UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Three Component Long-Period Data for the 1949 South Puget Sound, Washington Earthquake

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This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editoral standards and nomenclature.

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Introduction

The magnitude 7.1, 1949, South Puget Sound Earthquake was the largest event known to have occurred in the subducted Juan de Fuca Plate beneath Washington State. For this reason it is a critical event for defining the state of stress in the subducted slab. The results of body wave analyses for source parameters and a discussion of their tectonic implications are discussed in detail in Baker (1985).

Data

To analyze the event, requests for long-period seismograms were sent to observatories in the teleseismic range. Eight usable long period three component records were received. These were in the form of film and paper records. Each was digitized by hand. Table 1 gives the location of each station relative to the epicenter. The epicenter of the earthquake was at 122.62o west longitude and 47.17o north latitude (Nuttli, 1950). All the records except WES's were recorded on Galitzin Wilip seismographs (see fig. 1). The WES records were recorded on Benioff instruments. Table 2 lists the instrument constants. The impulse responses of each original instrument were matched as closely as possible. These were deconvolved from the original seismograms and a "standard" instrument response was convolved with each seismogram. This "standardization" enabled the originally unmatched horizontal records to be rotated into tangential and radial components. It also facilitated both forward and inverse body wave modelling. The standard instrument for most records had a fifteen second period seismometer pendulum and galvonometer, critical damping for both, and no coupling. The standard instrument for the S waves of SVE, DBN, and EDN had a 25 second period pendulum and galvonometer. The absolute amplitude is not well known, and so relative amplitude information between stations is not considered reliable. More confidence is placed in relative amplitudes between components within a station, since the cause of errors in absolute amplitude are likely to be systematic at a single station. Thus the rotated components are considered to be reliable. TAS is the most likely station to have correct absolute amplitudes.

The digital data made available on tape with this report includes the original digitized P waves from the vertical records and the S waves from the N-S and E-W records. North and east are defined to be positive. The standardized P waves and standardized, rotated S waves are also included, as are the 15 and 25 second impulse responses of the instruments. SV is defined to be positive away from the source as measured at the receiver. SH is positive to the right as one looks down the ray, away from the source. There are nine files on the tape altogether. The first contains all of the digitized P waves from the vertical components. The second and third contain the S waves from the north-south and the east-west components respectively. The next file contains the standardized P waves. The next two files contain the standardized SH and SV waves, respectively. The next two files are the impulse reponses of the 15 and 25 second instruments. The final file is the program used to generate the instrument responses and perform the change of instrument responses for a given seismogram. All the data files are written in the same format. The first line is alphanumeric identification. The second line holds two variables, the number of points and the time step. This is written in (I10,F10.3) format. The rest of the lines are the data, written in (8E10.3) format. The tape is written in ASCII at 1600 BPI. The logical record length is 80, and the blocking factor is 10.

Copies of the data tape are available through

National Geophysical Data Center
NOAA/EDIS/NGDC Code 64
325 Broadway
Boulder, Colorado 80303

telephone (303) 497-6338

Bibliography

Baker, G.E., Source Parameters of the Magnitude 7.1, 1949, South Puget Sound, Washington Earthquake Determined from Long Period Body Waves, Masters Thesis, University of Washington, 1985.

Charlier, Ch. et J.M. Van Gils, Liste des Stations Seismologiques Mondiales, 1953.

Nuttli, O.W., The Western Washington Earthquake of April 13,1949., Bull. Seis. Soc. Am., 42, pp 21-28, 1950.

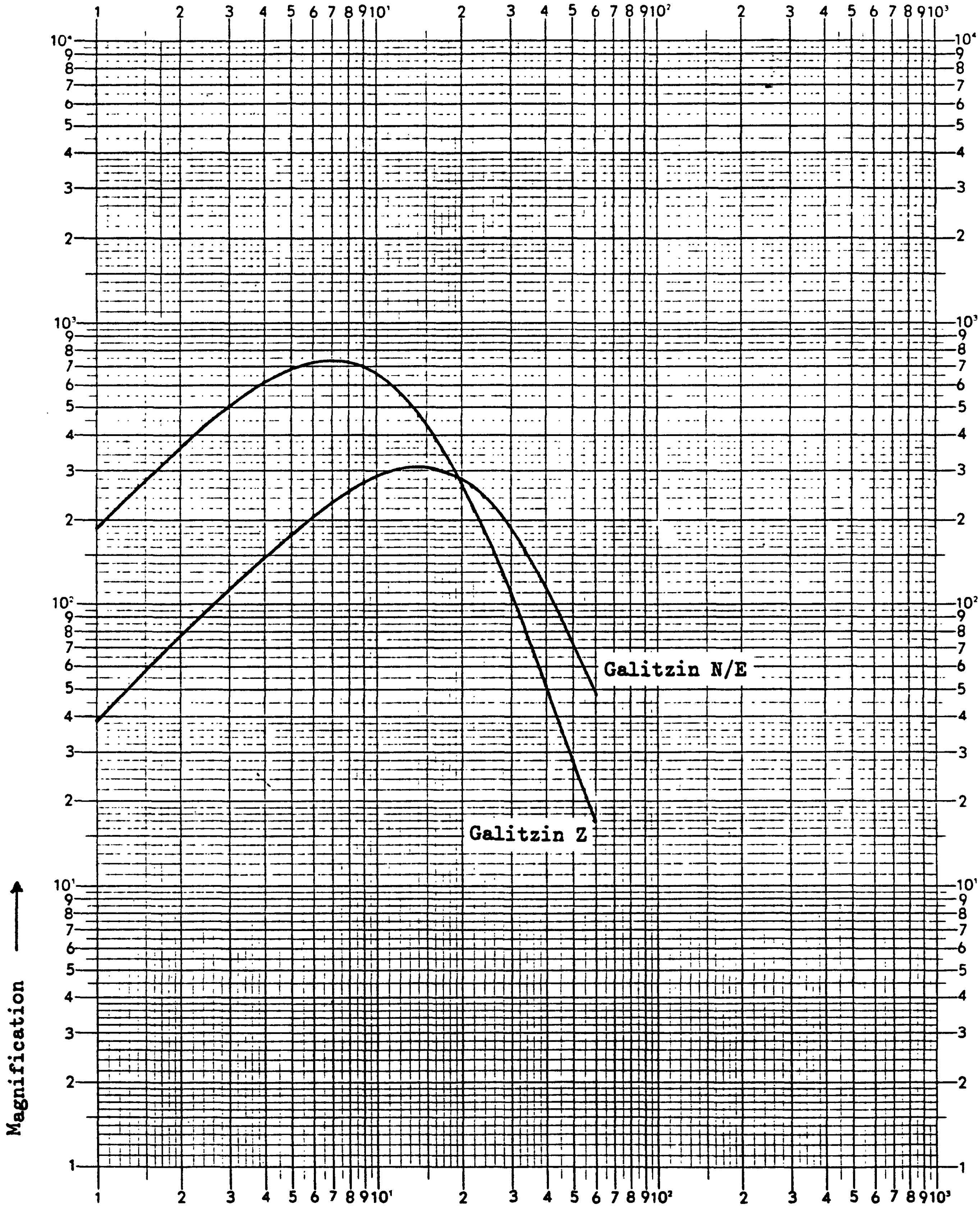
TABLE 1

Station Information

Geographic Location	abbreviation	Azimuth (deg.)	Δ (deg)
Tashkent, USSR	TAS	351	91.3
Sverdlosk, USSR	SVE	358	76.4
Moscow, USSR	MOS	12	77.1
Warsaw, Poland	WAR	22	76.2
DeBilt, Netherlands	DBN	31	71.5
Rome, Italy	ROM	32	82.8
Edinburgh, Scotland	EDN	34	70.2
Weston, Mass., USA	WES	78	36.2
St. Louis, Mo., USA	SLM	98	25.1
Pasadena, Cal., USA	PAS	168	13.4
Berkeley, Cal., USA	BRK	177	9.3

Figure 1. Response curves of typical Galitzin-Wilip electromagnetic seismographs. These curves were sent with the records from DBN and correspond to the vertical and horizontal components at that station.

Station: DBN (De Bilt, Netherlands) (52.1028 N - 5.1767 E)



Instrument: Galitzin Z Ts: 12s Tg: 12s
Galitzin N/E Ts: 25s Tg: 25s

Table 2. T_p and T_g are the periods of the seismometer pendulum and galvonometer respectively. D_p and D_g are the damping factors for the pendulum and galvonometer. C^2 is the coupling coefficient between the pendulum and galvonometer. V_m is the peak magnification of the seismogram.

Underlined parameters were sent with the seismograms by the observatories. The peak magnifications of the WAR, DBN, and EDN records (parameters distinguished by an aster isk) were not sent as those exact parameters. Those values for DBN were read off magnification curves sent with the records. EDN sent values for $(Ak)/(\pi l)$. Values of V_m were determined using the relation

$$V_m = (3\sqrt{3}kAT)/(16\pi l).$$

This is only strictly valid where $T_p = T_g$, but will provide a reasonably good estimate of the actual value when the periods are similar. WAR sent values for V_{ST}. This is assumed to be synchronous magnification, and so related to V_m by

$$V_S = kAT/4\pi l,$$

and the previous equation.

Most values not sent with the instruments were obtained from the Liste des Stations Seismologiques Mondiales (1953). There is less confidence placed in those parameters. Damping coefficients were not listed for DBN, ROM, EDN, or WES. Those factors are assumed to be 1.0. That is what they were conventially set at for most instruments. It takes a large deviation from unity before the instrument response is significantly altered, so this assumption should not cause large errors. Coupling information for WES wasn't available and so was assumed to be 0.05. This is a much less significant parameter than damping. The seismometer and galvonometer periods have the most significant effects on the instrument response.

TABLE 2

Long Period Instrument Parameters

Station (component)		Tp	Tg	Dp	Dg	C^2	$\bar{V}_m$
TAS	(P)	13.0	13.3	1.0	1.0	0.01	1537
	(N)	13.1	13.0	1.0	1.0	0.01	1820
	(E)	11.8	12.2	1.0	1.0	-0.04	1797
SVE	(P)	12.8	12.8	1.0	1.0	-0.07	----
	(N)	24.7	24.7	1.0	1.0	0.00	----
	(E)	25.1	25.1	1.0	1.0	-0.05	----
MOS	(P)	11.3	11.0	1.0	1.0	0.01	----
	(N)	12.1	12.1	1.0	1.0	0.00	----
	(E)	11.9	11.9	1.0	1.0	0.00	----
WAR	(P)	11.26	8.96	0.917	1.0	0.01	2728*
	(N)	11.69	11.52	0.976	1.0	0.01	1091*
	(E)	11.30	11.33	1.0	1.0	0.01	1000*
DBN	(P)	12.0	12.0	1.0	1.0	0.0	740*
	(N)	25.0	25.0	1.0	1.0	0.0	310*
	(E)	25.0	25.0	1.0	1.0	0.0	310*
ROM	(P)	9.6	10.1	1.0	1.0	-0.0038	----
	(N)	9.7	10.2	1.0	1.0	-0.0013	----
	(E)	9.4	9.8	1.0	1.0	0.0	----
EDN	(P)	12.5	14.2	1.0	1.0	-0.05	577*
	(N)	23.2	21.6	1.0	1.0	-0.06	379*
	(E)	18.3	17.8	1.0	1.0	0.04	415*
WES	(P)	1.0	60.0	1.0	1.0	0.05	----
	(N)	1.0	60.0	1.0	1.0	0.05	----
	(E)	1.0	60.0	1.0	1.0	0.05	----