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EASTERN WASHINGTON EARTHQUAKE CATALOG

1969 - 1974

Appendix To Annual Technical Report 1979

on

Earthquake Monitoring of the Hanford Region, Eastern Washington

Geophysics Program

University of Washington

Seattle, Washington

August 1, 1979

This catalog is for the period June 1969 - December 1974 in the Hanford area of eastern Washington. The seismic array was installed and operated by the U.S. Geological Survey during this period. The records were read by USGS personnel, predominantly Andrew Pitt, and explosions or probable explosions were identified. Preliminary locations for the seismic events have been computed by the USGS and various listings of these events have been available on an informal basis for use by interested workers. These events have now been relocated by the University of Washington using the latest velocity models and coda-length magnitude relation. This catalog represents combined efforts of the U.S. Geological Survey and the University of Washington to produce the most uniform, accurate listing of seismic events in eastern Washington for this period of time.

For additional copies of this catalog or maps or this catalog in computer compatible form, contact the Geophysics Program AK-50, University of Washington, Seattle Washington 98195.

Data Source. The Seismic array was established in the spring of 1969 in the immediate Hanford area by the U.S.Geological Survey to monitor earthquake activity in the local area for the U. S. Atomic Energy Commision. This array was changed and expanded several times during the next four years. It started as an eight station array centered on the Hanford project with station spacing of about 40 km. In the summer of 1970 the array was expanded to 16 stations with a station spacing of roughly 25 km and increased areal coverage. In the fall of 1971 eight additional stations were installed and several of the older stations were moved. Other minor changes occurred during 1972 and 1973 though the array was reasonably stable during this time. The average station spacing for the last three years of the USGS operated array was about 20 km. in the north Hanford-Saddle Mountains area and 30 km to the north and west. Table A-I lists the stations which made up the U.S. Geological Survey operated network. The stations which were retained by the University of Washington when they took over the network operation in the summer of 1975 are marked with a star and their U of W station name is in parentheses. Figure A-1 shows the location of the stations at the end of 1974. This is roughly the network configuration for the previous three years. Some of these stations were moved and some new stations were added by the U of W in the summer of 1975. This expansion increased the coverage, mostly to the north in the southern Lake Chelan area and to the south

into part of northeastern Oregon. The network density was reduced in the immediate Hanford area at this time.

Record Reading. The data from the eastern Washington network was sent by telephone to the U.S. Geological Survey offices in Menlo Park where they were recorded on standard Geotech develocorders. These records were scanned and picked by USGS personnel. Andrew Pitt was primarily responsible for these data and did the majority of the scanning and picking. Events were picked directly from the film viewers and coded onto computer cards. Besides arrival times, various other data were coded such as amplitude, first motion, coda length, and quality of the signal. Preliminary locations of the read events were produced using the then current USGS location routines such as HYPOLAYR and HYPO71. These locations were sent to the AEC and later ERDA on a monthly basis by the USGS All events were relocated in 1975 by the USGS using a common computer program and velocity model. This listing, which was never published, has been available on a limited basis to interested researchers.

The present catalog is a revised and updated version of the previous USGS epicenter listing and should be considered to supersede it. All events have been relocated using the current version of the University of Washington location routine. The velocity models used are the same as those in use for the last several years and are given in table A-II. Since the crustal structure varies considerably between the central Pasco Basin and the Lake Chelan area to the north it is necessary to use separate velocity models to locate events in

these areas. An arbitrary dividing line is defined at latitude 47 degrees north to separate these models. The crustal structure changes rapidly in this area. Station time corrections, as determined by previous work, were used in relocating these events. Like the velocity models, two sets of station corrections are necessary. These corrections are listed for each station in table A-I. For the stations which are still in use by the University of Washington, these corrections are just those determined in a previous investigation. For stations which are no longer in use, the corrections were determined by interpolating between the known stations since the major cause of the corrections is the slowly varying crustal structure.

Data Reduction. In 1975 when the University of Washington took over the operation of the eastern Washington array from the USGS, the data reduction techniques changed. Different people were scanning and picking the records and a different computer program was used to calculate locations. Because of these changes it is likely that the results of analysis done by the U.S. Geological Survey on the data prior to 1975 would not be compatible with those produced by the University of Washington for the subsequent period. Because of the obvious differences in the data handling between the USGS and the U of W, tests have been run to determine the degree of uniformity between the phase data picked by the two groups. This was done by selecting a suite of earthquakes previously picked by Andrew Pitt for processing in the routine U of W manner. Photographic copies of the film records for eight earthquakes

were made and processed using the U of W picking techniques. The resulting phase data were compared with those of the USGS for the same events. The resulting differences in "picks" averaged .05 sec. These events were located using the current U of W location techniques and are compared with the results of the preliminary USGS analysis in table A-III. The average difference in epicentral coordinates is 0.8 km, and the average difference in depth is 1.0 km. The differences in the parameters are almost always less than the error estimates. The selected events are all from the central Pasco Basin, in the middle of the seismic array, and in the area where the velocity structure used by the USGS is very similar to the one presently used by the U of W. For events to the north near Lake Chelan there is a much larger difference in the two sets of solutions. The previous USGS locations were produced using the same velocity model as the central basin while the solutions in the present catalog were obtained using a model determined particularly for that region. Figure A-2 compares the two sets of solutions for events in the south Chelan area. Note that on the average the U of W model solutions are farther to the northwest than those from the USGS model. Recent events in this area, located with new nearby staions lie in the same general area as the U of W model events in this figure.

Magnitude Determinations. Magnitudes reported in this catalog were determined by the coda length formula:

$$M_{coda} = -2.46 + 2.80 \log(T_{coda})$$

where T_{coda} is the duration of the event measured from first

onset until the trace has returned to twice background level. When coda lengths determined by the USGS are compared with those determined by the U of W, a systematic difference of four seconds was observed. The U of W coda lengths were consistently slightly longer than those determined by the USGS for the same events. When the magnitudes reported in this catalog were calculated four seconds were added to the coda lengths before the above formula was applied. The constants in this formula were determined by an empirical comparison of selected events for which standard Wood-Anderson magnitudes have been determined. (See section IV of the U of W Annual Technical Report, 1979) There is a noticeable difference between the magnitudes previously calculated by the USGS and those reported in this catalog. Those magnitudes for events prior to June of 1971 are the original magnitudes reported by the USGS since coda lengths were not read for these events. An amplitude based magnitude scale was used for the calculation of these events. Because of the difficulty of using ampitudes from high frequency instruments to calculate magnitudes, the data for this early period way be in question.

TABLE A-I U.S.G.S. STATIONS

STA		LAT	LON	DELAY south	DELAY north	OPEN	CLOSE	U of W
F	*	45 54.18	118 24.35	-0.15	.18	10/71	--	MFW
P	*	46 2.68	118 55.96	0.00	.54	12/70	--	WGW
BA	*	46 12.76	119 41.13	0.00	.60	10/71	--	PRO
B	*	46 14.08	119 19.05	0.00	.48	3/69	--	BDG
R	*	46 23.47	119 35.32	0.00	.62	8/70	--	RSW
I	*	46 25.93	119 17.29	0.00	.55	7/70	--	WIW
E	*	46 27.89	119 3.54	0.00	.30	3/69	--	ETP
D		46 28.22	119 14.55	0.00	.57	2/71	10/71	
Y		46 30.73	119 42.93	0.00	.58	10/71	7/75	
H		46 31.52	119 33.20	0.00	.45	7/70	10/71	
G	*	46 35.86	119 27.59	0.00	.57	3/69	--	GBL
DA	*	46 36.19	119 6.72	0.00	.46	10/71	7/75	
M	*	46 36.80	119 45.65	0.00	.53	3/69	--	MID
EA	*	46 38.33	119 37.21	0.00	.59	10/71	7/75	
C		46 39.18	118 55.02	0.00	.30	7/70	7/75	
CA	*	46 43.33	119 20.83	0.00	.30	10/71	7/75	
O	*	46 44.34	119 12.99	0.00	.39	3/69	--	OTH
AA	*	46 44.81	118 49.45	0.00	.18	10/71	10/72	
L	*	46 45.12	119 34.68	0.00	.55	11/70	--	WAH
N		46 47.13	119 55.33	0.00	.30	12/71	7/75	
AB	*	46 47.73	119 29.48	0.00	.48	10/72	7/75	
U	*	46 49.51	119 23.09	0.00	.47	7/70	--	CRF
S	*	46 51.78	119 37.07	0.00	.47	3/69	--	SYR
V	*	46 57.48	119 59.24	0.00	.28	7/70	--	VTG
W	*	46 58.19	119 8.60	-0.05	.35	7/70	--	WRD
A	*	47 18.40	118 44.70	-0.20	.11	8/69	--	ODS
T	*	47 21.13	119 35.77	-0.14	.20	11/71	--	EPH

TABLE A-II VELOCITY MODELS

USGS MODEL

Depth (km)	P Velocity (km/sec)
0.0	3.00
0.8	5.15
7.5	6.10
18.0	1.80
30.0	8.0

UNIVERSITY OF WASHINGTON - HANFORD AREA MODEL

Depth (km)	P Velocity (km/sec)
0.0	3.70
0.8	4.70
1.2	5.15
7.5	6.05
19.0	7.20
28.0	8.00

UNIVERSITY OF WASHINGTON - NORTH OF 47th PARALLEL

Depth (km)	P Velocity (km/sec)
0.0	5.10
0.5	6.05
19.0	7.20
24.5	8.00

TABLE A-III

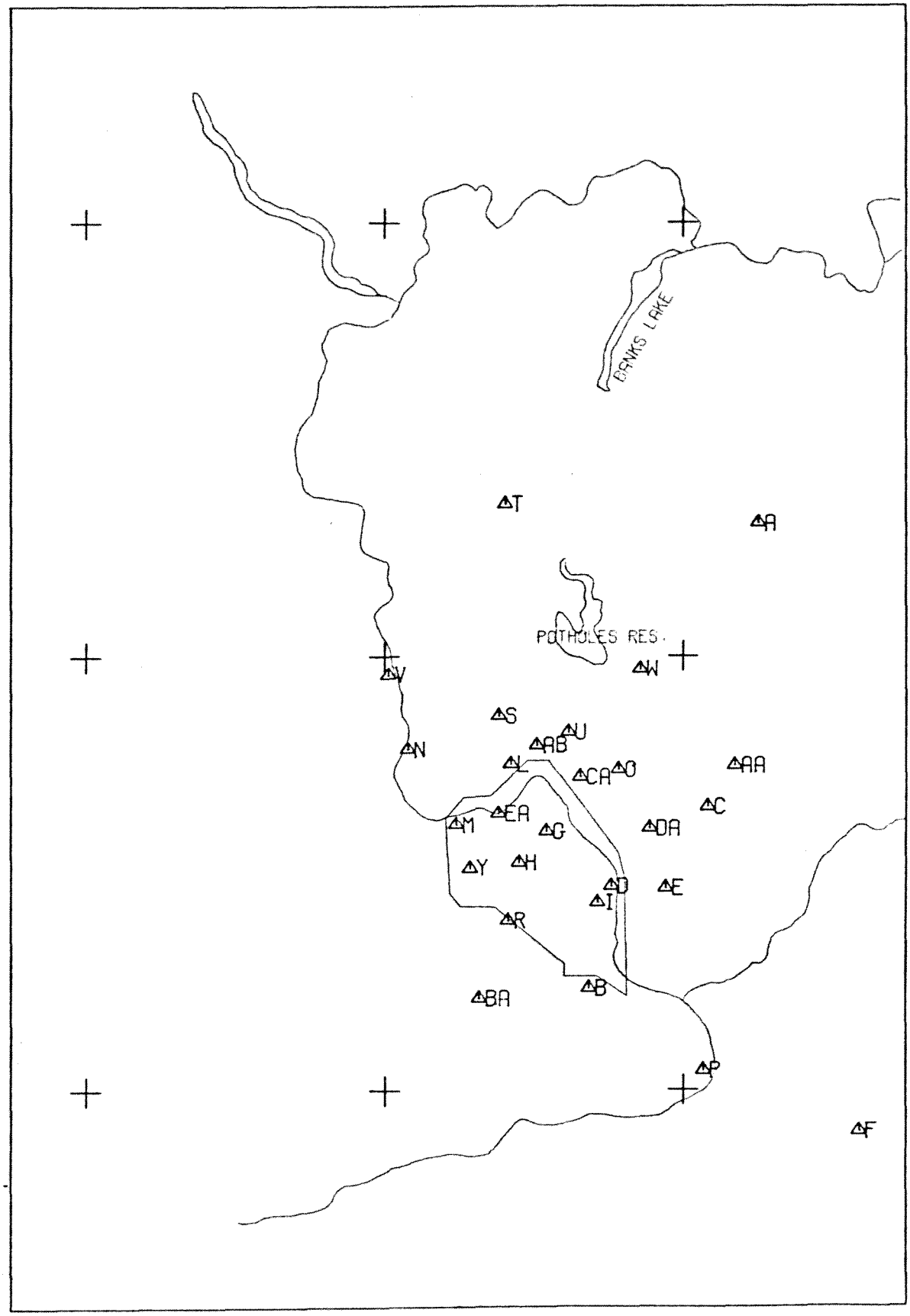
COMPARISON OF FOCAL PARAMETERS
AS DETERMINED BY USGS AND UNIVERSITY OF WASHINGTON

DATE	TIME	SEC	LAT	LONG	ERROR	Z	ERROR	M_A	M_C	#st	RMS	
04/22/74	0049	23.4	46 32.55	119 38.29	4.4	18.2	5.1	1.2	1.2	7	.38	*
		22.7	46 29.57	119 39.99	2.1	19.8	2.1		0.6	11	.07	**
05/22/74	0041	10.6	46 49.44	119 25.03	1.8	0.6	7.0	0.3	1.1	06	.11	*
		10.3	46 49.42	119 25.39	1.1	0.1	3.0		0.6	08	.11	**
09/04/74	0104	28.7	46 52.48	119 21.15	0.5	2.3	0.6		3.0	22	.16	*
		28.3	46 52.60	119 21.44	0.7	0.2	3.0		3.3	16	.20	**
10/28/74	0518	00.9	46 46.58	119 20.00	1.2	5.0	1.5	0.7	1.1	12	.28	*
		00.7	46 46.52	119 20.60	1.5	4.4	0.8		1.1	07	.15	**
12/15/74	1446	48.8	46 50.03	119 30.55	0.5	1.1	0.8	2.1	2.5	17	.13	*
		48.5	46 50.17	119 30.50	0.4	0.9	1.1		2.5	14	.16	**
12/15/74	1534	20.3	46 14.18	119 07.50	1.0	1.0	3.0		1.9	07	.16	*
		20.0	46 14.42	119 07.50	0.8	0.1	3.0		1.7	09	.20	**
12/17/74	2225	03.8	46 44.63	119 21.58	0.5	0.6	3.0		1.6	08	.09	*
		03.5	46 44.77	119 20.33	0.4	0.7	1.1		1.4	10	.31	**
12/21/74	0445	13.1	46 24.06	119 00.73	0.2	0.3	7.0		1.7	08	.06	*
		12.9	46 23.92	119 00.67	0.3	2.1	2.5		1.5	09	.14	**

*USGS
**University of Washington

Average difference between USGS and University of Washington: 0.8 km 1.0 km

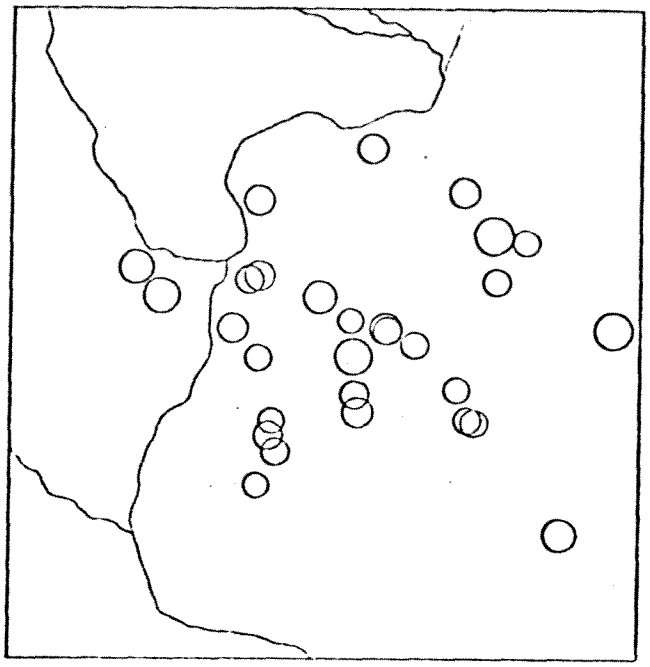
M_A Magnitude by amplitude method.
M_C Magnitude by coda length method.
#st Number of stations and location.



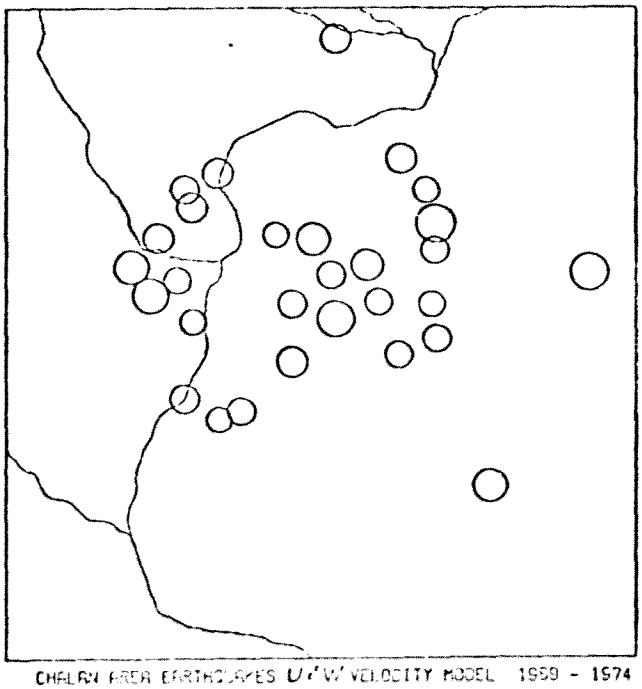
U.S.G.S. EASTERN WASHINGTON STATIONS 1974
CENTER OF MAP IS 47.00 N 119.75 W

MAGNITUDE KEY o 0.0 ○ 1.3 ◯ 2.7 ◯ 4.0

Fig. A-1



CHELAN AREA EARTHQUAKES USGS VELOCITY MODEL 1969 - 1974
CENTER OF MAP IS 47.60 N 120.10 W
MAGNITUDE KEY ○ -1.0 ○ 1.0 ○ 3.0 ○ 5.0



CHELAN AREA EARTHQUAKES U.o'W. VELOCITY MODEL 1969 - 1974
CENTER OF MAP IS 47.60 N 120.10 W
MAGNITUDE KEY ○ -1.0 ○ 1.0 ○ 3.0 ○ 5.0

Fig. A-2