	39-43.92	110-49.90	2.0*	2.0	16	219	13	0.37
85	310	1613	13.85	38-48.09	111-58.24	0.1*	1.6	11	105	20	0.24
85	311	732	55.31	40-34.48	111-56.55	2.1*	1.0	18	71	15	0.25
85	312	443	5.00	38-23.45	112-17.00	0.3*	1.8	11	134	16	0.44
85	312	1621	36.54	39-43.19	110-38.96	0.5*	1.2	11	232	29	0.48
85	315	130	53.28	41-54.96	112-32.10	2.3*	0.6	12	194	17	0.23
85	315	1726	21.68	42-22.04	111- 8.95	2.4*	1.9	17	184	46	0.23
85	316	318	7.53	41-51.05	112-41.81	6.6	1.5	19	161	10	0.20
85	318	255	13.29	39-45.13	110-58.38	3.3	2.3	16	235	1	0.35
85	318	1427	18.08	41-51.42	112-41.51	2.1*	0.6	13	164	11	0.24
85	318	2207	35.49	39-32.95	112-11.66	2.6*	1.4	14	102	19	0.39
85	319	1747	53.29	41-57.71	112-28.74	2.1*	0.5	6	247	13	0.12
85	319	1749	36.13	41-56.99	112-30.00	2.5*	1.1	5	258	14	0.06
85	320	137	9.81	41-36.79	109-37.32	7.0*	2.9	19	225	129	0.44
85	322	149	17.31	41-27.79	112-25.15	3.2	1.3	22	181	8	0.19
85	322	212	16.14	41-27.80	112-24.99	1.5	0.5	11	193	8	0.21
85	323	352	6.69	40-54.12	111-40.55	3.1*	0.7	12	169	17	0.18
85	323	1652	34.95	41-50.75	112-41.41	5.7	1.2	17	158	10	0.19
85	323	1729	0.14	41-50.68	112-40.92	4.1*	0.6	10	154	10	0.13
85	324	1136	8.92	41-26.44	111-42.86	11.2	1.0	14	162	21	0.20
85	325	1033	54.97	41-12.27	111-38.29	1.8*	1.0	14	170	20	0.18
85	326	838	42.87	38- 3.43	112- 5.89	1.5*	2.4	15	167	51	0.31
85	327	438	47.90	41-53.50	112-32.73	2.1*	0.9	15	127	18	0.15
85	327	1138	45.96	38- 4.48	112- 4.95	2.1*	2.0	8	165	70	0.25
85	330	508	7.63	42- 3.18	112-28.08	2.0*	0.7	11	119	11	0.15

UTAH EARTHQUAKES: JAN 1984 - DEC 1985

yr	date	orig	time	lat-n	long-w	depth	mag	no	gap	dmn	rms
85	402	2258	59.01	42-15.53	111-31.23	9.7*	2.2	17	188	26	0.18
85	404	2343	9.50	38- 2.91	112-52.94	8.4	1.6	6	157	11	0.16
85	405	101	20.92	39-36.24	110-23.14	0.4*	2.3W	23	240	54	0.45
85	405	129	47.15	37-50.79	113-11.11	3.9*	1.1	7	109	21	0.34
85	405	543	26.79	42-23.43	111-34.27	4.5*	3.2W	30	162	35	0.29
85	406	1525	42.70	41-54.31	112-31.78	2.4*	0.5	9	126	17	0.23
85	407	248	47.45	41-54.05	112-32.49	3.0*	1.1	17	127	18	0.27
85	409	920	49.56	41-22.31	112-41.55	2.4*	1.4	15	229	53	0.39
85	409	1727	3.12	39-32.37	111-54.28	0.1	1.4	16	99	8	0.49
85	410	40	14.11	39-43.85	110-56.18	0.1	2.6W	24	196	5	0.40
85	410	353	54.29	41-21.54	112-39.48	5.4*	1.8	25	163	21	0.38
85	410	743	39.38	41-48.48	112-23.22	2.3*	0.3	7	116	14	0.12
85	410	1253	14.57	41-21.21	112-39.40	3.0*	1.5	11	231	49	0.16
85	410	1256	50.31	41-22.18	112-25.39	18.7*	1.0	9	234	37	0.39
85	410	1311	31.64	41-21.53	112-37.41	3.8*	1.6	17	211	18	0.26
85	411	350	0.91	37-22.43	112-40.58	1.8*	1.3	9	253	48	0.23
85	411	425	43.32	37-24.16	112-40.99	2.0*	1.7	8	249	45	0.19
85	411	432	46.72	37-21.22	112-40.23	1.9*	1.7	7	288	50	0.21
85	411	1142	33.14	41-30.74	111-54.49	1.9*	0.6	6	140	11	0.15
85	413	226	43.38	38-50.02	111-31.84	1.2*	1.6	10	161	40	0.22
85	414	17	44.50	39-29.66	112- 9.09	8.0	1.4	13	96	13	0.42
85	414	1603	46.51	42- 2.92	112-30.41	2.2*	0.2	8	139	11	0.45
85	415	1609	24.06	41-53.66	111-50.04	10.2	0.5	10	72	11	0.10
85	417	300	44.71	41-27.73	112-24.76	2.3	0.7	17	143	7	0.13
85	417	2219	3.74	39-32.53	112-10.90	2.3*	0.8	10	105	18	0.21
85	418	2115	58.96	41-52.18	111-29.01	8.3*	0.9	11	135	21	0.04
85	419	509	26.84	39-36.06	110-32.05	1.3*	1.5	14	221	91	0.43
85	420	1105	45.58	41-21.21	112-35.53	10.1	1.3	14	223	15	0.20
85	420	2316	37.34	41-31.40	112-16.54	11.3	0.7	7	159	7	0.29
85	421	1934	55.44	39-36.75	110-25.74	0.0*	2.2	12	237	50	0.45
85	421	2300	20.75	40-45.29	111-50.85	5.3	1.8W	16	76	1	0.22
85	422	408	12.54	41-55.99	112-34.51	1.5*	1.5	18	146	20	0.21
85	424	1924	58.36	39-37.36	110-25.68	9.6*	1.8	12	237	52	0.42
85	425	1337	43.26	41-50.68	112-27.11	7.8	0.3	7	153	14	0.17
85	426	2323	5.35	39-36.34	110-24.79	0.0*	2.3	13	239	51	0.48
85	427	2241	12.60	39-17.62	111-10.09	0.8*	1.3	10	109	31	0.23
85	429	349	59.64	41-37.39	112-23.00	3.3*	0.7	10	183	11	0.08
85	429	1001	4.75	41-39.52	111-56.75	6.1	1.1	15	93	5	0.15
85	504	137	29.84	41-35.69	111-41.44	10.1	2.0	23	92	14	0.22
85	505	530	56.68	39-36.48	110-22.49	0.4*	2.6	17	243	52	0.39

UTAH EARTHQUAKES: JAN 1984 - DEC 1985

yr	date	orig	time	lat-n	long-w	depth	mag	no	gap	dmn	rms
85	506	505	22.42	39-36.59	111-37.22	1.7*	1.7	18	54	22	0.32
85	506	552	51.23	39-36.60	111-37.53	3.9*	1.5	15	100	21	0.32
85	506	1519	10.50	40-12.05	110-59.04	2.9*	1.2	8	285	32	0.13
85	507	1123	8.76	39-36.59	111-37.37	3.4*	2.3W	23	54	21	0.29
85	507	1930	46.46	39-35.92	110-29.17	0.2*	2.2	16	229	46	0.40
85	507	2158	48.54	39-35.17	110-25.32	6.0*	2.1	13	238	49	0.40
85	508	324	46.64	39-36.51	110-23.98	0.1*	2.7	17	240	52	0.43
85	509	408	36.08	41-51.26	112-40.00	5.0*	0.9	15	152	12	0.31
85	509	1555	48.83	39-16.03	111-10.09	15.4*	2.2	7	139	32	0.20
85	509	1957	3.98	39- 2.02	111-54.70	0.7*	1.4	9	96	17	0.41
85	509	2108	50.09	41-40.71	112-10.79	21.0	0.6	9	144	13	0.46
85	510	1309	49.49	40-28.81	111-27.85	7.6	0.7	10	108	9	0.18
85	510	1346	53.85	42-11.47	111-33.62	17.5	0.8	9	244	20	0.35
85	510	2013	48.72	41-42.63	112- 8.39	4.8	0.5	11	114	9	0.15
85	514	233	52.99	41-39.42	111-57.57	5.8	0.7	9	87	5	0.08
85	514	2244	20.76	39-36.60	110-24.34	0.3*	2.4	16	239	52	0.31
85	515	1948	57.95	39- 6.85	111-27.31	0.6*	2.5	19	85	17	0.39
85	518	402	3.73	41-46.82	111-38.81	0.1*	2.1	28	86	10	0.37
85	518	411	18.08	41-47.07	111-37.62	11.2	0.4	9	115	11	0.10
85	518	416	45.67	41-46.77	111-38.17	11.3	1.0	11	114	11	0.10
85	521	657	50.69	39-36.40	110-21.98	0.6*	2.2	15	244	53	0.40
85	521	2050	16.06	39-36.98	110-16.44	5.1*	2.0	11	245	57	0.41
85	523	634	4.87	41-39.28	111-58.40	2.7	1.0	10	120	5	0.27
85	523	1851	54.88	39-32.14	112- 4.74	2.6*	0.9	8	104	19	0.16
85	524	1434	54.59	41-32.21	112-40.03	4.0*	0.7	7	267	26	0.20
85	524	1742	17.22	41-29.53	111-42.68	3.2*	1.1	13	191	23	0.26
85	525	248	23.38	41-47.29	112-13.81	9.2	0.4	8	117	17	0.27
85	525	733	57.99	41-31.83	112-40.21	7.0*	0.8	9	197	29	0.21
85	527	227	52.80	39- 9.86	112- 4.10	0.2*	1.7	13	99	22	0.23
85	528	2223	34.62	41-59.56	112-28.56	2.4*	0.8	8	122	14	0.16
85	530	332	39.70	39-14.24	112- 0.52	10.6	1.0	6	219	20	0.17
85	531	52	2.11	39-35.64	110-25.37	0.2*	2.3	20	232	49	0.45
85	531	1032	30.93	41-41.00	111-57.78	3.5	0.7	7	127	6	0.09
85	531	1034	3.41	41-41.04	111-57.28	4.8	0.6	8	134	7	0.05
85	601	1822	58.70	39-41.81	110-43.17	0.1*	2.4W	20	199	24	0.37
85	602	1623	58.36	41-49.83	112-17.99	2.2*	0.7	12	71	11	0.24
85	603	205	24.77	38-30.23	111-52.32	0.6*	1.9	14	93	26	0.33
85	603	736	46.61	39-41.98	110-43.18	0.4*	2.5	23	197	23	0.44
85	604	2031	22.43	38-30.06	111-52.78	1.4*	1.5	10	108	25	0.39
85	605	141	18.86	38-29.87	111-51.92	1.6*	1.6	14	106	26	0.35

UTAH EARTHQUAKES: JAN 1984 - DEC 1985

yr	date	orig	time	lat-n	long-w	depth	mag	no	gap	dmn	rms
85	605	423	47.85	40-52.75	111-41.03	5.6*	2.1	24	139	15	0.27
85	605	1822	25.73	41-58.92	111-49.65	2.9*	0.7	9	132	15	0.36
85	606	16	25.79	41-56.06	112-25.99	3.9	0.6	13	105	9	0.24
85	606	48	9.60	38-30.89	111-52.23	10.5*	1.4	10	144	26	0.31
85	606	1912	50.60	42-14.40	111-40.09	13.3	1.0	13	229	16	0.20
85	607	640	47.83	39-33.39	110-22.21	0.1*	2.2	15	245	47	0.43
85	607	2101	15.32	39-11.66	111-48.45	0.1*	2.2	24	69	14	0.32
85	610	29	0.35	39-15.21	112-16.53	7.8*	1.1	14	101	16	0.26
85	610	1804	4.18	38-58.14	111-34.24	14.3	1.3	11	90	24	0.23
85	610	2014	11.78	40-24.05	111-22.99	12.4	0.6	9	130	10	0.14
85	611	721	45.12	39- 9.93	111-28.21	0.1*	3.0	8	169	15	0.42
85	612	358	3.38	39-37.13	110-28.38	0.1*	2.1	15	232	46	0.45
85	613	1936	49.45	42- 0.37	112-33.21	2.2*	0.5	8	153	15	0.12
85	614	327	34.44	39- 2.07	111-59.36	6.5	0.9	14	86	11	0.29
85	615	534	5.08	39-37.58	110-25.24	0.2*	1.5	14	237	50	0.46
85	617	1824	48.67	40-24.16	111-35.43	1.8	1.1	12	90	5	0.47
85	618	127	30.98	39-11.78	111-47.96	1.0*	1.6	14	78	13	0.32
85	618	2111	30.08	39-32.16	111-55.44	0.4	1.3	16	101	9	0.33
85	619	1745	49.72	37-48.45	113-49.30	6.9*	3.0W	15	140	67	0.42
85	622	346	51.45	39-31.39	112- 1.69	0.2*	1.7	18	101	17	0.25
85	622	1315	58.23	42-20.44	111-20.54	0.3*	2.3	16	97	43	0.34
85	624	13	20.48	39-57.29	111-38.49	2.3*	0.9	12	209	14	0.28
85	624	1401	22.72	38-31.47	112-17.82	1.4*	1.8	15	89	10	0.36
85	624	1502	52.86	39-44.96	110-37.76	0.1*	1.4	10	214	30	0.41
85	627	711	9.31	41-46.84	112-36.99	5.1*	1.4	19	106	13	0.21
85	627	905	28.18	42- 4.60	111-57.26	0.0*	2.4	31	67	14	0.34
85	627	1036	29.53	39-33.50	110-23.74	0.6*	3.0	21	234	47	0.43
85	627	1119	56.45	41-46.76	112-36.65	3.9*	2.6	33	164	28	0.23
85	627	1704	35.58	40-31.37	111-20.99	2.2*	0.6	10	115	12	0.33
85	627	1850	23.48	39-36.00	110-26.06	1.1*	2.6	25	219	50	0.41
85	628	819	28.68	41-46.89	112-36.07	3.0*	1.3	13	144	14	0.28
85	628	1400	36.22	41-46.47	112-37.05	4.2*	1.5	20	110	13	0.28
85	628	1407	5.22	41-47.05	112-37.32	5.4*	1.2	14	110	12	0.20
85	629	1758	45.78	39-36.20	110-23.81	0.3*	2.2	18	232	51	0.40
85	703	1008	7.49	39-32.66	111-55.69	1.8*	1.0	10	116	10	0.32
85	705	145	55.17	39-24.17	111-24.74	16.8	1.5	16	68	14	0.29
85	705	300	33.85	41-47.38	112-37.42	6.3*	0.8	15	107	12	0.22
85	708	1456	35.56	41-46.87	112-36.77	3.5*	2.1	31	84	13	0.25
85	708	1502	34.47	41-47.19	112-36.86	3.4*	0.9	12	109	13	0.32
85	708	1916	17.17	41-17.72	111-44.48	12.8	0.9	13	182	15	0.29

UTAH EARTHQUAKES: JAN 1984 - DEC 1985

yr	date	orig	time	lat-n	long-w	depth	mag	no	gap	dmn	rms
85	709	114	46.47	41-47.25	112-36.46	3.7*	2.4	34	83	13	0.26
85	711	300	21.62	41- 7.44	111-40.69	8.6	1.7	26	134	17	0.20
85	712	1848	47.17	40-25.06	111-25.26	3.3	1.0	14	117	9	0.25
85	713	321	8.08	41-24.05	112- 8.61	3.3*	1.2	13	77	14	0.18
85	717	1848	51.02	39-36.56	110-23.82	1.2*	2.6	21	237	53	0.46
85	720	907	37.04	41-54.46	111-58.50	6.5*	1.0	13	127	18	0.13
85	720	1628	18.41	38-47.06	111-55.18	4.8*	1.5	10	148	24	0.15
85	721	139	0.36	39-36.10	110-23.82	0.3*	2.3	22	223	51	0.43
85	725	316	44.48	41-11.34	111-34.94	3.0*	1.7	20	152	24	0.28
85	727	249	20.04	40-27.66	111-27.14	3.9	1.7	17	98	8	0.24
85	728	2150	51.34	41-56.13	112-35.83	2.4*	0.6	10	154	22	0.21
85	728	2319	7.07	41-56.26	112-36.37	1.4*	2.7W	21	132	22	0.26
85	729	1437	43.69	40-41.54	111-52.68	1.7*	0.5	12	124	11	0.27
85	730	1050	55.47	41-56.67	112-35.65	8.5*	1.2	9	232	22	0.24
85	730	1930	13.17	39-42.14	110-33.88	1.8*	1.7	16	203	36	0.37
85	731	822	1.24	38- 6.14	112-46.45	1.5*	2.0	13	107	19	0.20
85	801	2125	3.72	41-43.97	112-46.28	7.3*	1.6	19	223	42	0.31
85	802	430	30.93	41-44.20	112-48.06	6.7*	1.1	17	226	44	0.27
85	802	1034	8.67	38-30.94	111-51.69	7.0*	0.9	7	121	53	0.25
85	802	1725	10.41	39-54.39	111-58.52	2.1	0.6	7	206	10	0.41
85	804	514	1.36	41-28.02	112- 5.84	1.3*	0.8	17	133	11	0.22
85	804	834	46.78	41-27.98	112- 5.91	5.0*	0.8	8	206	11	0.04
85	804	1900	1.48	40-45.38	111-28.48	9.3	0.9	13	196	17	0.14
85	806	446	30.40	42- 6.90	112-28.90	5.4	2.0	18	106	4	0.20
85	806	858	18.23	39-33.40	110-23.82	0.0*	2.5	20	225	46	0.48
85	806	1010	24.66	39-36.01	110-24.45	0.3*	2.3	18	231	51	0.39
85	807	710	33.25	42- 6.48	112-19.32	0.5*	2.8W	28	90	16	0.25
85	807	1757	11.69	41-39.48	111-40.28	1.4	0.6	13	73	9	0.40
85	808	411	32.54	42- 6.52	112-19.36	3.2*	1.0	16	104	16	0.18
85	809	1608	28.94	41-46.17	112-25.75	0.2*	2.0	21	176	19	0.21
85	810	13	51.93	39-44.03	111-47.28	15.8	1.1	13	125	17	0.32
85	811	1949	4.06	42-28.58	111-35.61	8.7*	1.1	9	168	64	0.15
85	813	945	16.44	41-34.18	111-46.14	8.2*	0.6	9	153	16	0.17
85	813	1207	43.52	41-44.26	112-22.24	2.4*	0.7	9	131	19	0.14
85	813	1754	50.44	41- 5.22	110-29.39	0.7*	2.5W	18	237	97	0.37
85	816	2257	38.68	40-20.62	111-47.77	3.8*	1.5	21	99	25	0.23
85	816	2305	26.74	40-20.76	111-47.39	2.3*	1.0	16	108	25	0.24
85	820	1948	18.32	39-40.18	112- 3.08	5.1*	1.4	14	89	31	0.39
85	820	2005	29.15	40-49.30	111-54.13	6.0	0.8	10	125	9	0.22
85	822	1748	30.10	39-32.77	112-13.52	0.4*	1.4	12	105	19	0.31

UTAH EARTHQUAKES: JAN 1984 - DEC 1985

yr	date	orig time		lat-n	long-w	depth	mag	no	gap	dmn	rms
85	822	2215	24.76	41-33.31	111-43.08	1.5*	1.0	11	175	19	0.20
85	823	1707	59.51	38-31.62	112-14.91	5.8	1.0	7	132	6	0.34
85	824	650	56.05	38-31.75	112-16.68	0.8	1.6	15	90	9	0.43
85	824	921	8.48	38-31.10	112-16.33	1.5	1.2	10	123	8	0.34
85	824	949	40.56	37-47.93	113-12.41	0.4*	1.5	9	186	20	0.31
85	826	301	34.57	39-28.90	111-17.15	4.5*	1.0	10	164	28	0.26
85	826	2220	37.78	40-33.35	111-31.00	1.8	0.3	9	92	7	0.14
85	828	320	22.89	41-51.06	112-42.65	9.3	1.2	15	171	9	0.31
85	831	1424	24.65	39-36.22	110-22.48	0.3*	2.2	18	237	52	0.42
85	901	119	34.63	40-24.35	111-38.21	7.5	0.9	11	105	9	0.09
85	901	1521	29.44	37-10.38	112-46.16	0.7*	1.5	9	193	61	0.28
85	903	316	18.90	42-18.82	111-29.30	0.4*	2.2	20	190	61	0.34
85	903	814	27.01	39-42.84	110-38.74	0.1*	2.5	20	207	29	0.41
85	903	2147	32.76	39-32.37	112-13.17	1.7*	1.6	11	86	18	0.36
85	905	2217	31.50	39-36.02	110-24.49	0.3*	2.2	19	221	51	0.43
85	906	143	40.87	39-35.63	110-25.19	1.1*	2.8	25	223	50	0.42
85	906	2027	58.02	42- 5.69	112-19.70	1.0*	0.6	8	183	16	0.10
85	907	510	2.17	41-58.17	112-28.95	1.9*	1.4	23	118	13	0.23
85	907	809	35.71	40-43.01	111-58.50	5.5	0.5	11	106	4	0.08
85	908	125	40.98	41-51.32	112-42.16	8.1	0.6	9	169	10	0.22
85	909	209	37.80	41-50.23	112-41.32	4.7	1.7	21	125	9	0.36
85	909	2057	32.18	37-53.96	113- 2.65	13.1	1.1	7	119	23	0.19
85	912	1433	18.33	41-29.73	112-27.24	0.1*	0.8	15	155	20	0.24
85	912	2208	14.64	39-35.29	110-27.43	0.4*	2.4	16	233	48	0.54
85	913	1320	46.51	39- 8.71	111-48.06	0.0*	2.3	23	69	14	0.44
85	918	2347	34.10	40-36.63	110-37.19	0.1*	1.8	6	278	58	0.46
85	919	1605	15.31	41-45.21	111-37.15	12.4	0.7	10	118	9	0.15
85	919	2318	5.61	39-33.96	110-29.84	0.3*	1.6	17	212	45	0.43
85	923	426	52.40	39-38.09	110-37.26	0.2*	2.0	6	260	101	0.39
85	923	442	8.17	41-39.76	112-22.80	6.7*	0.6	9	107	13	0.18
85	923	448	31.36	41-40.37	112-22.68	1.5*	0.9	18	105	14	0.29
85	923	757	25.21	38-41.63	112-14.61	0.3*	1.5	12	80	20	0.46
85	923	1107	5.13	40-22.70	111-25.35	9.9	0.9	11	136	9	0.36
85	923	1531	18.96	39-15.18	111-12.04	7.2*	1.6	12	108	29	0.29
85	923	2154	24.77	41-36.53	110-48.19	0.1*	2.5W	5	263	99	0.09
85	924	1811	2.87	39-35.30	110-25.23	0.6*	2.6	14	163	114	0.41
85	924	2355	12.92	41-39.16	112-22.76	2.8*	1.9	34	101	12	0.31
85	924	2355	12.98	41-43.01	112-24.31	12.8*	2.0	5	158	48	0.24
85	925	906	59.00	41-56.50	112-33.24	2.7*	1.9	32	123	19	0.27
85	926	546	52.87	39-14.74	111-11.83	7.8*	1.7	7	128	30	0.33

UTAH EARTHQUAKES: JAN 1984 - DEC 1985

yr	date	orig	time	lat-n	long-w	depth	mag	no	gap	dmn	rms
85	926	844	42.45	41-53.03	112-31.73	12.7	1.4	12	192	17	0.27
85	926	1630	58.14	40- 0.59	111-49.76	0.2	1.4	15	84	7	0.36
85	927	1239	50.90	41-56.90	112-32.15	2.4*	0.8	12	136	17	0.23
85	927	1643	7.17	41-56.33	112-32.86	1.4*	1.6	17	138	18	0.23
85	928	2355	11.85	41-56.32	112-33.05	1.4*	1.3	17	139	18	0.31
85	929	245	40.00	41-56.28	112-32.79	2.4*	1.3	20	137	18	0.29
85	929	510	36.94	39-36.67	110-25.55	0.5*	2.5	13	237	51	0.39
85	929	1643	54.53	41-56.51	112-32.60	5.6*	1.8	20	138	18	0.36
85	929	2339	45.01	41-56.95	112-32.51	2.5*	0.6	11	139	18	0.25
85	930	1634	53.89	39- 8.89	111-47.81	1.1*	2.0	17	69	13	0.37
85	930	1836	45.18	41-56.71	112-32.38	2.2*	1.6	14	137	17	0.32
85	1002	1453	6.58	41-57.10	112-31.74	2.0*	0.6	11	135	17	0.23
85	1002	1512	36.38	39-15.40	111-10.38	0.4*	1.4	10	258	32	0.47
85	1003	1955	25.83	41-37.54	111-58.07	1.2	2.4	28	69	1	0.28
85	1004	230	39.26	41-43.74	112-46.59	4.8	1.5	17	203	5	0.27
85	1006	44	50.60	41-57.07	112-32.05	2.2*	1.0	12	136	17	0.25
85	1006	259	13.09	40-29.27	111-20.88	11.0	0.6	10	171	11	0.27
85	1006	1144	41.69	41-47.64	111-27.58	3.2*	1.3	8	132	14	0.18
85	1006	1724	53.07	41-47.38	111-27.14	2.3*	0.9	11	131	14	0.24
85	1006	2213	49.58	39-36.20	110-26.74	0.2*	2.4W	21	183	49	0.46
85	1007	722	15.38	40-29.55	111-22.85	8.5	1.1	18	126	13	0.38
85	1007	2033	40.07	40-24.41	109-29.90	20.6*	3.0	22	214	148	0.35
85	1007	2345	10.87	39-32.21	110-18.87	21.5*	1.5	14	249	62	0.44
85	1008	6	37.74	41-28.54	112-14.64	1.5*	0.8	7	132	12	0.15
85	1008	1247	12.84	40-29.45	111-21.23	13.5	0.3	8	169	12	0.20
85	1008	1629	33.50	40-29.17	111-21.41	13.3	0.8	9	164	11	0.19
85	1008	1901	26.64	39-15.97	111-14.59	10.9*	1.4	7	207	25	0.26
85	1010	1913	8.89	39-32.60	112-12.28	1.3*	1.2	14	104	18	0.46
85	1011	518	56.77	39-36.80	110-25.03	0.6*	2.2	14	244	51	0.48
85	1014	709	16.76	37-45.38	112-38.17	1.7*	1.9	10	140	39	0.36
85	1015	1127	51.88	39-42.41	110-36.14	0.1*	1.6	11	261	33	0.30
85	1015	2112	9.71	40- 2.25	111-47.20	0.1	1.8	12	125	5	0.43
85	1016	2200	17.30	39-26.46	111- 7.31	2.9*	1.7	7	234	38	0.31
85	1016	2202	31.21	40- 5.89	111-23.16	3.2*	2.0	22	121	36	0.40
85	1017	1651	9.57	39-35.64	110-28.39	1.4*	1.7	12	277	47	0.49
85	1020	210	19.14	41-45.00	112-47.19	7.8	1.0	18	195	3	0.26
85	1020	744	45.15	42-27.95	112-38.29	9.5*	1.2	10	158	36	0.40
85	1021	644	47.45	41-26.39	111-41.17	9.4	0.6	10	132	15	0.18
85	1021	1140	9.75	41-26.02	111-40.11	1.4*	2.4W	10	204	25	0.16
85	1021	1327	21.00	41-44.71	112-48.36	8.2	1.7	23	164	4	0.17

UTAH EARTHQUAKES: JAN 1984 - DEC 1985

yr	date	orig	time	lat-n	long-w	depth	mag	no	gap	dmn	rms
85	1024	210	5.72	40-42.40	112- 4.19	10.7	0.9	22	56	2	0.22
85	1024	820	16.78	41-44.78	112-47.69	7.0	2.2	19	221	4	0.20
85	1025	443	46.18	41-44.76	112-48.06	9.4	1.0	11	241	4	0.22
85	1025	708	45.62	41-44.49	112-48.21	7.2	1.4	20	230	4	0.15
85	1026	1137	17.07	39-35.85	110-23.74	1.0*	2.1	15	241	51	0.47
85	1027	1054	24.89	41-48.94	112-23.97	3.6*	0.9	14	83	14	0.21
85	1103	636	28.41	37-43.04	110-43.68	0.2*	1.4	10	217	73	0.36
85	1103	2054	21.54	40-29.68	111-20.98	9.5	0.8	13	110	12	0.32
85	1104	813	35.34	40-12.49	111-48.14	4.2*	2.4W	34	104	14	0.31
85	1105	759	27.47	41-20.61	111-44.11	2.9*	0.5	7	162	20	0.23
85	1105	1309	59.58	39-23.87	111-53.32	6.7	1.4	16	81	11	0.43
85	1106	640	20.35	38-29.81	111-40.47	3.7*	1.2	10	128	43	0.37
85	1111	636	59.59	39-59.90	111-53.36	6.1	0.5	6	134	9	0.16
85	1111	750	8.85	38-49.35	111-31.43	0.5*	1.9	14	162	41	0.43
85	1111	1859	41.08	41-44.65	112-48.66	10.6	0.8	11	249	4	0.27
85	1112	1500	33.65	40-11.03	111-14.43	4.4*	2.6W	28	154	25	0.29
85	1116	149	35.43	38-41.72	112-36.91	5.2*	1.4	8	209	10	0.11
85	1116	223	25.94	38-39.78	112-35.32	7.7	1.3	8	174	6	0.31
85	1120	823	50.76	38-59.91	111-20.51	6.0*	1.7	17	99	33	0.46
85	1121	1552	0.71	38-39.75	112-32.74	0.9	2.2	12	74	4	0.31
85	1124	1039	2.90	39-34.22	110-28.60	10.0*	2.5	8	240	48	0.28
85	1125	1104	20.92	42- 3.10	111-26.12	19.9	1.5	10	162	19	0.19
85	1125	1131	10.05	41-58.84	111-31.83	0.1*	1.8	15	115	24	0.34
85	1126	743	36.41	39-55.34	111-37.65	11.0	1.0	10	226	14	0.40
85	1127	146	54.94	41-34.65	111-43.41	8.1*	0.6	10	107	18	0.15
85	1127	208	32.79	41-23.00	111-25.39	4.6*	1.7	17	159	11	0.15
85	1127	746	11.79	39-42.46	110-32.79	0.2*	2.2	13	239	38	0.37
85	1127	1421	56.74	38-41.63	112-24.70	1.6*	1.1	11	91	13	0.39
85	1127	1735	9.62	41-41.00	111-58.64	7.2	0.8	6	283	8	0.11
85	1128	1403	18.61	39-10.88	112- 3.15	1.3*	2.4	21	65	24	0.38
85	1130	1015	6.43	41-57.46	112-31.66	1.4*	1.2	19	136	17	0.33
85	1203	1755	36.17	39-42.09	111-10.28	1.3*	2.7	22	73	16	0.34
85	1204	14	41.67	39-43.94	111-59.46	0.3*	1.6	14	96	24	0.47
85	1205	301	15.37	41-20.75	111-41.78	11.2	1.6	24	110	20	0.29
85	1205	1612	46.38	42-23.37	111-34.35	6.8*	2.9	28	74	34	0.38
85	1205	2232	4.14	42-19.00	111-34.29	12.9*	1.1	8	191	28	0.31
85	1206	1557	27.00	38-50.32	109- 2.78	7.0*	2.9	18	261	140	0.47
85	1211	1323	47.57	38- 9.00	112-21.72	0.9*	1.9	14	113	43	0.27
85	1212	1515	35.06	39-42.89	110-36.64	0.4*	1.5	11	235	32	0.32
85	1214	918	42.08	40-29.40	111-20.59	11.6	0.8	9	113	11	0.14

UTAH EARTHQUAKES: JAN 1984 - DEC 1985

yr	date	orig	time	lat-n	long-w	depth	mag	no	gap	dmn	rms
85	1217	1522	4.50	39-41.22	110-41.28	0.1*	2.3	14	254	26	0.32
85	1218	123	38.61	39-38.78	111-57.16	3.2*	0.9	9	131	20	0.24
85	1218	2214	31.59	40- 0.71	111-48.34	1.6	1.3	10	139	7	0.34
85	1219	1416	32.99	39-41.23	110-43.22	0.1*	1.9	14	212	24	0.49
85	1219	2207	54.13	39-40.90	110-48.89	8.2*	2.1	13	219	17	0.27
85	1221	2	2.07	39-41.94	113-12.58	0.7*	1.8	13	111	15	0.47
85	1222	1633	1.26	39-16.38	111-41.66	0.3*	1.5	14	86	10	0.39
85	1224	311	25.18	38-44.11	111-32.21	1.7*	2.3	16	153	50	0.48
85	1224	1506	41.40	39-32.16	111-49.94	1.8	0.8	8	119	4	0.30
85	1225	1153	23.77	41-53.81	112-40.62	7.5*	0.6	12	173	15	0.14
85	1227	135	36.05	37-51.05	113-10.67	1.5*	2.4	15	101	21	0.30
85	1227	1559	48.72	41-53.55	112-41.28	7.4	1.4	11	176	14	0.15
85	1228	918	19.79	39-42.70	110-35.79	1.0*	2.5	16	235	34	0.32
85	1231	730	57.36	39-17.80	111-10.16	11.5*	1.6	8	189	31	0.24
85	1231	1719	26.88	39-30.63	111- 3.67	1.1*	1.6	8	209	28	0.47

number of earthquakes = 855

* indicates poor depth control
W indicates Wood-Anderson data used for magnitude calculation

LISTING OF FELT EARTHQUAKES WITHIN THE UUSS NETWORK:
JANUARY 1984 TO DECEMBER 1985*

1984

March 21, 1984 11:19:30.58 Near Castle Dale, Utah

39N20.64, 111W06.53 M_L 2.9 (UU), M_L 3.5 (USGS)
Felt near Castle Dale, Utah

June 10, 1984 14:10:30.92 Near Magna, Utah

40N45.21, 112W04.08 M_C 2.7 (UU)
Felt in Magna, Utah

August 16, 1984 14:19:21.71 12 miles South of Levan Utah.

39N23.50, 111W56.16 M_L 3.7 (UU)
Felt (IV) at Ephraim, Fayette, Levan, and Gunnison, Utah
Felt (III) at Chester, Leamington, Manti, Moroni, Oak City, Scipio, and Wales, Utah.

August 22, 1984 09:46:30.08 Near Challis, Idaho

44N08.98, 113W35.71 M_L 5.8 (UU)
Felt (V) at Challis, Clayton, Ellis, Hailey, Howe, May, North Fork, Salmon, and Stanley. Felt throughout much of central an southern Idaho. Also felt in southwestern Montana.

August 22, 1984 13:34:21.6 Challis, Idaho area

44N28.16, 114W09.07 M_L 4.0 (UU), M_L 4.1 (USGS)
Felt at Challis, Idaho.

August 23, 1984 13:21:53.0 Near Challis, Idaho

44N27.50, 114W08.20 M_L 3.8 (USGS)
Felt at Challis, Idaho.

*(Times are UTC. Magnitudes are indicated variously as: M_L, local Richter magnitude; M_C, coda magnitude; or m_b, body-wave magnitude. The magnitude estimates are ascribed either to the University of Utah, UU, or to the U.S. Geological Survey, USGS, Golden, Colorado.)

<u>1984</u>

September 5, 1984   12:25:29.23   Near Magna, Utah

40N45.28, 112W10.64 M_C 2.3 (UU)
Felt in Magna, Utah.

September 7, 1984   03:12:26.79   Near Marysvale, Utah

38N32.14, 112W17.23 M_L 2.5 (UU)
Felt 4 miles NW of Marysvale, Utah.

October 15, 1984   23:23:56.53   Near Tremonton, Utah

41N[illegible].27, 112W24.10 M_L 3.4 (UU)
15 miles NW of Tremonton, Utah. Felt (IV) at Howell and (III) at Portage, Utah.

November 25, 1984   14:06:50.74   Near St. George, Utah

37N07.90, 113N34.33 M_L 2.5 (UU)
Felt in St. George, Utah.

November 25, 1984   21:24:21.90   Near St. George, Utah

37N09.60, 113W34.15 M_L 2.2 (UU)
Felt at St. George, Utah.

1985

January 26, 1985   15:08:06.71   Near Snowville, Utah

41N53.43, 112W31.80 M_L 3.6 (UU)
Felt (III) at Snowville, Utah.

January 27, 1985   10:46:49.60   Near Portage, Utah

41N53.40, 112W32.21 M_L 3.3 (UU)
Felt (III) at Portage, Utah.

March 20, 1985   01:37:09.81   Trona Mine, 20 mi. W. of Green River, Wyo.

41N36.79, 109W37.32 M_L 2.9 (UU)
Miners underground felt violent shock.

April 21, 1985   23:00:20.75   One-half mile SW of the U. of U.

40N45.29, 111W50.85 M_L 1.8 (UU)
Felt by many residents in SW area from 7th So. to 13th So. and from 10th East through 17th East.

July 2, 1985   03:03:56.6   Eastern Idaho, near Wyoming border

43N16.63, 111W11.98 M_L 3.7 (UU), M_L 4.0 (USGS)
Felt (IV) at Palisades, and (III) at Irwin. Also felt (III) at Alpine, Wyoming.

August 7, 1985   07:10:33.25   Eastern Idaho

42N06.48, 112W19.32 M_L 2.8 (UU), M_L 2.5 (USGS)
Felt at Samaria and Malad City, Idaho

August 16, 1985   06:05:23.09   Near Sheridan, Wyoming.

42N44.26, 108W00.92 M_L 4.3 (USGS)
Felt in Sheridan. Felt (IV) at Lander, Jeffery City, Midwest, South Pass City, and Point of Rock. Felt (III) at Casper, Rock Springs, Ethete, Hanna and Superior. Felt (II) at Basin, Edgerton and Hyattville.

1985

August 21, 1985 18:05:30.03 Approximately 8 miles East of Alpine Wyo.

43N10.40, 110W56.00 M_L 4.3 (UU), m_b 4.9 (USGS), M_L 4.8 (USGS)
Felt strongly in the Jackson area. Felt (V) at Alpine and (IV) at Lander and Wilson. Also felt (IV) at Palisades and Victor Idaho. Felt (III) at Swan Valley Idaho.

August 22, 1985 06:17:39.5 Near Alpine Wyoming.

43N11.52, 110W57.06 M_L 4.1 (UU), m_b 4.3 (USGS)
Felt (IV) at Alpine, Wyoming.

August 30, 1985 21:08:07.34 Alpine Junction, Wyoming

43N10.98, 110W55.23 M_L 4.3 (UU), M_L 4.3 (USGS)
Felt (V) at Alpine. Also felt in the Jackson, Wyoming area and parts of Eastern Idaho.

September 7, 1985 03:47:28.3 Wyoming

43N10.37, 110W46.22 M_L 4.6 (UU), M_L 4.6 (USGS)
Felt (V) at Alpine, and (IV) at Wilson. Felt (IV) at Palisades, and Victor, Idaho. Also felt at Bondurant, Moose and Jackson, Wyoming. The earthquake triggered a rockslide in the Snake River Canyon South of Jackson temporarily closing U.S. Highway 89

October 21, 1985 11:40:09.75 20 miles NE of Ogden, Utah

41N26.02, 111W40.11 M_L 2.9 (UU)
Felt in Ogden and Clearfield, Utah.

October 29, 1985 21:30:37.89 Challis Idaho area

44N17.41, 113W53.73 M_L 4.1 (USGS)
Felt in Challis, Idaho.

APPENDIX A

ABSTRACTS OF UNIVERSITY OF UTAH THESES INVOLVING SEISMOLOGICAL RESEARCH AND/OR EARTHQUAKE-RELATED STUDIES: JANUARY 1, 1984 TO DECEMBER 31, 1985

Source Parameters and Faulting Processes of the August 1959 Hebgen Lake, Montana Earthquake Sequence

(Ph.D Thesis, June 1984)

Author: Diane Irene Doser

Support: University of Utah Graduate Research Fellowship, U.S. Geological Survey

Supervisor: Robert B. Smith

ABSTRACT

The August 1959 (M=7.1) Hebgen Lake, Montana earthquake was the largest earthquake to have occurred in the intermountain region in historic time. Studies of waveforms at regional and teleseismic distances indicate that the mainshock of the sequence was composed of two subevents, the first of M=6 (M_o=3 x 10^{18}N-m) followed 5 seconds later by a M=7 (M_o=1 x 10^{20}N-m) subevent.

Two en-echelon normal faults that ruptured during the mainshock were observed to dip 70 to 80°S at the surface. Fault plane solutions from short period first motion data and seismic moment tensors determined from the inversion of long period body wave data indicate that the subevents occurred along normal faults that dip 40 to 60°S at depth. This suggests that the subevents occurred along faults that change orientation with depth. A close association between the surface scarps and Laramide thrust faults also suggests that the subevents may have reactivated the older thrust faults.

Focal mechanisms from short period first motion data for aftershocks in northwestern Yellowstone showed strike-slip, normal, and reverse mechanisms with a variety of nodal plane orientations that reflect the complex geology of the region. Aftershocks with good body wave coverage of the focal sphere had body wave mechanisms that agreed well with surface wave mechanisms. Limited focal depth suggests a shallowing in focal depth eastward from Hebgen Lake to Yellowstone.

A return period of 4300±1000 years for a $7.0 \leq M \leq 7.5$ earthquake is estimated for the Red Canyon-Hebgen Lake fault system from geologic moment rates. Similar values are obtained for the Centennial and Madison faults.

Determination of Crustal and Upper Mantle Structure From Analysis of Broadband Teleseismic P-Waveforms

(Ph.D. Thesis, August 1984)

Author: Thomas Joseph Owens

Support: Lawrence Livermore National Laboratory, University of Utah Graduate Research Fellowship, University of Utah Geophysics Special Funds

Supervisor: George Zandt

ABSTRACT

Time-domain inversion of broadband radial receiver functions is evaluated as a means of estimating the shear velocity structure in the vicinity of an isolated seismic station. The receiver functions are developed from teleseismic P-waveforms using a source equalization deconvolution that effectively replaces the complex earthquake source with a simple Gaussian pulse. Stacking receiver functions from earthquakes clustered in distance and back azimuth from the station provides an estimate of the variability of the mean receiver function. The time-domain inversion routine utilizes the mean radial receiver function to determine the structure assuming a crustal model parameterized by many thin, flat-lying, homogeneous layers. Lateral changes in structure are identified by examining azimuthal variation in the vertical structure.

This technique is applied to two broadband seismic stations. At station RSCP, located in the Cumberland Plateau of eastern Tennessee, the results reveal rapid lateral changes in the midcrustal structure beneath the station that are interpreted in relation to the origin of the East-Continent Gravity High, located northeast of RSCP. The velocity structure can be shown to support the idea that this feature is part of a Keweenawan rift system. At station KNB, located on the western margin of the Colorado Plateau in southwestern Utah, the derived velocity structure reflects the complex recent tectonism of the region. Evidence for a broad crustal low shear velocity zone, a complex crust-mantle boundary, and an upper mantle partial melt zone all support current models involving a recent upwelling of hot asthenosphere to shallow depths in the Basin and Range-Colorado Plateau transition zone.

Normal Faulting in an Extensional Domain: Constraints From Seismic Reflection Interpretation and Modeling

(M.S. Thesis, August 1984)

Author: Kelsey Anne Smith

Support: University of Utah Graduate Research Fellowship, National Aeronautics and Space Administration, Society of Exploration Geophysicists Scholarships, University of Utah Geophysics Special Funds

Supervisor: Robert B. Smith

ABSTRACT

Detailed interpretation and analytic modeling of seismic reflection data provide important constraints on the geometry and structural style of low-angle fault zones in the northern Basin-Range of Nevada and Utah. The data (provided by the oil industry) represent upper crustal sections in areas of surface normal faulting: southern Cache Valley, Utah; Great Salt Lake, Utah; Milford Valley, Utah; and Lamoille Valley, Nevada (near Elko, Nevada). The reflection data consist of 12 to 24 fold CDP stacked migrated sections and display imbricated, listric, and continuous planar reflections that are interpreted as faults. The geometry of the reflection planes/zones were modeled with a two-dimensional, ray-tracing synthetic seismogram method. Detailed analysis of a seismic profile near Elko, Nevada included compilation of raw seismic traces into common offset sections; interpretation of slant stacks applied to the unprocessed data; amplitude spectra calculations of fault zone reflections; and quantitative synthetic seismogram modeling of sedimentary and fault reflections in the section. The primary results include: 1) listric faults can produce planar seismic reflections for curved to planar fault length ratios of 1.1 : 1 to 1.5 : 1 for faults with surface dips of 30° and 60°, respectively; 2) curved fault reflections can suggest either listric faults or a sequence of sibsidiary steeply dipping normal faults with less than 400 m vertical offset and 400 m to 500 m horizontal separation; 3) fault zones of 100 m or more in width containing 500 m to 800 m long inhomogeneous zones should be discernible on seismic reflection sections for typical Basin-Range geologic models given an accoustic impedance contrast of 2×10^{5} kg m^{-2} s^{-1}; 4) intensive seismic modeling indicates that the fault zone identified on the Lamoille Valley, Nevada profile dips 15° to 20° westward; varies in thickness from 80 m to 120 m; and has an accoustic impedance contrast with surrounding bedrock on the order of 10^{5} kg m^{-2} s^{-1}. Geometries of faulting indicate extension is 20 to 40 percent for a 10^{-16} s^{-1} strain rate in the Lamoille Valley area. These data suggest a brittle/ductile transition at 7 km depth at the inception of faulting. Flattening of faults into horizontal detachments at 4 km to 5 km depth and asymmetry of adjoining sediment suggest listric and tilted block fault models of Basin-Range formation are dominant in the area. Methods presented for modeling of the Nevada seismic profile provide techniques that can be used in interpreting seismic reflection in other regions.

Geologic and Mechanical Properties of the Sevier Desert Detachment as Inferred by Seismic and Rheologic Modeling

(M.S.Thesis, March 1985)

Author: Donald Glen Gants

Support: Society of Exploration Geophysicists Scholarship, University of Utah Geophysics Special Funds

Supervisor: Robert B. Smith

ABSTRACT

The velocity structure of the upper crust in the Sevier Desert area of west-central Utah has been investigated using the joint interpretation and modeling of seismic refraction and reflection data. The study revealed the geometry and material properties of a regional low angle fault, the Sevier Desert detachment. The detachment can be traced in reflection data for at least 120 km dipping gently westward perpendicular to the strike of major Basin and Range extensional features. It can be shown from the refraction data that the Sevier Desert detachment occurs above a crustal low velocity zone beginning at approximately 5 km depth. Fault zone mylonitization, high temperatures, and elevated pore fluid pressure are believed to be responsible for the observed velocity reversal. Rheologic considerations for this region of high heat flow, approximately 90 $mW \cdot m^{-2}$, for inferred upper to mid crustal materials suggest ductile deformation may be important below 5 km. A correlation of ductility and velocity reversals cannot be directly inferred, but the similarity of the physical properties governing both suggest a possible relationship. Thus the Sevier Desert detachment appears to be correlatable with the top of a ductile zone as well as a low velocity layer at 5 km depth. The detachment is believed to be a zone of lithospheric decoupling along which much of the upper to mid crustal extension has been accomodated. A plausible explanation for the detachment and movement along such a low angle normal fault plane is the existence of an asthenospheric "hot spot" responsible for thermal weakening and ductile stretching of the lower lithosphere.

Calculation of Synthetic Seismograms in One and Two Dimensional Media

(M.S. Thesis, June 1985)

Author: John Anthony DeSisto

Support: Gulf Research and Development Company

Supervisor: Robert B. Smith

ABSTRACT

The amplitude information contained in seismic data can be utilized by modeling the data with synthetic seismogram techniques. Asymptotic and

transform solution methods of calculating synthetic seismograms were investigated and found to be useful modeling techniques. The asymptotic method, called asymptotic ray theory, is a fast algorithm capable of modeling body waves in one or two-dimensional media. The algorithm uses ray tracing to calculate the geometry and travel-times of the waves traveling from source to receiver. The transform or reflectivity methods are only one-dimensional, however, both body and inhomogeneous waves can be calculated, and the effects of attenuation and dispersion can be included in the seismogram. The numerical problems inherent in reflectivity methods were treated by two different matrix techniques.

Comparisons between the two synthetic seismogram methods were made by calculating synthetic seismograms for a suite of simple models. The comparisons were used to determine the suitability of each method for modeling a variety of one-dimensional velocity models. A reflectivity algorithm stable at vertical incidence and including the effects of attenuation and dispersion was written. The problem of the long computation time taken by the algorithm was solved by adapting the algorithm to run in an array processor.

Upper Crustal Interpretation of Yellowstone Determined from Ray-Trace Modeling of Seismic Refraction Data

(M.S. Thesis, August 1985)

Author: Mark Alan Brokaw

Support: U.S. Geological Survey, National Science Foundation, National Park Service

Supervisor: Robert B. Smith

ABSTRACT

In June and July, 1980, a seismic refraction/reflection survey was conducted in the Yellowstone-Eastern Snake River Plain province (YSRP-80). This survey was designed to refine and build upon the results of a prior survey conducted in 1978 (YSRP-78). The Yellowstone portion of YSRP-80 included intracaldera shotpoint locations and used back-country recording stations to provide better control on the caldera structure interpretation. Two-dimensional ray-trace modeling of the travel time data from the Yellowstone portion of YSRP-80 determined an upper crustal velocity structure for Yellowstone consisting of: a generalized two-layer near-surface (P-wave velocities = 3.0-3.75 km/s and 3.7-4.75 km/s, respectively); P-wave velocities of 5.9-6.0 km/s for the Precambrian granitic basement of northeast Yellowstone; Pg velocities of 5.4 km/s beneath the Yellowstone caldera and 5.6-5.7 km/s beneath the Island Park caldera, with a horizontal velocity gradient between Island Park and the Yellowstone caldera; basement depths of 1.0-1.2 km (1200-1400 m above Sea Level) in the Yellowstone caldera and 1.6-1.7 km (200-300 m above Sea Level) in Island Park; a 4.8 km/s low-velocity zone beneath Hot Springs Basin and apparently coincident with the northeast caldera -20 mgal gravity anomaly; and termination of the 6.5 km/s intermediate crustal layer of the

Eastern Snake River Plain southwest of the Yellowstone caldera

Relative Earthquake Locations by Cross-Correlation of Waveforms: Application to Preshock-Mainshock-Aftershock Sequences in Utah

(M.S. Thesis, August 1985)

Author: Bergthora Solveig Thorbjarnardottir

Support: U.S. Geological Survey

Supervisor: James C. Pechmann

ABSTRACT

The major objectives of this thesis were to: (1) test the validity of a method for determining relative earthquake locations by cross-correlation of waveforms using data from quarry blasts with known locations, (2) apply the waveform cross-correlation technique to the study of two preshock-mainshock ($M_L \geq 4.0$)-aftershock sequences in Utah, and (3) determine the source radius and stress drop of the $M_L \geq 4.0$ mainshock in both study areas.

Results from the blast study suggest that the waveform cross-correlation technique is a valid way of constraining relative earthquake locations. The method was applied to earthquakes within 20 km of 1) an M_L 4.3 mainshock that occurred on October 8, 1983 near Magna, Utah, and 2) and M_L 4.0 mainshock that occurred on May 24, 1982 near Richfield, Utah. No unusual seismicity was observed prior to the Magna event during the time period studies, i.e. 1981-1983. However, a cluster of 4 preshocks within 80 m of each other, possibly representing the failure of a critical asperity, was observed 5 km NW of the Richfield event. No similar clusters were found among other preshocks within the Richfield study area that were not apparently associated with the mainshock.

The aftershocks studied in both regions during the first 2-3 weeks occupy areas smaller than the rupture areas estimated for the mainshocks. Both aftershock sequences showed migration of the initial events. Possible explanations for this migration include propagating stress changes caused by either the occurrence of the aftershocks themselves or else by some other process.

The stress drop values obtained for the two mainshocks fall within the range of normal values for crustal earthquakes: 8-16 bars for the Magna event and 15-41 bars for the Richfield event.

APPENDIX B

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NOTE

For further information or assistance regarding earthquake data in the Utah region, contact:

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(Appointment required)

The University of Utah Seismograph Stations routinely complies with earthquake data requests from local, national, and international users. Significant costs for reproductions, computer charges, postage, or materials must be borne by the requesting party.