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LONG RANGE SEISMIC MEASUREMENTS

SCOTCH

23 MAY 1967

Prepared for

AIR FORCE TECHNICAL APPLICATIONS CENTER
Washington, D. C.

25 OCTOBER 1967

By

TELEDYNE, INC.

Under

Project VELA UNIFORM

Sponsored By

ADVANCED RESEARCH PROJECTS AGENCY
Nuclear Test Detection Office
ARPA Order No. 624

LONG RANGE SEISMIC MEASUREMENTS

SCOTCH

23 May 1967

SEISMIC DATA LABORATORY REPORT NO. 200

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Project Title:	Seismic Data Laboratory
ARPA Order No.:	624
ARPA Program Code No.:	5810
Name of Contractor:	TELEDYNE, INC.
Contract No.:	F 33657-67-C-1313
Date of Contract:	2 March 1967
Amount of Contract:	$ 1,736,617
Contract Expiration Date:	1 March 1968
Project Manager:	William C. Dean (703) 836-7644

P. O. Box 334, Alexandria, Virginia

AVAILABILITY

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SCOTCH

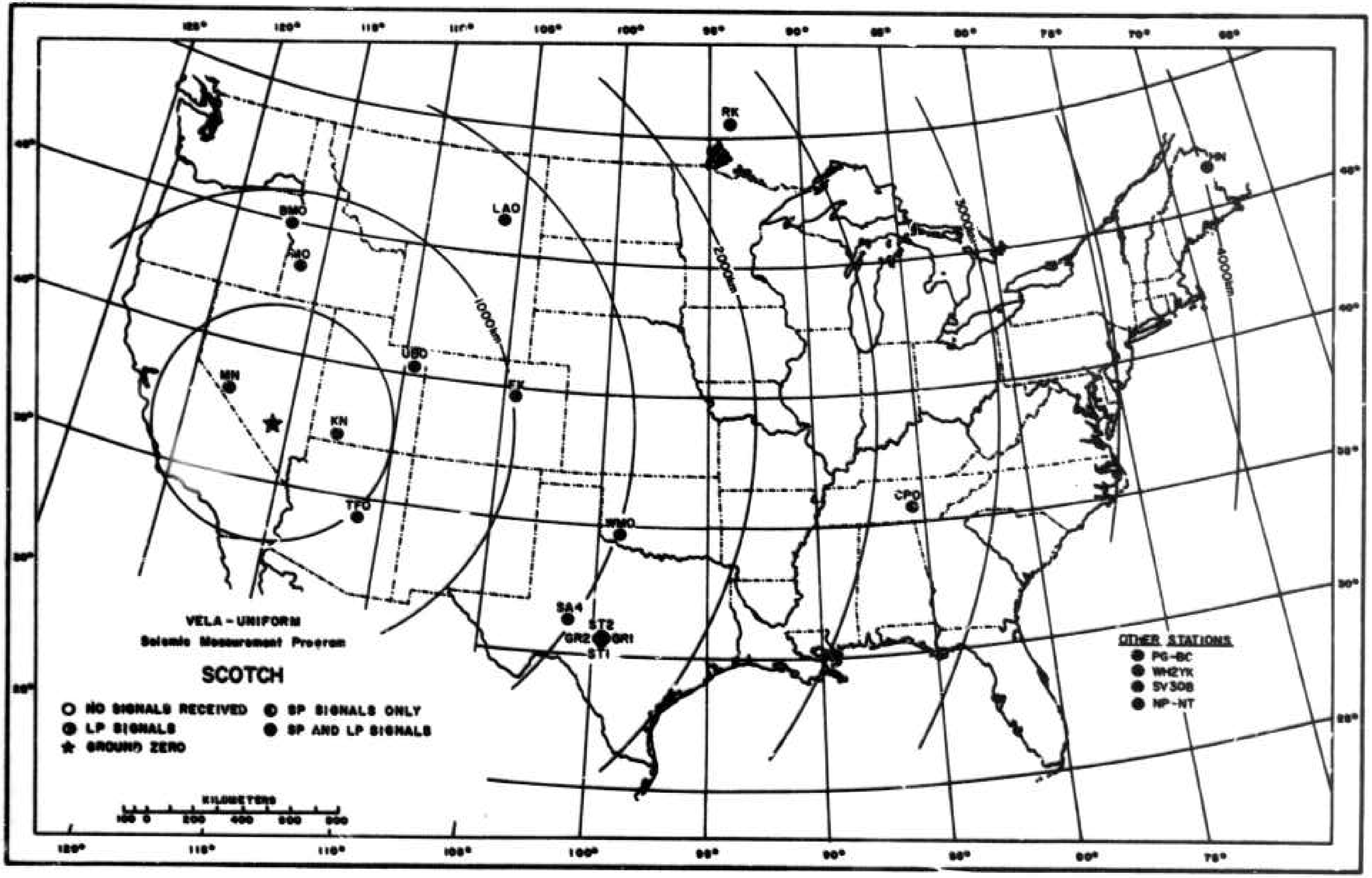
EVENT DESCRIPTION

DATE:	23 May 1967	
TIME OF ORIGIN:	14:00:00.0Z	
YIELD:		
MAGNITUDE:	5.51 ± 0.75	
LOCATION:		
SITE:	Nevada Test Site, Area U19as	
	GEOGRAPHIC COORDINATES:	
	Lat:	37° 16' 30.0" N
	Long:	116° 22' 12.0" W
ENVIRONMENT:		
	GEOLOGIC MEDIUM:	RHYOLITE
	SURFACE ELEVATION:	6761 ft.
	SHOT ELEVATION:	3492 ft.
	SHOT DEPTH:	3269 ft.
COMPUTED EPICENTER:	ALL STATIONS	
	GEOGRAPHIC COORDINATES:	
	Lat:	37° 14' 16.8" N
	Long:	116° 28' 58.8" W
	TIME OF ORIGIN:	14:00:01.4Z
	DEPTH CONSTRAINED TO:	0 km
	EPICENTER SHIFT:	10.8 km S 68° W

Code	Station	Final							
		SPZ	SPR	SPT	LPZ	LPR	LPT	Tape	Timing
MN-NV	Mina, Nevada	+	+	+	+	+	+	*	P
KN-UT	Kanab, Utah	+	+	+	+	+	+	*	P
TFSO	Tonto Forest Seismological Observatory, Arizona	+	+	+	+	+	+	*	P
MO-ID	Mountain Home, Idaho	+	I	+	+	+	+	*	P
UBSO	Uinta Basin Seismological Observatory, Oregon	+	+	+	+	+	+	*	P
BMSO	Blue Mountain Seismological Observatory, Oregon	+	+	+	+	+	+	*	P
FK-CO	Franktown, Colorado	+	+	+	+	+	+	*	P
LAO	Subarray, AO-10,Montana	+	N	N	**	**	**		P
SA4TX	San Angelo, Texas	+	N	N	+	+	<	*	P
WMSO	Wichita Mountains Seismological Observatory, Oklahoma	+	+	+	+	+	+	*	P
ST2TX	Streeter, Texas	+	N	N	+	+	-	*	P
GR2TX	Grit, Texas	+	N	N	+	+	+	*	P
GR1TX	Grit, Texas	+	N	N	+	+	+	*	P
ST1TX	Streeter, Texas	+	N	N	+	+	+	*	P
PG-BC	Prince George, British Columbia, Canada	+	+	+	+	+	+	*	P
RK-ON	Red Lake, Ontario, Canada	+	+	+	+	+	+	*	P
CPSO	Cumberland Plateau Seismological Observatory,Tenn.	+	+	+	I	I	I		P
WH2YK	Whitehorse, Yukon Territory, Canada	+	+	+	+	+	+	*	P
HN-ME	Houlton, Maine	+	+	+	+	+	+	*	P
SV3QB	Schefferville, Quebec, Canada	+	+	+	+	+	+	*	P
MB-NT	Mould Bay, Northwest Territories, Canada	+	+	+	+	+	+	*	P

I	Inoperative	-	No Signal
N	No Instrument	*	Magnetic Tape Available
P	Primary Timing	**	Magnification Questionable
+	Signal		

Table 1



Recording Stations and Signals Received

Figure 1

INTRODUCTION

A long seismic measurements (LRSM) program and several larger seismographic observatories were established under VELA-UNIFORM to record seismological data resulting from natural seismic activity and a planned series of U. S. underground nuclear tests. The LRSM teams are mobile and occupy locations selected to provide optimum data from events of special interest; the observatories are permanent installations as follows:

Wichita Mountains Seismological Observatory (WMSO)
Lawton, Oklahoma

Uinta Basin Seismological Observatory (UBSO)
Vernal, Utah

Tonto Forest Seismological Observatory (TFSO)
Payson, Arizona

Large Aperture Seismic Array (LASA)
Billings, Montana

The purpose of this report is to provide an analysis of data resulting from the SCOTCH event recorded by the LRSM teams and the VELA observatories and a preliminary summary of data reported by other permanent and temporary seismographic stations.

INSTRUMENTATION AND PROCEDURE

The instrumentation at each of the LRSM locations consists of three-component short-period and three-component long-period seismographs. In general, data are recorded on 35 millimeter film and on one-inch 14 channel magnetic tape, although recently more portable instrumentation has been incorporated which records only on magnetic tape. The stations are all equipped to record WWV continuously to provide accurate time control. Calibration is accomplished once each day and just prior to each shot at the operational settings. Pertinent information useful for analysis of LRSM data is available to qualified users of this data and is contained in Technical

Report 65-43, "Interpretation and Usage of Seismic Data, LRSM Program." General information on LRSM van and portable system equipment and operation is given in Technical Report 66-27, "The LRSM Mobile Seismological Laboratory," and 65-74, "A Portable Seismograph." Copies of these reports may be obtained from DDC. The AD control number of Technical Report 66-27 is 480343. All the observatories have both long-period and short-period, three-component instrumentation, in addition to their other specialized facilities.

Station information is presented in Appendix I(A). This includes the station name and code; the geographic coordinates; the distances and azimuths involved; the station elevations; and the type of instruments in use at each location. Representative instrumental response curves are shown in Appendix II(B), II(C), and II(D).

The procedures used in measuring amplitudes reported herein are illustrated in Appendix II(A) and the unified magnitude is calculated as shown in Appendix I(B). The distance factors (B) beyond 16^{o} are from Gutenberg and Richter*. For distance less than 16^{o} values were read from a curve in the Gutenberg and Richter paper back to 10^{o} and then extrapolated to 2^{o}, using an inverse cube relationship. An additional magnitude for less than 16^{o} was computed using a method described by Evernden**. (Figure 3)

A standard hypocenter location program for a digital computer is used to determine the location using data from all stations analyzed.

* Gutenberg, B. and Richter, C. F., Magnitude and Energy of Earthquakes Ann. Geofis., 9 (1956), pp. 1-15.

** Evernden, J. F. , Magnitude Determination at Regional and Near Regional Distances in the United States, AFTAC/VELA Seismological Center Technical Report VU-65-4A, (1965), pp. 6,13.

Best-fit values of latitude, longitude, and time of origin are determined statistically by a least squares technique. This utilizes a Jeffreys-Bullen travel-time curve as modified by Herrin in 1961 on the basis of Pacific surface-focus recordings. Precision of the computation is limited primarily by the accuracy of arrival times, the validity of the standard travel-time curve, and by local velocity deviations. This method is based on P-wave arrivals with depth constrained to zero.

DATA AND RESULTS (LRSM AND VELA OBSERVATORIES)

The parameters of the SCOTCH event and a summary of the seismic evaluation are shown on the Event Description page. The operational status of the 21 LRSM stations and observatories is given in Table I, and illustrated in Figure 1.

Table 2 summarizes the measurements made of the principal phases from the SCOTCH event at the LRSM and VELA stations. Included are the Pn and P arrival times, the maximum amplitudes (A/T) of Pn or P motion and other phases as seen on the short-period instruments. Long-period Love and Rayleigh wave motion are also tabulated in (A/T) form. In addition, individual station Rayleigh wave areas (mm^2) is indicated as measured on the LPZ only. Although reduced to 1K magnification, they have not been normalized to any magnitude. Twenty-one stations recorded short-period and long-period signals.

The unified magnitudes determined from the LRSM and VELA observatories are shown in Figure 2. The average magnitude is 5.51 $\pm$ 0.75. The adjusted unified magnitude is 5.29 $\pm$ 0.62.

The travel-time residuals from the Pn and P phases are shown in Figure 4. Figures 5 through 9 illustrate plots of the amplitudes of P, Pg, Lg, LQ, and LR.

Attached to the report are illustrative seismograms showing the signals recorded at four stations. The most distant station analyzed that recorded SCOTCH was NP-NT at a distance of 4348 kilometers.

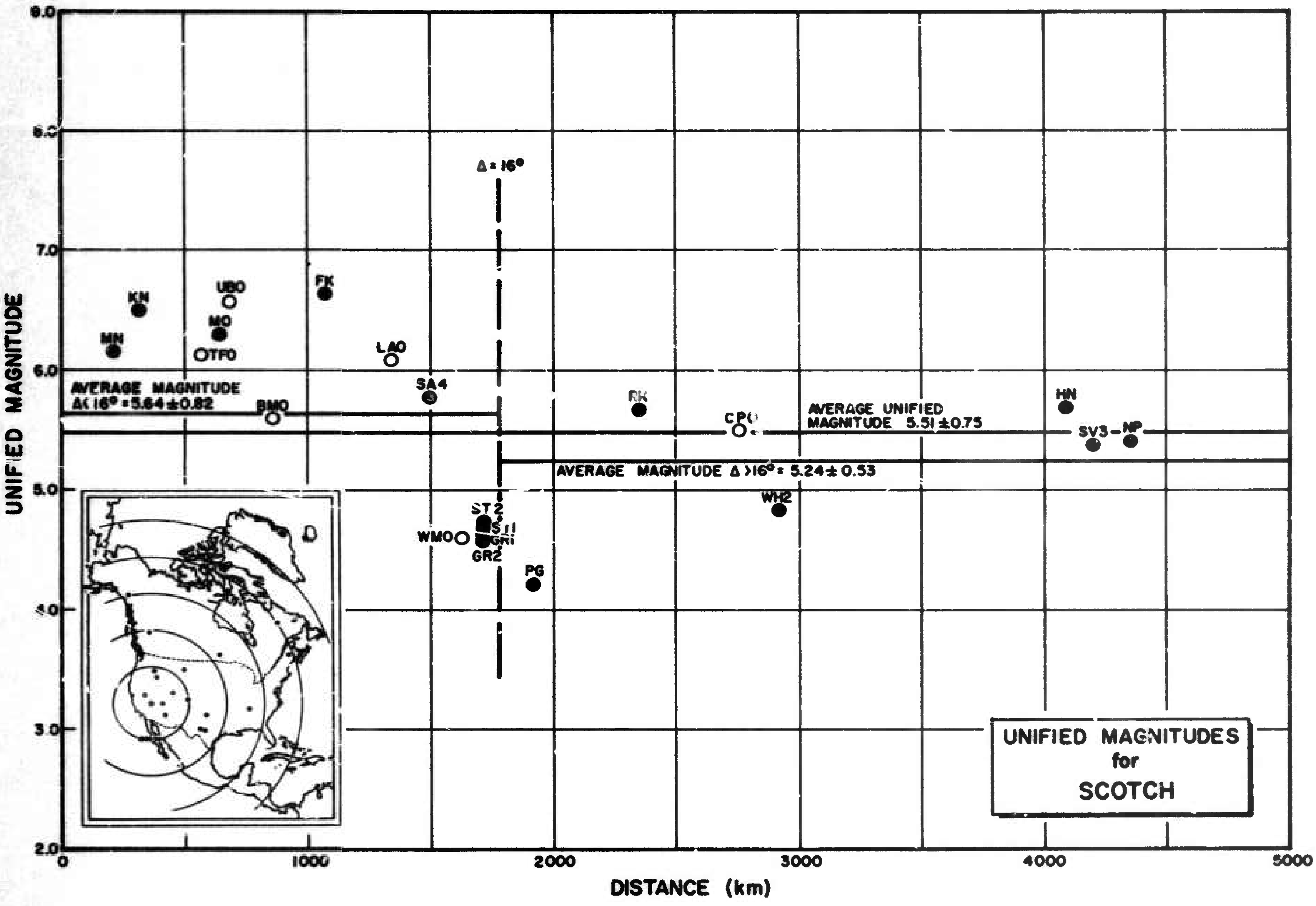
Code	Station	Distance (km)	Inst.	Magnification (K) Film x 10	Phase	Observed Travel Time (min)	Observed Travel Time (sec)	Period T (sec)	Maximum Amplitude A/T	Magnitude (m) mb	Magnitude (m) ms	Area (km²) LPZ
MN-NV	Mina, Nevada	165	SPZ	0.110	Pn	00	32.5	5.45	11,673	6.55	5.85	
			SPZ	0.100	Pg	49	30.5	0.5	(100,002)			
			SPT	0.113	Lg			(5.0)	34,300			
			LPZ		LQ			---	---			
			LPZ	0.9n	LQ			(0.0)	(31,015)			2965.01
KN-UT	Kanab, Utah	510	SPZ	0.0905	Pn	10	47.7	0.4	7667	6.10	6.34	
			SPZ	0.0900	Pg	00	55.0	0.35	33,344			
			SPT	0.087	Lg			0.6	16,482			
			LPZ	0.0830	LQ			(10.0)	(10,397)			
			LPZ	0.710	LQ			(10.0)	(4400)			990.33
TFSO	Tonto Forest Seismological Observatory, Arizona	548	SPZ-60	3.37	Pn	01	19.5	(0.6)	(911)	(6.15)	(5.84)	
			SPZ-60	1.97	e	01	9n.3	0.9n	907			
			SPZ-60	1.97	e	01	97.0	0.4	815			
			SPZ-60	1.37	Pg	01	00.9	0.6	419n			
			SPZ	1.31	Lg			1.1	1496			
			SPZ	1.37	Lg			3.1	1530			
			LPZ	3.5	LQ			16.0	240			
			LPZ	3.1	LQ			16.0	3?0			
			LPZ	0.002	LQ			16.0	(9710)			00.00
MO-ID	Mountain Home, Idaho	544	SPZ	0.005	Pn	01	(30.3)	0.5	900	6.30	6.10	
			SPZ	0.305	e	07	30.6	0.6	19n0			
			SPZ	0.323	e	03	45.0	0.6	5600			
			SPZ	0.335	Pg	01	9n.3	(0.4)	(9026)			
			SPT	0.354	Lg			0.8	5400			
			LPZ	0.174	LQ			1?.0	4870			
			LPZ	0.0155	LR			(14.0)	(1600)			1003.03
UBSO	Uinta Basin Seismological Observatory, Utah	481	SPZ-30	0.9n	Sn	01	(37.?)	5.55	531	6.9n	6.63	
			SPZ-10	0.9n	Pg	01	51.0	0.59	2237			
			SPZ	5.5	Lg			0.7	2455			
			SPZ	5.5	Lg			0.?	1406			
			LPZ	0.9n	LQ			16.0	905			
			LPZ	0.9n	LQ			16.0	305			
			LPZ	0.53	LR			16.0	675			306.76
BMSO	Blue Mountain Seismological Observatory, Oregon	185	SPZ-5	34.0	Pn	01	55.5	0.9	81.5	5.60	5.9n	
			SPZ-3	34.0	e	01	57.5	(5.0)	(105)			
			SPZ-5	9n.0	Pg			---	---			
			SPZ		Lg			---	---			
			SPZ		Lg			---	---			
			LPZ		LQ			---	---			
			LPZ		LQ			---	---			
			LPZ	1.0	LQ			15.?	900			630.00
FK-CO	Franktown, Colorado	1370	SPZ	15.00	Sn	00	03.4	0.75	340	6.34	5.17	
			SPZ	15.00	(Pn)	32	30.7	(2.0)	(167)			
			SPZ	15.10	e	00	30.0	0.75	155			
			SPZ	15.10	Pg	05	(01.4)	(0.7)	(894)			
			SPT	11.37	Lg			5.5	1541			
			LPZ	0.053	LQ			(15.0)	(3030)			
			LPZ	0.100	LQ			11.0	3000			601.37
LAO	[illegible], AO-10, Montana	1300	SPZ	42.5	Pn	00	55.5	1.1	97.0	5.00	6.00	
			SPZ	42.5	e	00	00.6	0.9	510			
			SPZ	42.5	e	05	00.5	0.0	100			
			SPZ	42.4	e	05	37.0	?.0	200			
			SPZ	41.5	(Pg)	05	00.0	0.75	19n			
			LPZ	**	LQ			14.0	**			
			LPZ	**	LQ			16.0	**			
			LPZ	**	LR			17.0	**			..
SA-TX	San Angelo, Texas	1497	SPZ-1	9n.0	Pn	05	115.6)	0.0	00.0	5.7n	5.05	
			SPZ-1	34.0	e	03	57.4	10.0)	151.51			
			SPZ-1	9n.0	e	05	10.0	(0.7)	(10.7)			
			SPZ-1	9n.0	e	00	33.0	1.1	111			
			SPZ-1	9n.0	Pg	00	00.5	10.7)	1197)			
			LPZ	0.10	LQ			(15.0)	(000)			
			LPZ	0.15	LQ			(15.0)	(0973)			300.00
WMSO	Wichita Mountains Seismological Observatory, Okla.	1635	SPZ-6	33.7	P	03	(30.4)	(1.0)	(10.4)	(6.60)	(6.30)	
			SPZ-6	31.7	e	03	30.5	1.3	303			
			SPZ-6	33.7	Pg	10	(30.0)	0.0	110			
			LPZ	13.?	e	00	35	10.0	31.6			
			SPZ	00.0	Lg			15.75	(1530)			
			LPZ	3.35	LQ			72.0	[illegible]			
			LPZ	0.10	LR			(14.0)	(396)			170.10
SV-TX	[illegible], Texas	1717	SPZ-1	00.5	P	03	(00.0)	0.0	30.0	4.75	4.79	
			SPZ-1	30.0	e	03	45.0	0.7	10.0			
			SPZ-1	30.3	e	10	10.0	0.7	00.0			
			SPZ-1	00.5	10	00	30.0	0.0	03.5			
			SPZ-1	10.0	Pg	10	44.3	0.0	10.0			
			LPZ	0.000	LQ			(31.0)	(0300)			963.00
GR-TX	[illegible], Texas	1790	SPZ-2	10.0	P	03	01.0	0.0	30.5	0.10	0.07	
			SPZ-2	10.0	e	03	40.7	0.7	30.0			
			SPZ-2	44.0	e	00	00.0	0.0	00.0			
			SPZ-2	10.0	Pg	00	00.0	1.5	77.0			
			LPT	0.10	LQ			10.0	000			
			LPZ	0.000	LQ			10.0	1,000			300.00

Principal Phases
Table 2 Page 1

Code	Station	Distance (km)	Inst.	Magnification (K) Film x 14	Phase	Observed Travel Time (min)	Observed Travel Time (sec)	Period T (sec)	Maximum Amplitude A/T	Magnitude mb	Magnitude ms	Area (mm^3) LPZ
GRITX	Grit, Texas	1723	SPZ-1	04.0	P	03	41.1	0.8	93.0	4.04	4.71	
			SPZ-1	35.0	e	03	04.3	0.4	70.3			
			SPZ-1	35.0	PP	03	53.3	1.1	93.0			
			SPZ-1	35.0	(Pg)	04	(04.0)	(0.7)	(04.0)			
			LPT	0.06	LQ			(13.0)	(040)			
			LPZ	0.04	LR			(11.0)	(1700)			348.04
[illegible]	[illegible], Texas	1727	SPZ-1	34.6	P	03	(41.0)	0.0	41.3	4.72	4.04	
			SPZ-1	04.6	e	03	04.6	0.7	04.1			
			SPZ-1	34.1	e	03	44.0	0.4	95.4			
			SPZ-1	04.6	e	03	04.4	(0.4)	(51.3)			
			SPZ-1	04.5	e	04	04.2	0.0	110			
			SPZ-1	04.6	Pg	04	(49.4)	0.7	(33.3)			
			LPT	0.309	LQ			14.0	043			
			LPZ	0.143	LQ			13.0	0439			304.04
PG-BC	Prince George, British Columbia, Canada	1910	SPZ	14.3	P	04	04.1	0.0	06.7	4.38		
			SPZ	14.3	e	04	04.3	1.0	08.0			
			SPZ	14.3	e	04	04.4	0.0	220			
			SPZ	14.3	e	04	08.7	0.0	204			
			SPZ	14.3	e	04	10.0	0.0	189			
			SPZ	14.3	e	04	13.0	0.7	04.0			
			SPZ	14.3	PP	04	14.0	1.1	134			
			SPZ	14.3	e	04	21.0	0.0	30.4			
				14.3	e	04	34.4	1.1	109			
			SPZ	14.0	Lg			3.1	189			
			SPT	14.0	Lg			3.1	104			
			LPZ	0.74	LQ			13.0	361			
			LPT	0.04	LQ			13.0	543			
			LPZ	3.04	LR			13.0	360			104.73
RK-ON	Red Lake, Ontario, Canada	2346	SPZ	0.04	P	04	43.0	0.4	360	4.04		
			SPZ	0.04	e	04	47.7	(0.7)	(331)			
			SPZ	0.04	e	04	04.4	0.0	340			
			SPZ	0.04	e	04	04.3	1.0	360			
			SPZ	0.04	e	04	37.3	0.7	104			
			SPZ	0.04	e	04	(03.0)	0.0	131			
			SPT	0.09	Lg			1.7	143			
			LPT	1.04	LQ			13.0	104			
			LPZ	13.7	LQ			13.0	334			91.61
CPSO	Cumberland Plateau Seismological Observatory, Tenn.	2704	SPZ-9	04.0	P	04	34.3	0.73	111	3.61		
			SPZ-9	04.0	e	04	04.7	1.0	93.0			
			SPZ		Lg			—	—			
[illegible]	Whitehorse, Yukon Territory, Canada	2917	[illegible]	37.0	P	[illegible]	(37.4)	[illegible]	29.7	4.83		
			SPZ	27.0	e	04	30.4	0.8	04.4			
			SPZ	37.0	e	04	41.3	(1.0)	(37.0)			
			SPZ	37.0	(PcP)	06	07.[illegible]	0.0	4.0			
			LPZ	1.53	(S)	10	38	10.0	30.0			
			SPT	36.0	Lg			0.3	(42.4)			
			LPT	0.013	LQ			18.0	164			
			LPZ	3.53	LR			(14.0)	(810)			438.91
HN-ME	Houlton, Maine	4401	SPZ	14.3	P	07	09.0	(0.83)	(144)	(3.04)		
			SPZ	14.3	e	07	15.0	0.0	31.4			
			SPZ	14.3	PcP	04	31.3	0.0	13.0			
			SPT	17.8	Lg			(1.7)	(04.0)			
			LPT	1.11	LQ			(13.0)	(131)			
			LPZ	7.0	LQ			13.0	180			37.04
[illegible]	Schefferville, Quebec, Canada	4104	SPZ	29.0	e	07	14.3	(3.0)	(77.4)	(3.39)		
			SPZ	04.0	(04)	04	47.0	(0.0)	(04.4)			
			SPL	04.9	Lg			(1.4)	(33.0)			
			SPT	04.7	Lg			1.4	27.7			
			LPZ	3.42	LQ			13.0	70.3			
			LPT	4.10	LQ			13.0	73.0			
			LPZ	4.44	LR			14.0	120			46.04
[illegible]	Mould Bay, Northwest Territories, Canada	4041	SPZ	114	P	07	39.0	0.7	198	0.61		
			SPZ	114	e	07	33.3	0.7	61.0			
			SPZ	114	e	07	47.4	0.7	04.3			
			SPZ	114	e	37	58.2	0.8	04.0			
			SPZ	114	04	08	58.4	1.3	04.1			
			SPZ	114	PcP	09	30.4	0.0	30.7			
			SPT	128	Lg			0.8	116			
			LPT	10.14*	LQ			18.0	398			
			LPZ	13.41*	LQ			17.0	390			337.48

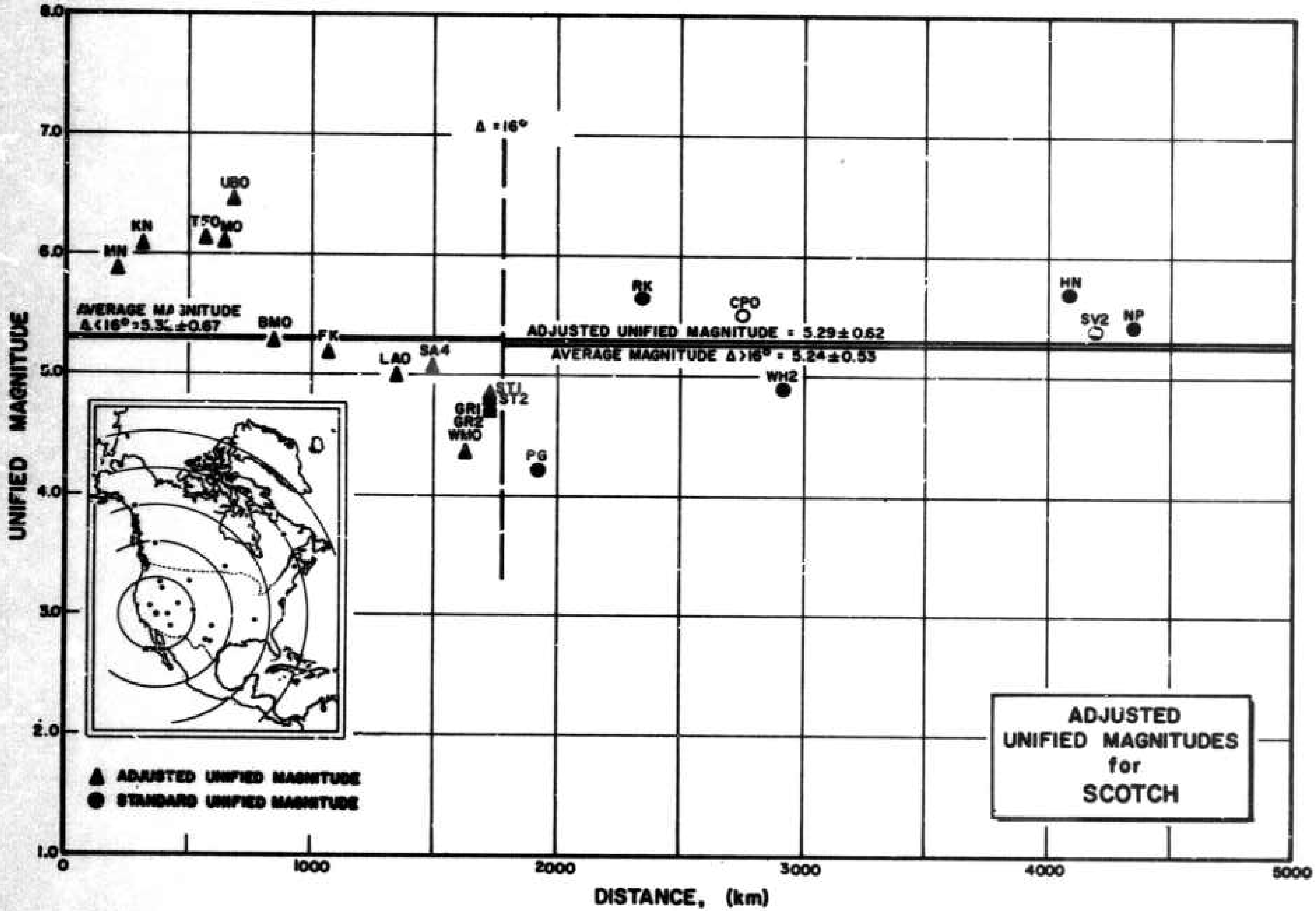
A/T mμ/sec
() Doubtful Values or Phases
e Measurements Made from Playouts
— Maximum Amplitudes Clipped on Film and Tape
** Magnification Questionable

Principle Phases- SCOTCH
Table 2 - Page 2



UNIFIED MAGNITUDES
for
SCOTCH
UNIFIED MAGNITUDE
DISTANCE (km)
AVERAGE MAGNITUDE
Δ<16° = 5.64 ± 0.82
AVERAGE UNIFIED
MAGNITUDE 5.51 ± 0.75
AVERAGE MAGNITUDE Δ>16° = 5.24 ± 0.53
Δ = 16°
MN
KN
UBO
MO
OTFO
FK
LAO
SA4
BMO
RK
CPO
HN
SV3
NP
WH2
ST2
ST1
GR1
GR2
WMO
PG

Figure 2



UNIFIED MAGNITUDE
DISTANCE, (km)
ADJUSTED UNIFIED MAGNITUDES for SCOTCH
ADJUSTED UNIFIED MAGNITUDE = 5.29 ± 0.62
AVERAGE MAGNITUDE Δ>16° = 5.24 ± 0.53
Δ = 16°
ADJUSTED UNIFIED MAGNITUDE
STANDARD UNIFIED MAGNITUDE
MN
KN
UBO
MO
BMO
FK
LAO
SA4
ST1
ST2
GR1
GR2
WMO
PG
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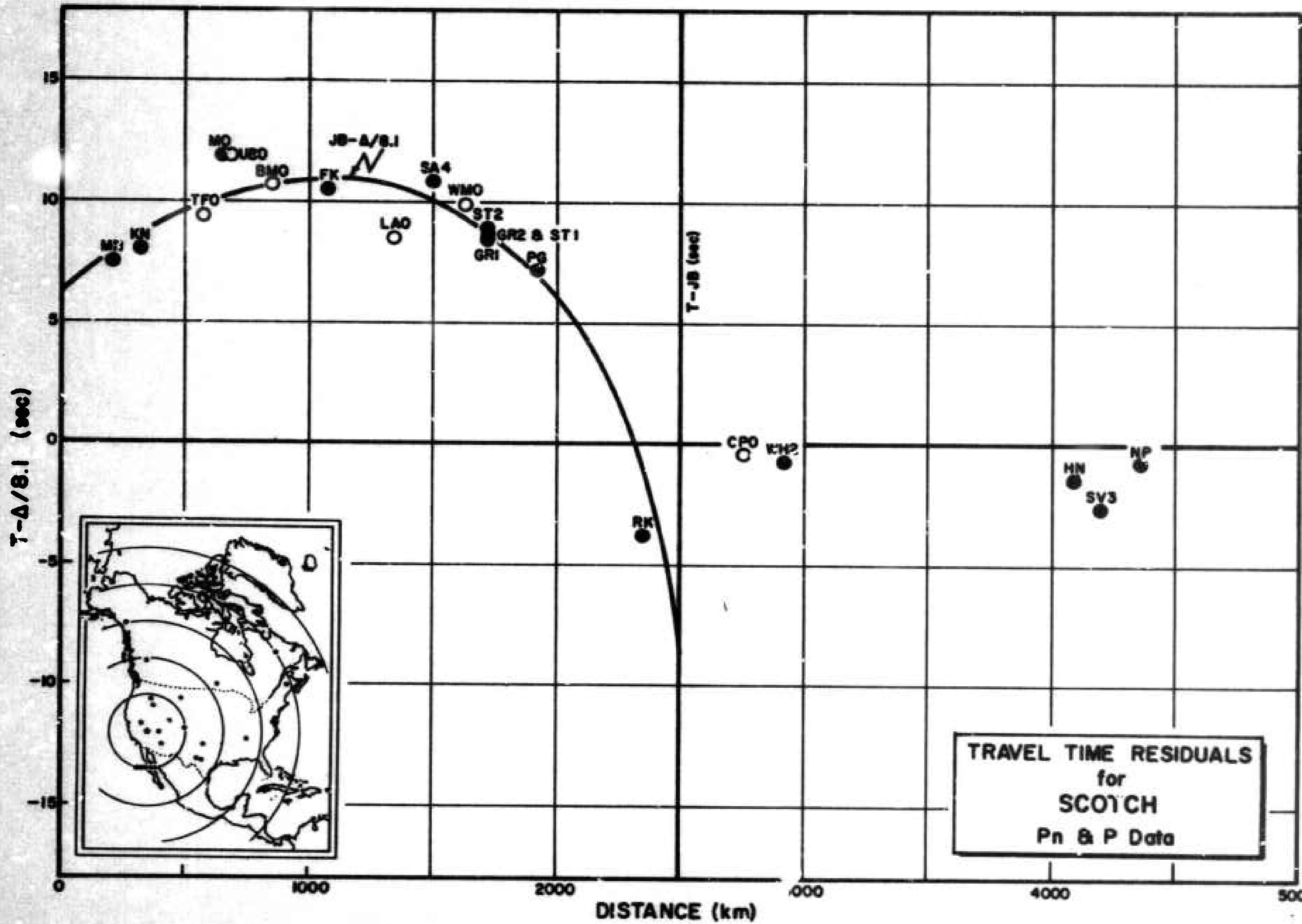
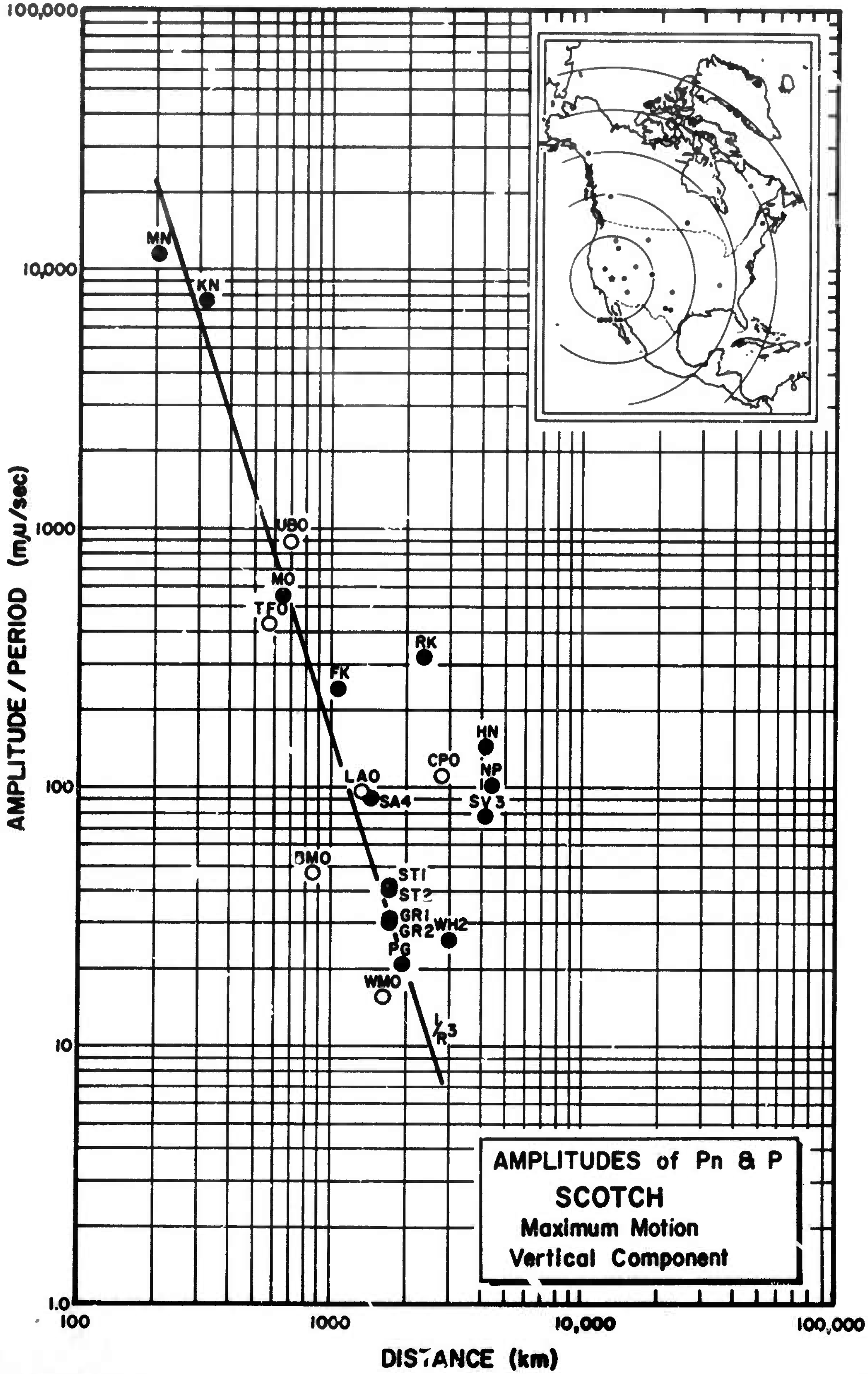
CPO
WH2
HN
SV2
NP

Figure 3



TRAVEL TIME RESIDUALS
for
SCOTCH
Pn & P Data
T-Δ/8.1 (sec)
DISTANCE (km)
T-JB (sec)
JB-Δ/8.1
0
1000
2000
4000
5000
15
10
5
0
-5
-10
-15
MO
UBO
BMO
TFO
KN
FK
SA4
WMO
ST2
GR2 & ST1
GRI
PG
LAO
RK
CPO
HN
SV3
NP

Figure 4



AMPLITUDES of Pn & P
SCOTCH
Maximum Motion
Vertical Component
AMPLITUDE / PERIOD (mμ/sec)
DISTANCE (km)
100,000
10,000
1000
100
10
1.0
100
1000
10,000
100,000
MN
KN
UBO
MO
TFO
FK
RK
HN
CPO
NP
LAO
SA4
SV3
BMO
ST1
ST2
GR1
GR2
WH2
PG
WMO
$1/R^3$

Figure 5

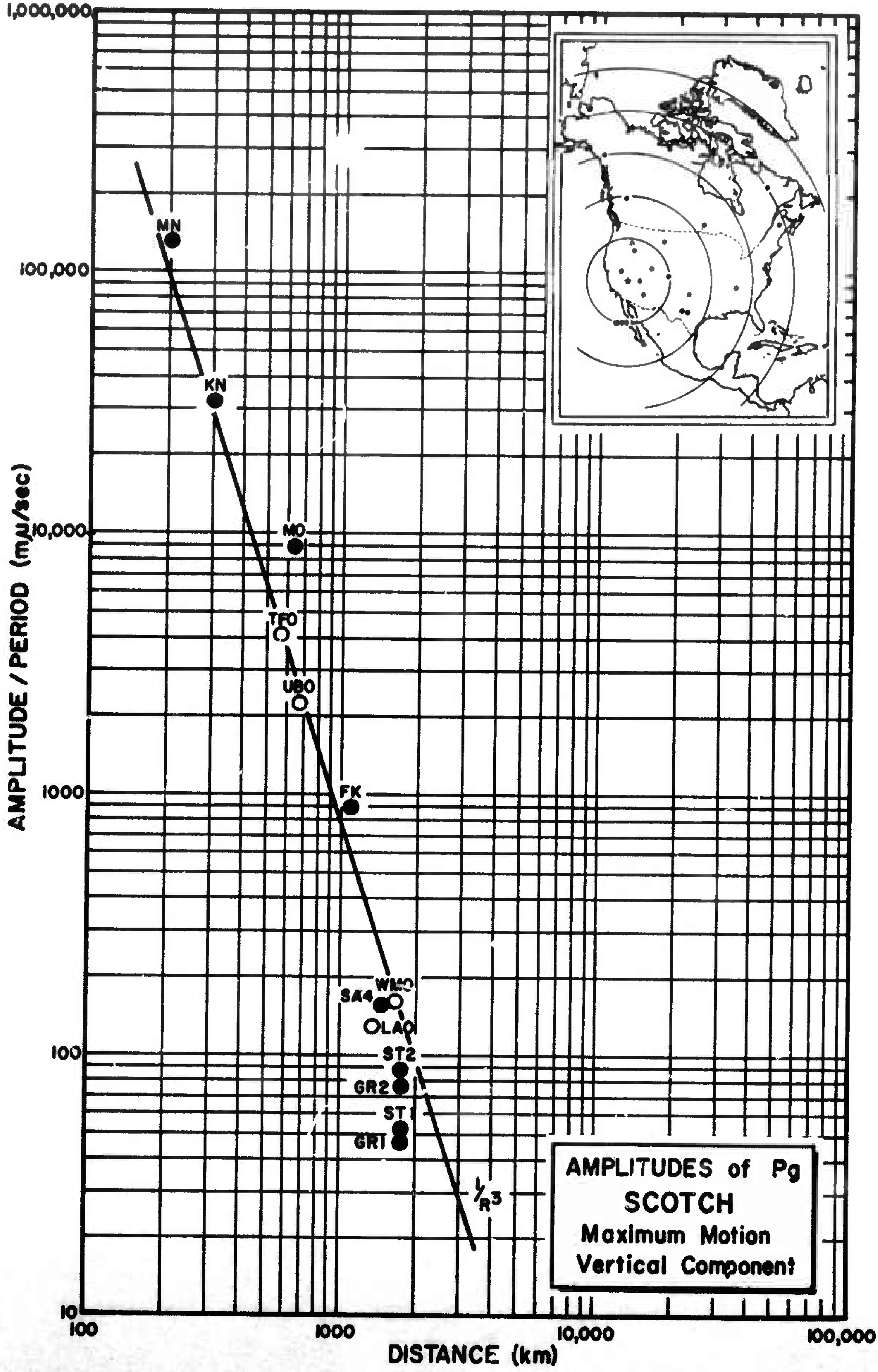

1,000,000
100,000
10,000
1000
100
10
100
1000
10,000
100,000
AMPLITUDE / PERIOD (mμ/sec)
DISTANCE (km)
MN
KN
MO
TFO
UBO
FK
WMO
SA4
LAO
ST2
GR2
ST1
GR1
1/R3
AMPLITUDES of Pg
SCOTCH
Maximum Motion
Vertical Component

Figure 6

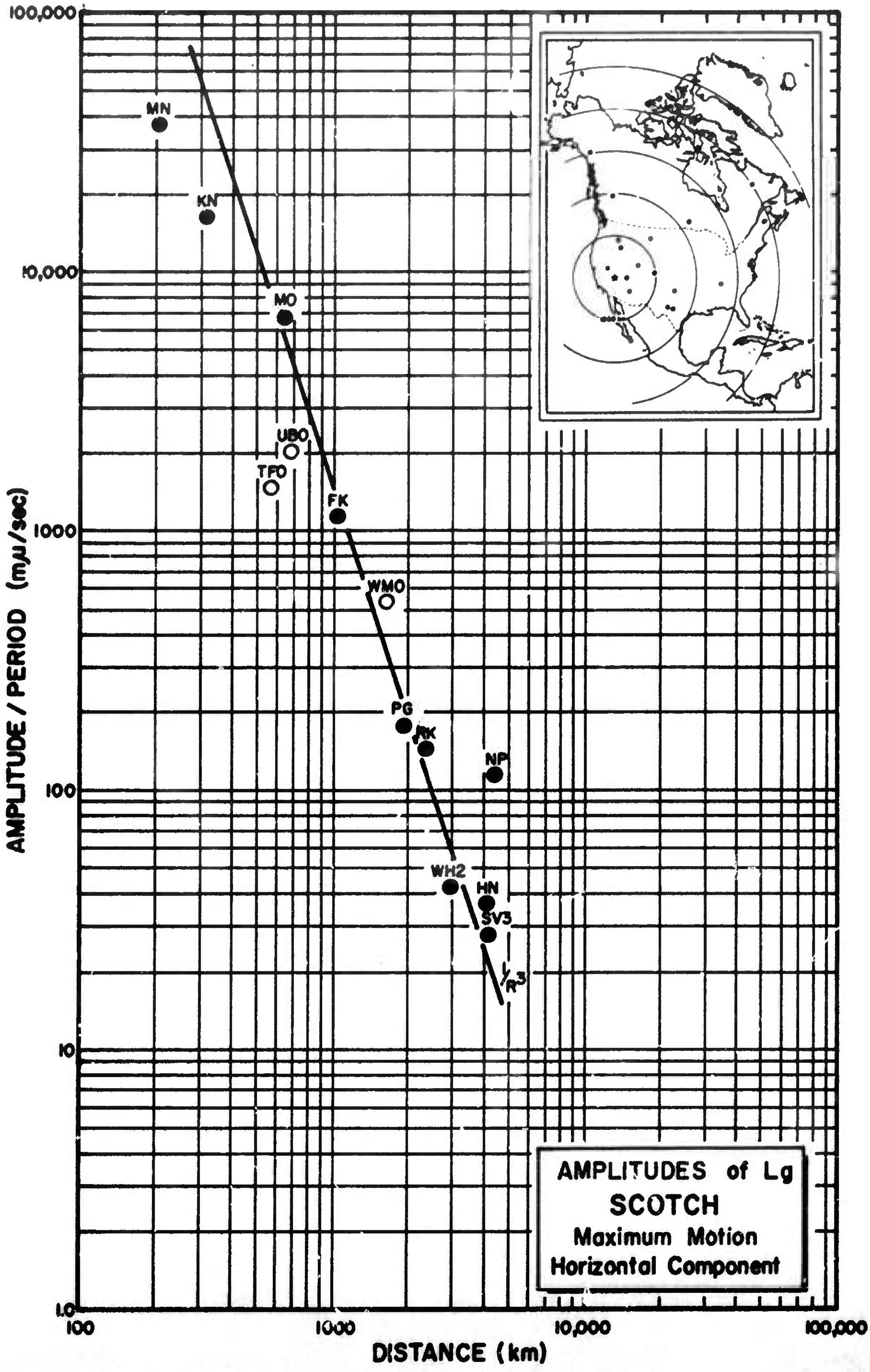
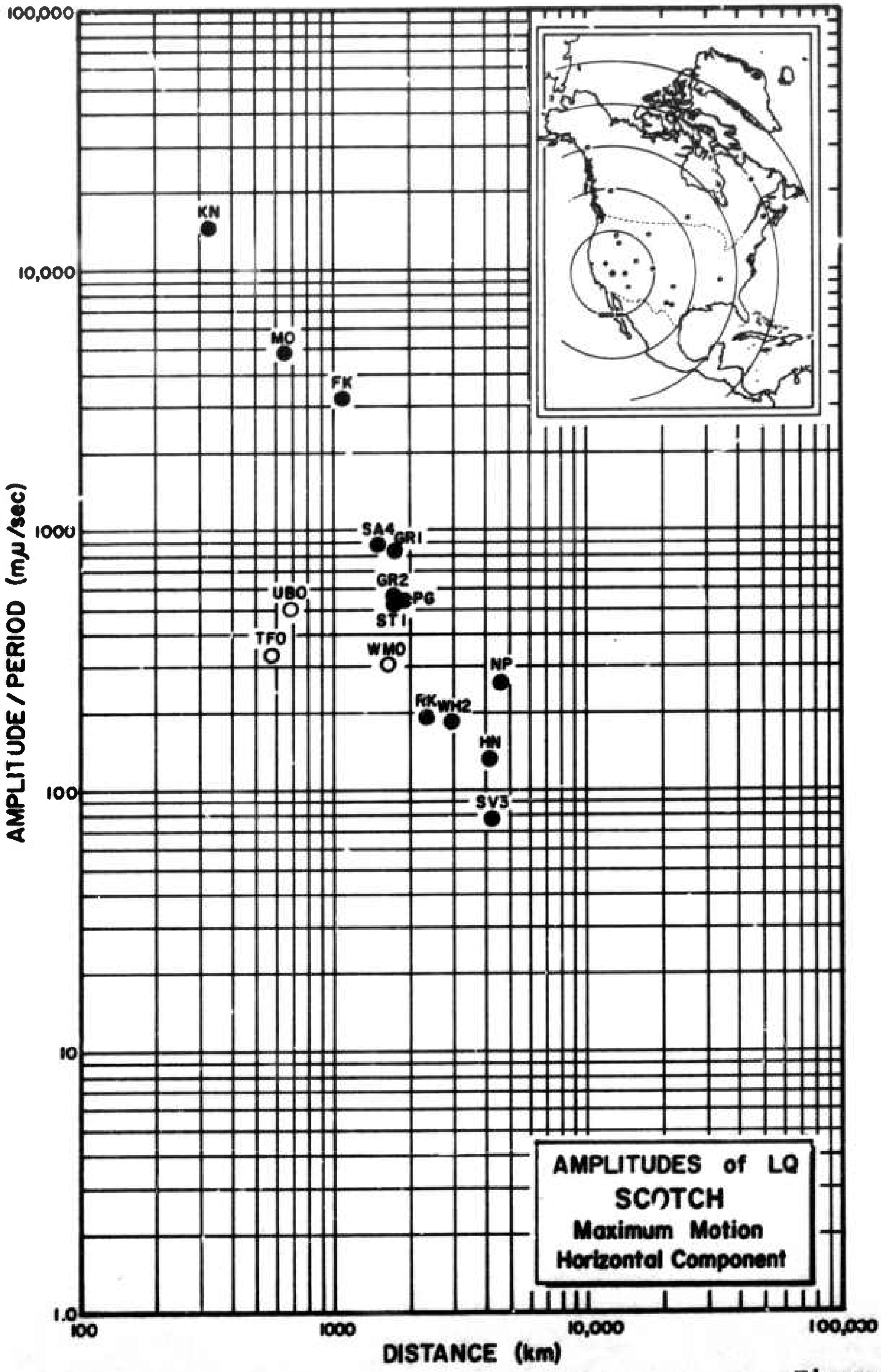
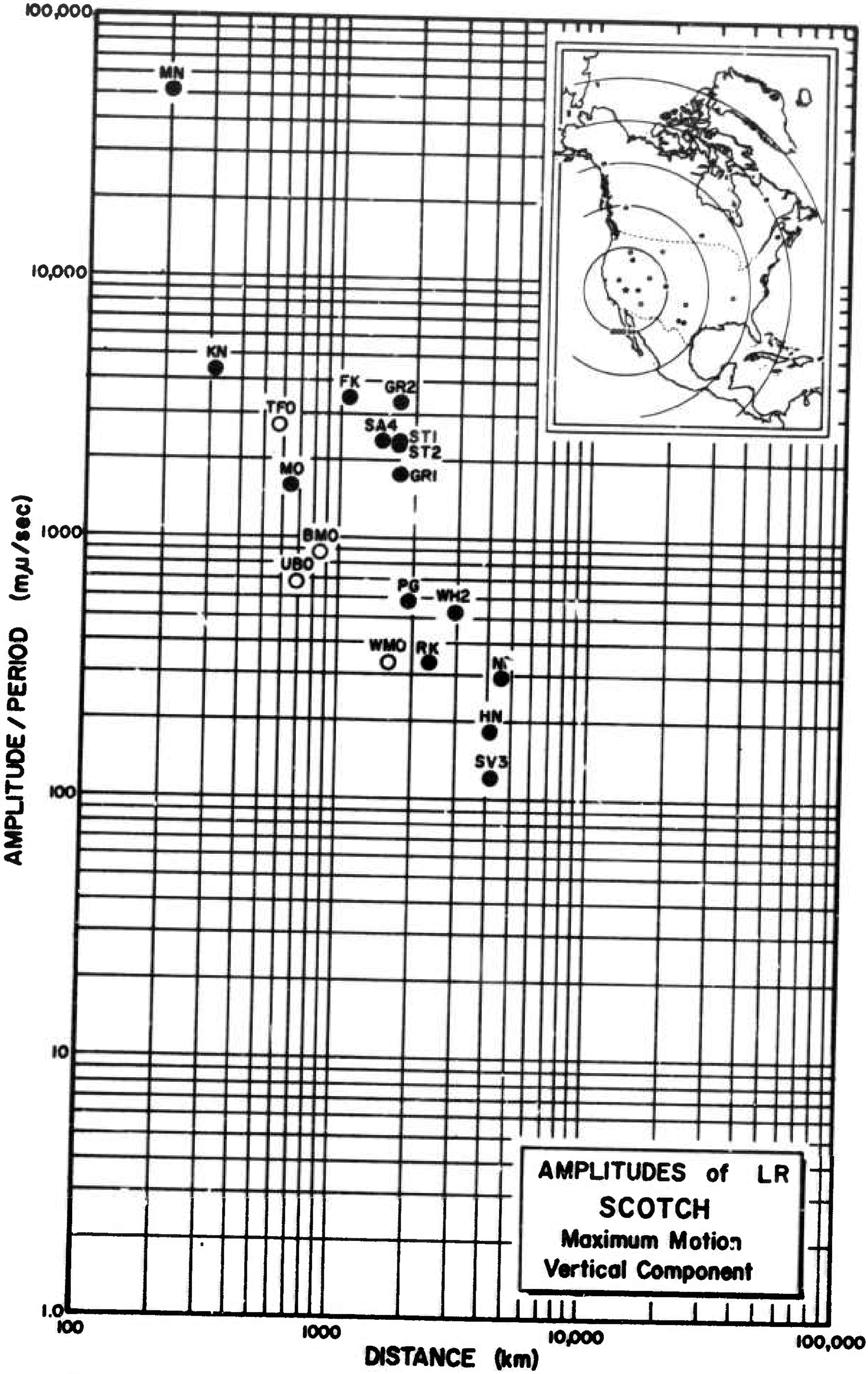

AMPLITUDES of Lg
SCOTCH
Maximum Motion
Horizontal Component
AMPLITUDE / PERIOD (mμ/sec)
DISTANCE (km)
100,000
10,000
1000
100
10
1.0
100
1000
10,000
100,000
MN
KN
MO
UBO
TFO
FK
WMO
PG
RK
NP
WH2
HN
SV3
$1/R^3$

Figure 7



100,000
10,000
1000
100
10
1.0
100
1000
10,000
100,000
AMPLITUDE / PERIOD (mμ/sec)
DISTANCE (km)
KN
MO
FK
SA4
GR1
GR2
PG
ST1
UBO
TFO
WMO
NP
RK
WH2
HN
SV3
AMPLITUDES of LQ
SCOTCH
Maximum Motion
Horizontal Component

Figure 8



AMPLITUDE / PERIOD (mμ/sec)
100,000
10,000
1000
100
10
1.0
100
1000
10,000
100,000
DISTANCE (km)
MN
KN
TFO
FK
GR2
SA4
ST1
ST2
GR1
MO
BMO
UBO
PG
WH2
WMO
RK
HN
SV3
AMPLITUDES of LR
SCOTCH
Maximum Motion
Vertical Component

Figure 9

SCOTCH - 23 May 1967

Code	Station	Distance (km)	Geographic Latitude	Geographic Longitude	Elev. (km)	Computed Azimuth		Installed Azimuth		Large or Small SP	LP Inst.
						Epi. Sta.	Sta. Epi.	Radial	Tang.		
MN-NV	Mina, Nevada	203	38°26'10" N	118°08'53" W	1.52	310°	129°	308°	38°	L	X
KN-UT	Kanab, Utah	316	37°01'22" N	112°49'39" W	1.74	94°	276°	95°	185°	L	X
TFSO*	Tonto Forest Seismological Observatory, Arizona	568	34°17'12" N	111°16'03" W	1.49	124°	307°	90°	0°	JM	X
MO-ID	Mountain Home, Idaho	644	43°04'19" N	116°15'56" W	0.79	1°	181°	359°	89°	L	X
UBSO*	Uinta Basin Seismological Observatory, Utah	681	40°19'18" N	109°34'07" W	1.60	58°	242°	90°	0°	JM	X
BMSO*	Blue Mountain Seismological Observatory, Oregon	845	44°50'56" N	117°18'20" W	1.19	355°	174°	0°	90°	JM	X
FK-CO	Franktown, Colorado	1070	39°35'12" N	104°27'42" W	1.80	72°	260°	79°	169°	L	X
LAO*	Subarray, AO-10, Montana	1340	46°41'19" N	106°13'20" W	0.90	36°	222°	90°	0°	HSZ	X
SA4TX	San Angelo, Texas	1497	31°49'29" N	101°25'35" W	0.79	109°	298°	118°	208°	Geotech	X
WMSO*	Wichita Mountain Seismological Observatory, Okla.	1625	34°43'05" N	98°35'21" W	0.51	55°	285°	90°	0°	JM	X
ST2TX	Streeter, Texas	1717	30°47'32" N	99°26'52" W	0.58	110°	299°	119°	209°	Geotech	X
GR2TX	Grit, Texas	1720	30°47'11" N	99°24'58" W	0.55	110°	299°	119°	209°	Geotech	X
GR1TX	Grit, Texas	1723	30°46'40" N	99°23'03" W	0.52	110°	299°	119°	209°	Geotech	X
ST1TX	Streeter, Texas	1727	30°45'08" N	99°21'20" W	0.52	110°	299°	119°	209°	Geotech	X
PG-BC*	Prince George, British Columbia, Canada	1919	53°59'50" N	122°31'23" W	0.91	348°	163°	110°	200°	L	X
RK-ON	Red Lake, Ontario, Canada	2346	50°50'20" N	93°40'20" W	0.37	43°	239°	58°	148°	S	X
CPSO*	Cumberland Plateau Seismological Observatory, Tenn.	2756	35°35'41" N	85°34'13" W	0.57	85°	283°	90°	0°	JM	X
WH2YK	Whitehorse, Yukon Territory Canada	2917	60°41'41" N	134°58'02" W	0.85	339°	145°	325°	55°	L	X
HN-ME	Houlton, Maine	4081	46°09'43" N	67°59'09" W	0.21	60°	274°	93°	183°	S	X
SV3QB*	Schefferville, Quebec, Canada	4195	54°48'39" N	66°45'00" W	0.58	46°	263°	139°	229°	S	X
MP-NT	Mould Bay, Northwest Territories, Canada	4348	76°15'08" N	119°22'18" W	0.06	359°	176°	356°	36°	JMS S	X

* Seismometers Not Oriented Toward NTS

Recording Site Information
Appendix I(A)

Unified Magnitude: $m = \log_{10} (A/T), + B$

where

A = zero to peak ground motion in millimicrons

$= \frac{(mm)\ (1000)}{K}$

T = signal period in seconds

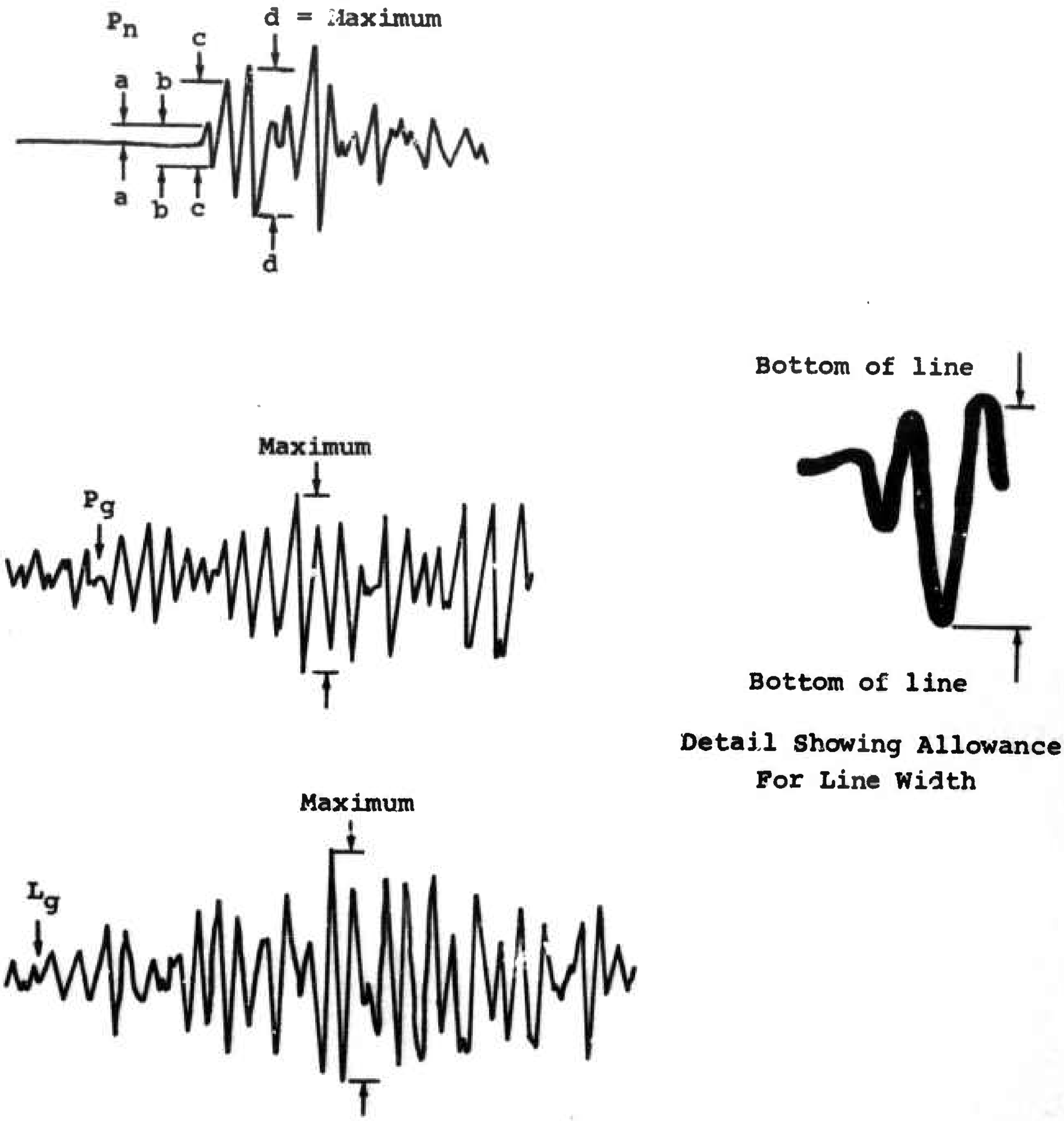
B = distance factor (see Table below)

mm = record amplitude in millimeters zero to peak

K = magnification in thousands at signal frequency

Table of Distance Factors (B) for Zero Depth

Dist (deg)	B	Dist (deg)	B	Dist (deg)	B	Dist (deg)	B
0°	-	27°	3.5	54°	3.8	80°	3.7
1	-	28	3.6	55	3.8	81	3.8
2	2.2	29	3.6	56	3.8	82	3.9
3	2.7	30	3.6	57	3.8	83	4.0
4	3.1	31	3.7	58	3.8	84	4.0
5	3.4	32	3.7	59	3.8	85	4.0
6	3.6	33	3.7	60	3.8	86	3.9
7	3.8	34	3.7	61	3.9	87	4.0
8	4.0	35	3.7	62	4.0	88	4.1
9	4.2	36	3.6	63	3.9	89	4.0
10	4.3	37	3.5	64	4.0	90	4.0
11	4.2	38	3.5	65	4.0	91	4.1
12	4.1	39	3.4	66	4.0	92	4.1
13	4.0	40	3.4	67	4.0	93	4.2
14	3.6	41	3.5	68	4.0	94	4.1
15	3.3	42	3.5	69	4.0	95	4.2
16	2.9	43	3.5	70	3.9	96	4.3
17	2.[illegible]	44	3.5	71	3.9	97	4.4
18	2.9	45	3.7	72	3.9	98	4.5
19	3.0	46	3.8	73	3.9	99	4.5
20	3.0	47	3.9	74	3.8	100	4.4
21	3.1	48	3.9	75	3.8	101	4.3
22	3.2	49	3.8	76	3.9	102	4.4
23	3.3	50	3.7	77	3.9	103	4.5
24	3.3	51	3.7	78	3.9	104	4.6
25	3.5	52	3.7	79	3.8	105	4.7
26	3.4	53	3.7				



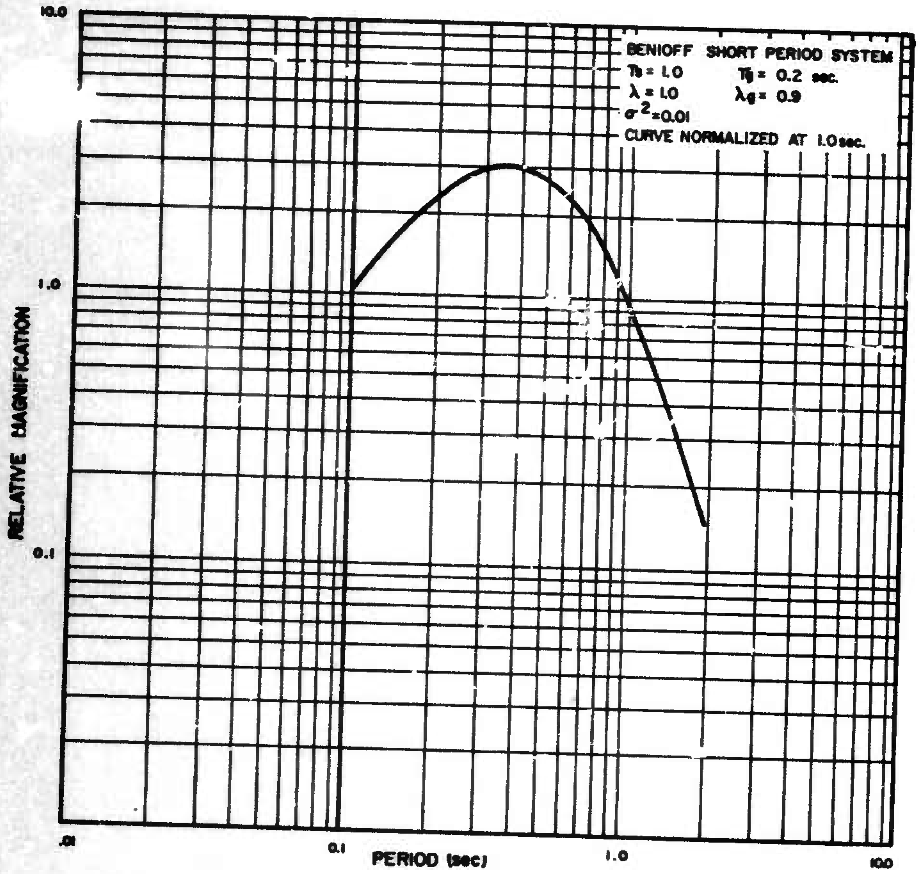
Pick time of Pn at beginning of "a" half cycle.

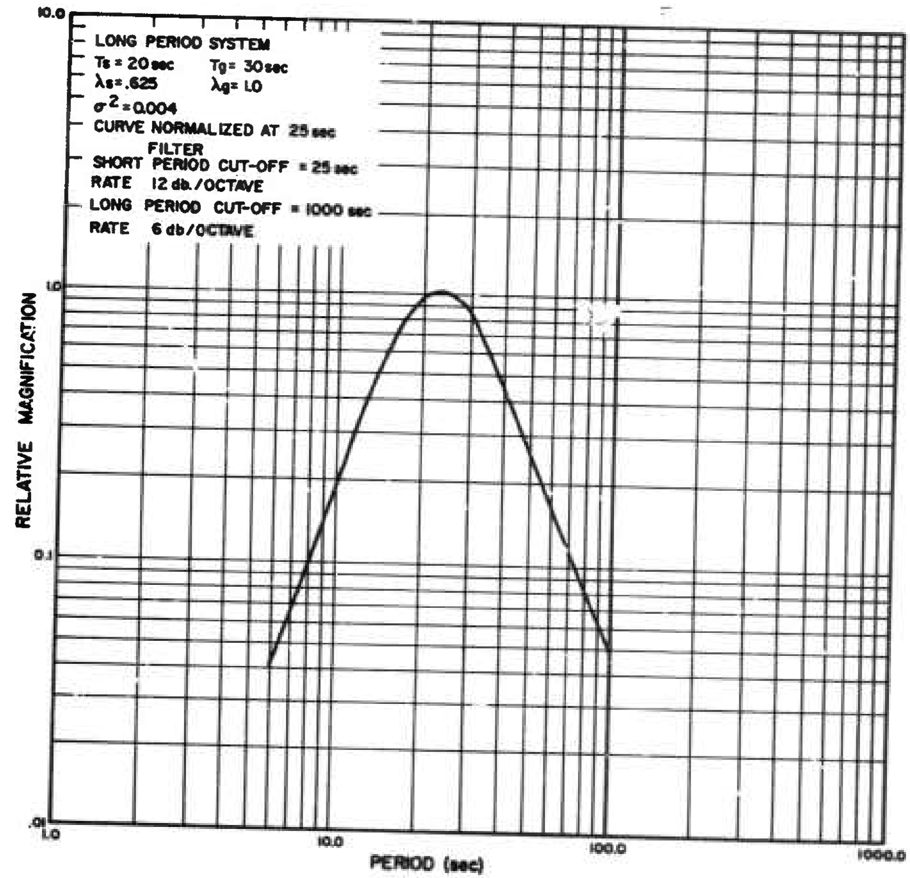
Pick amplitude of Pn as maximum "$d/2$" within 2 or 3 cycles of "c".

Pick amplitudes of Pg and Lg at maximum of corresponding motion.

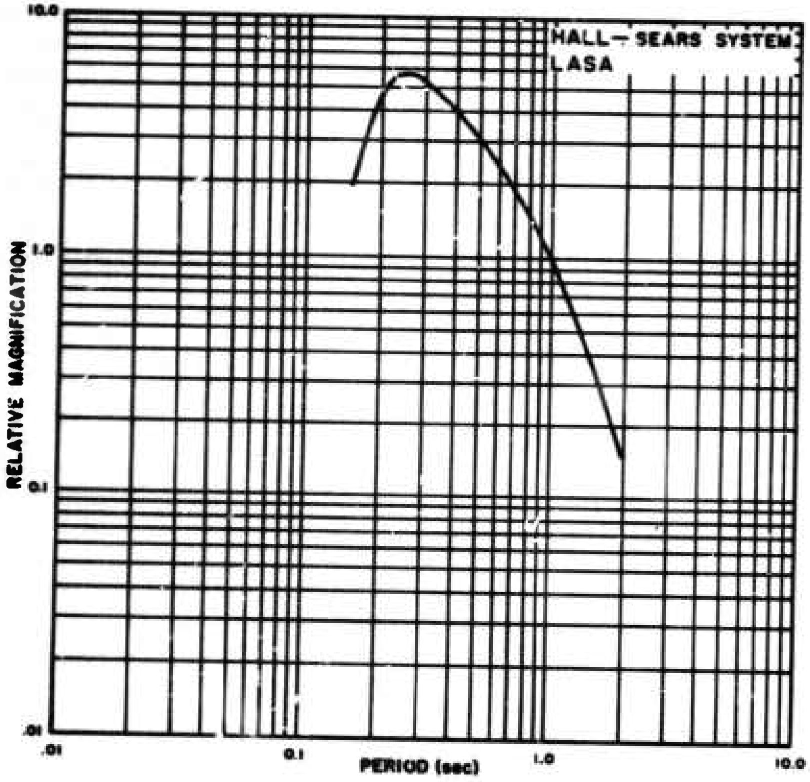
Seismic Analysis Diagram

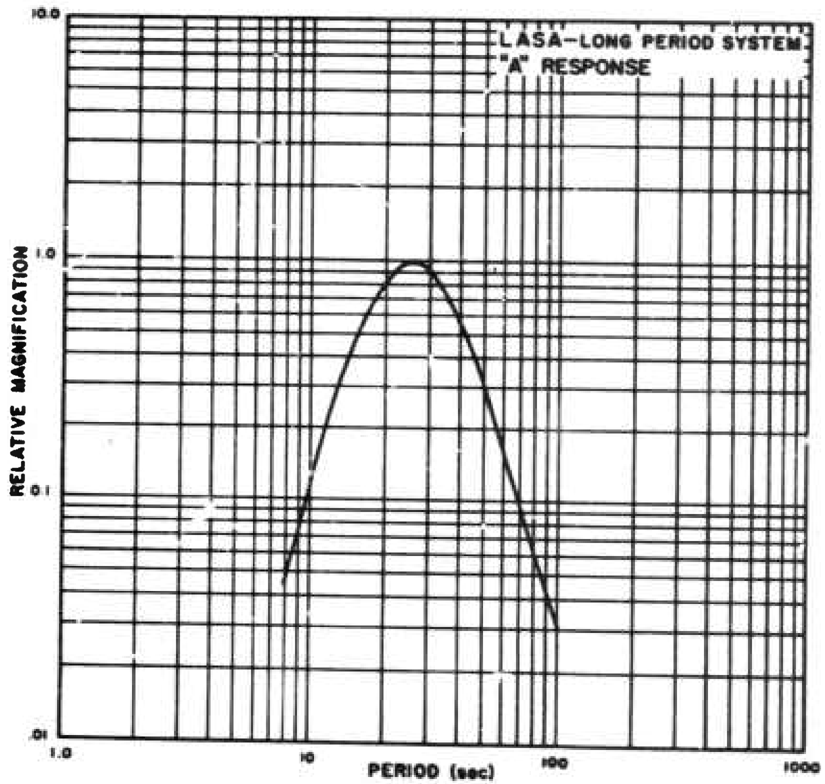
APPENDIX II(A)





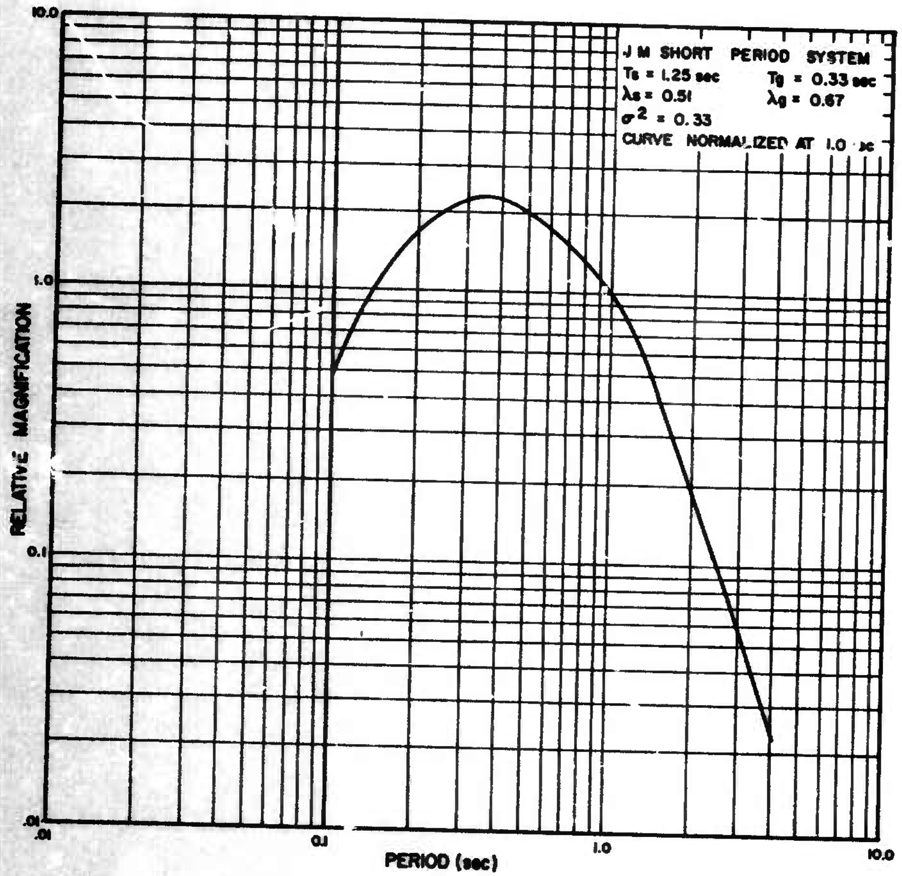
INSTRUMENT RESPONSE CURVES - LRSM

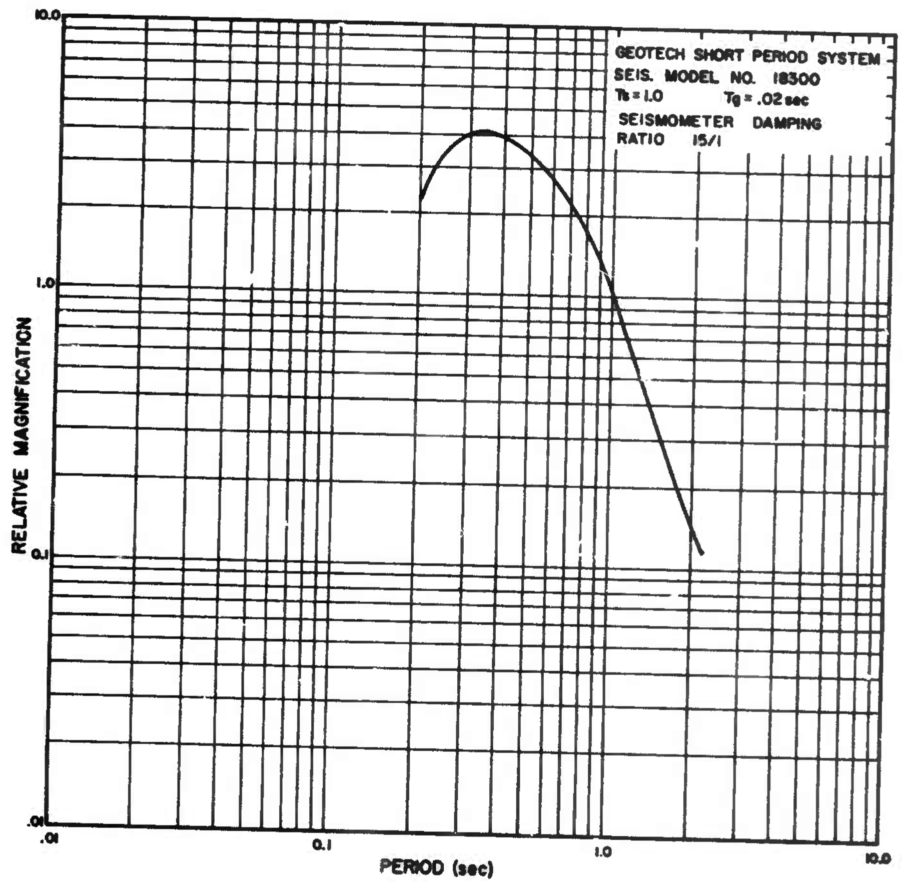




INSTRUMENT RESPONSE CURVE - LASA

APPENDIX II(C)





INSTRUMENT RESPONSE CURVES - OTHER SHORT PERIOD

45

Unclassified
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3. REPORT TITLE

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4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

Scientific

5. AUTHOR(S) (Last name, first name, initial)

Clark, Don M.

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
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13. ABSTRACT

An analysis of seismological data from an underground nuclear explosion as a continuing study to provide information to aid in distinguishing between earthquakes and explosions. A table of travel-times and amplitudes of P, Pg, Lg, and surface waves are included along with other unidentified phases.

DD FORM 1 JAN 64 1473

Unclassified
Security Classification

Unclassified

Security Classification

14. KEY WORDS	LINK A ROLE	LINK A WT	LINK B ROLE	LINK B WT	LINK C ROLE	LINK C WT
Seismic Magnitude						
Seismic Travel-Time						
Seismic Amplitude						
VELA-UNIFORM						
Nuclear Tests						

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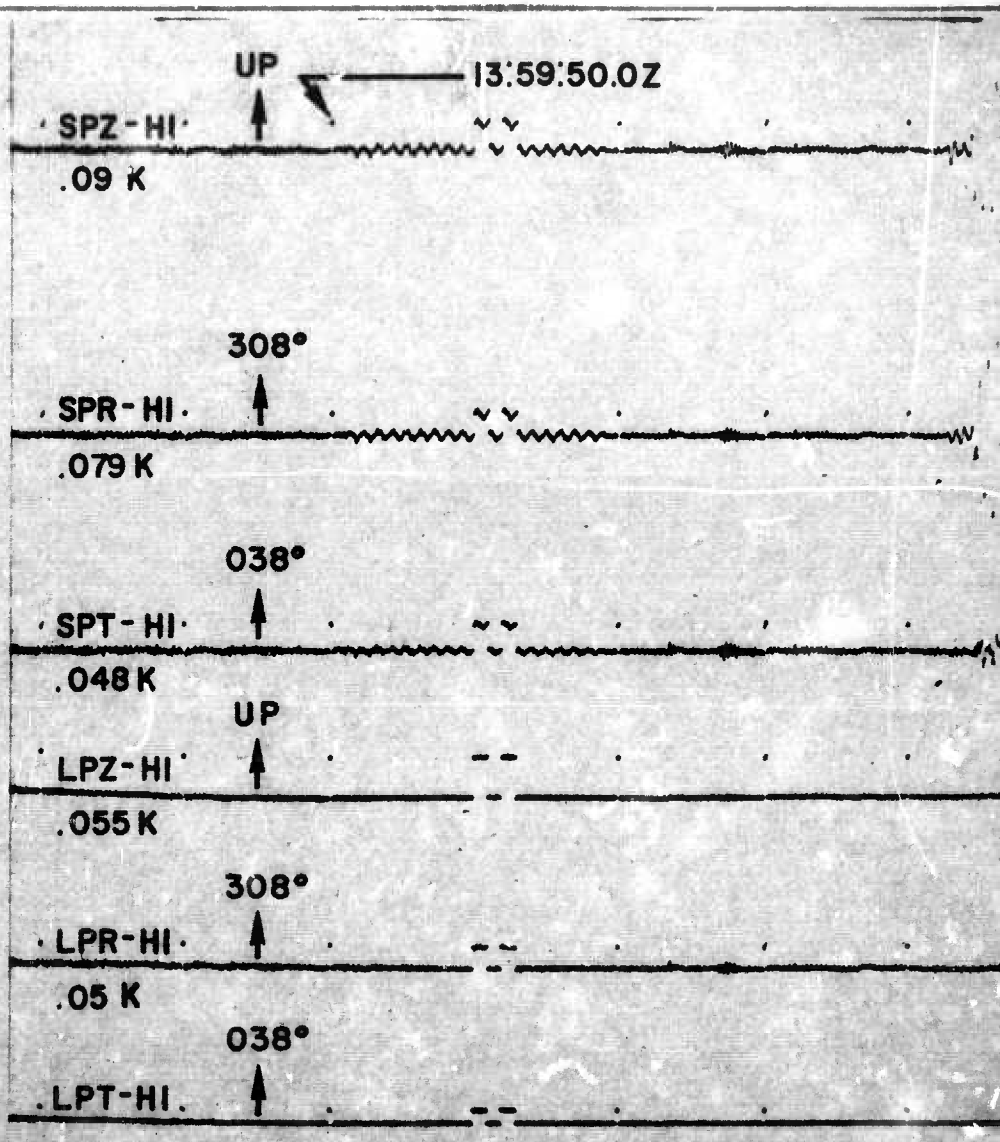
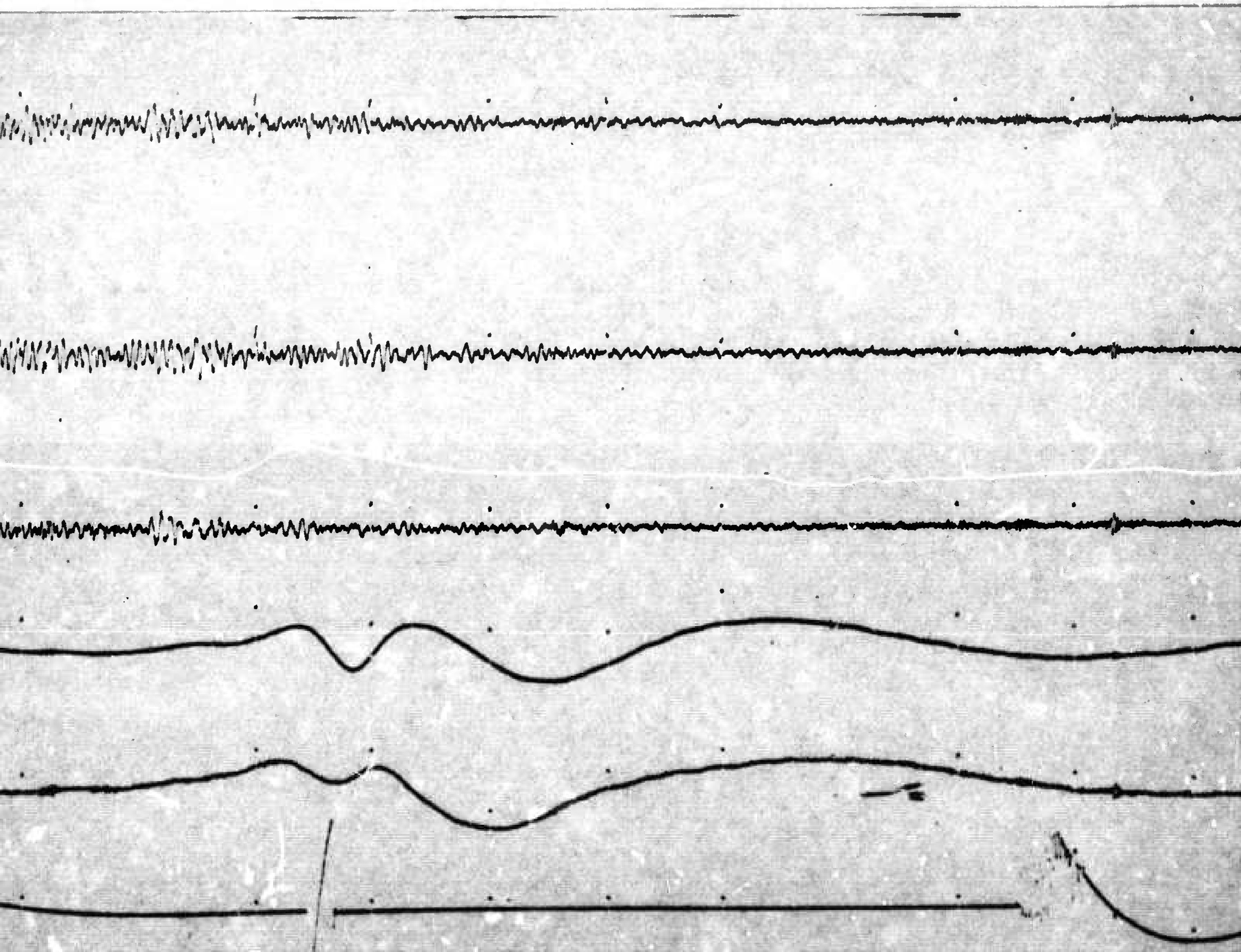
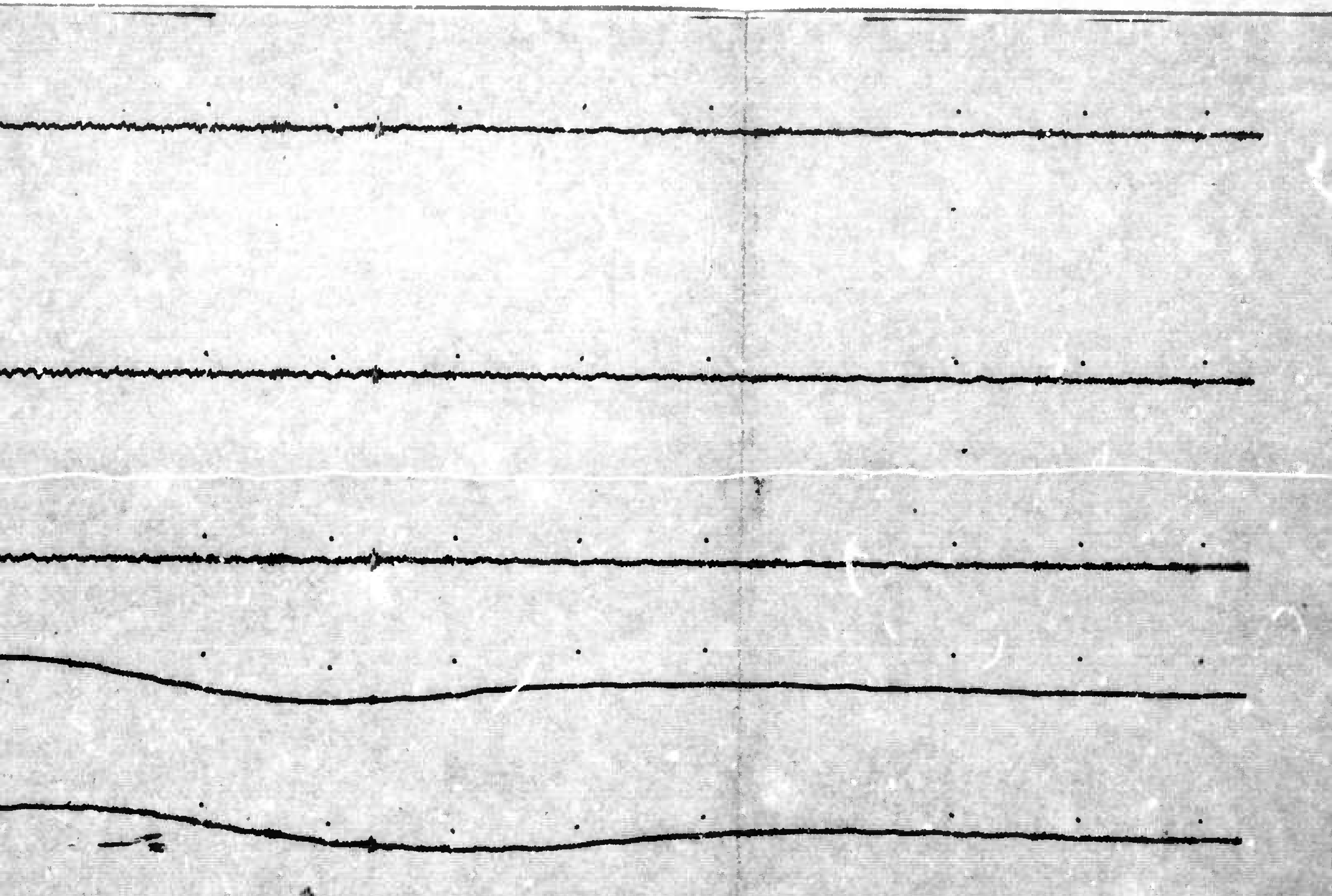
Security Classification

COTCH
N - NV
ng, Nevada
May 1967
= 203 Km







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May 1967
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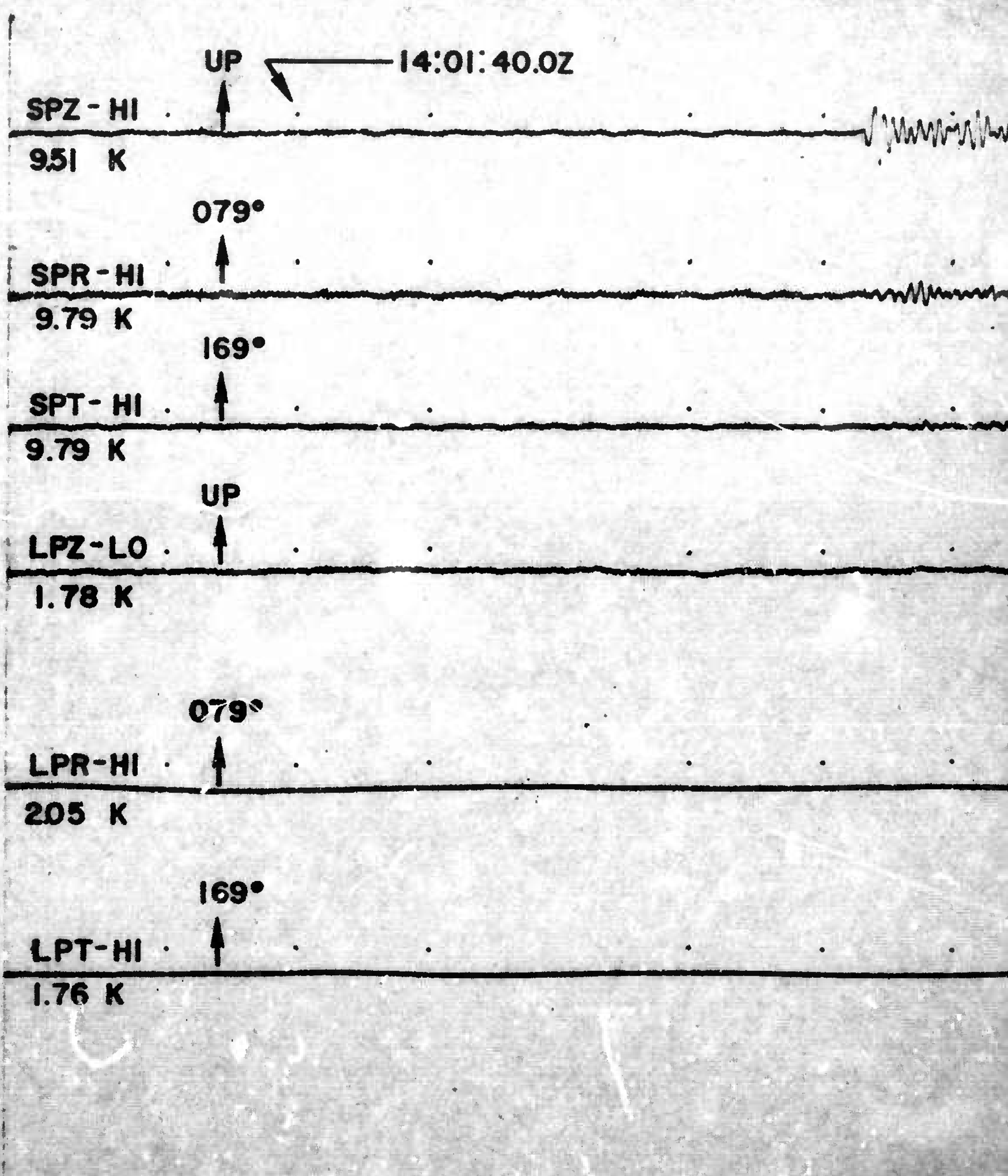

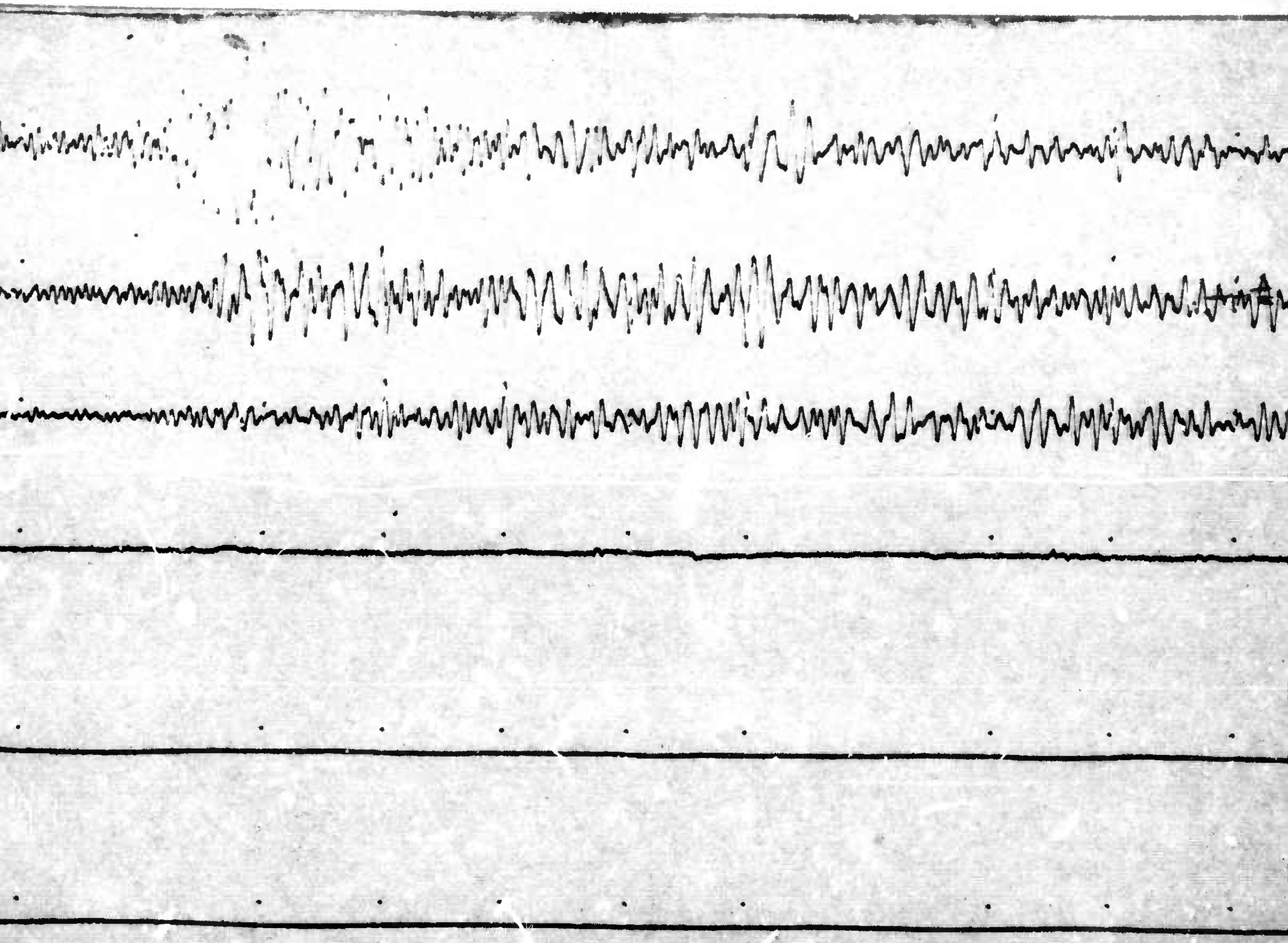

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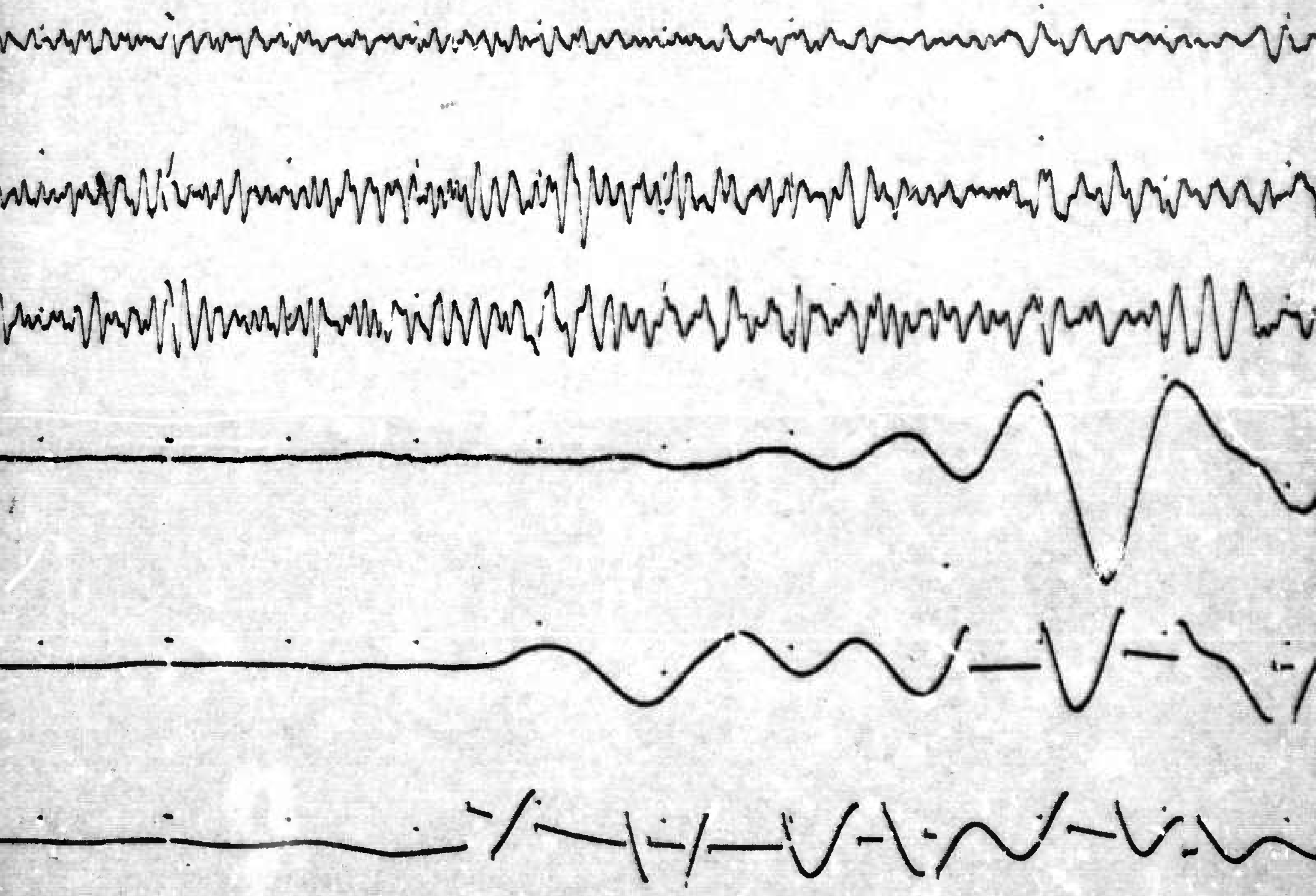

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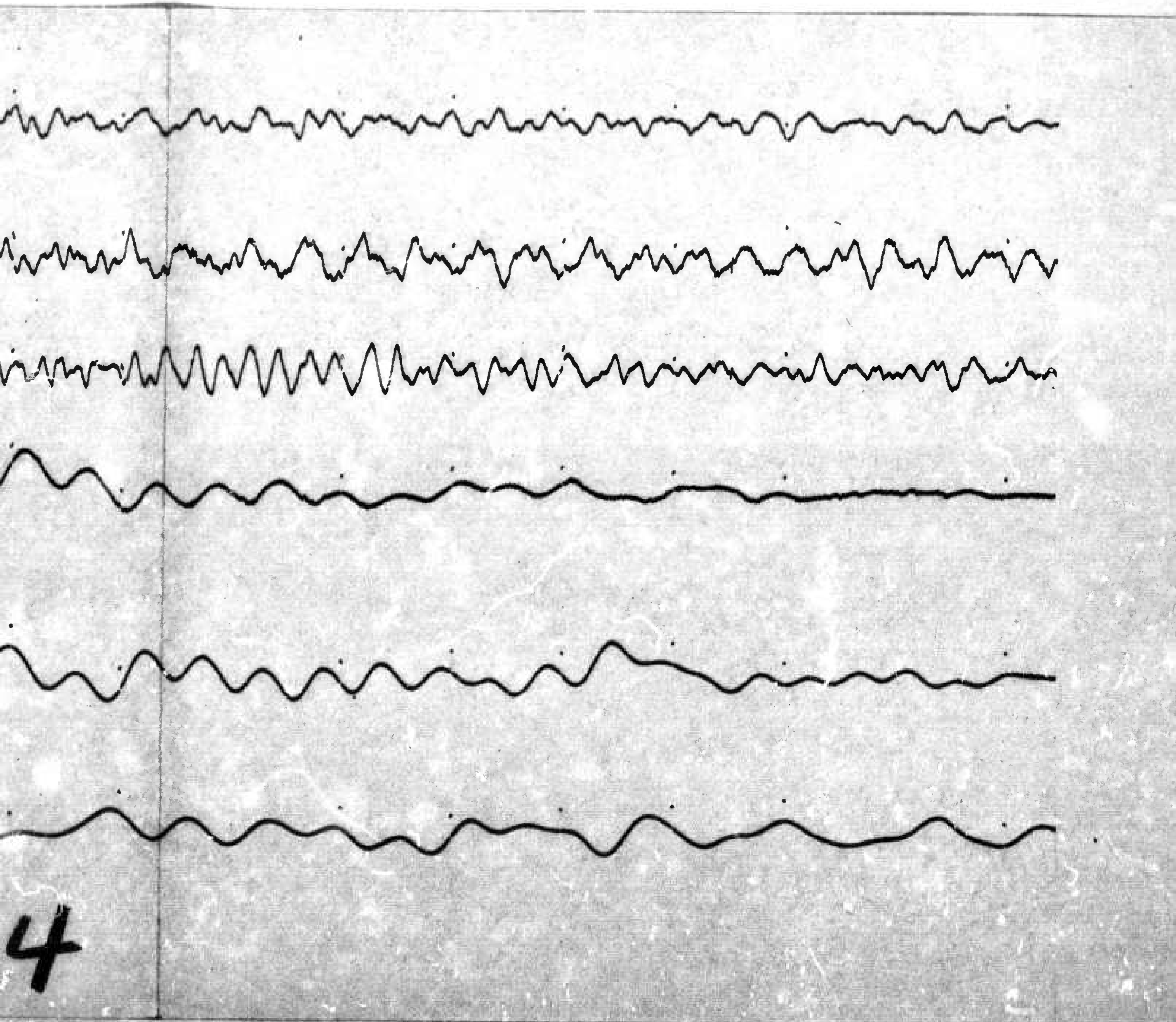

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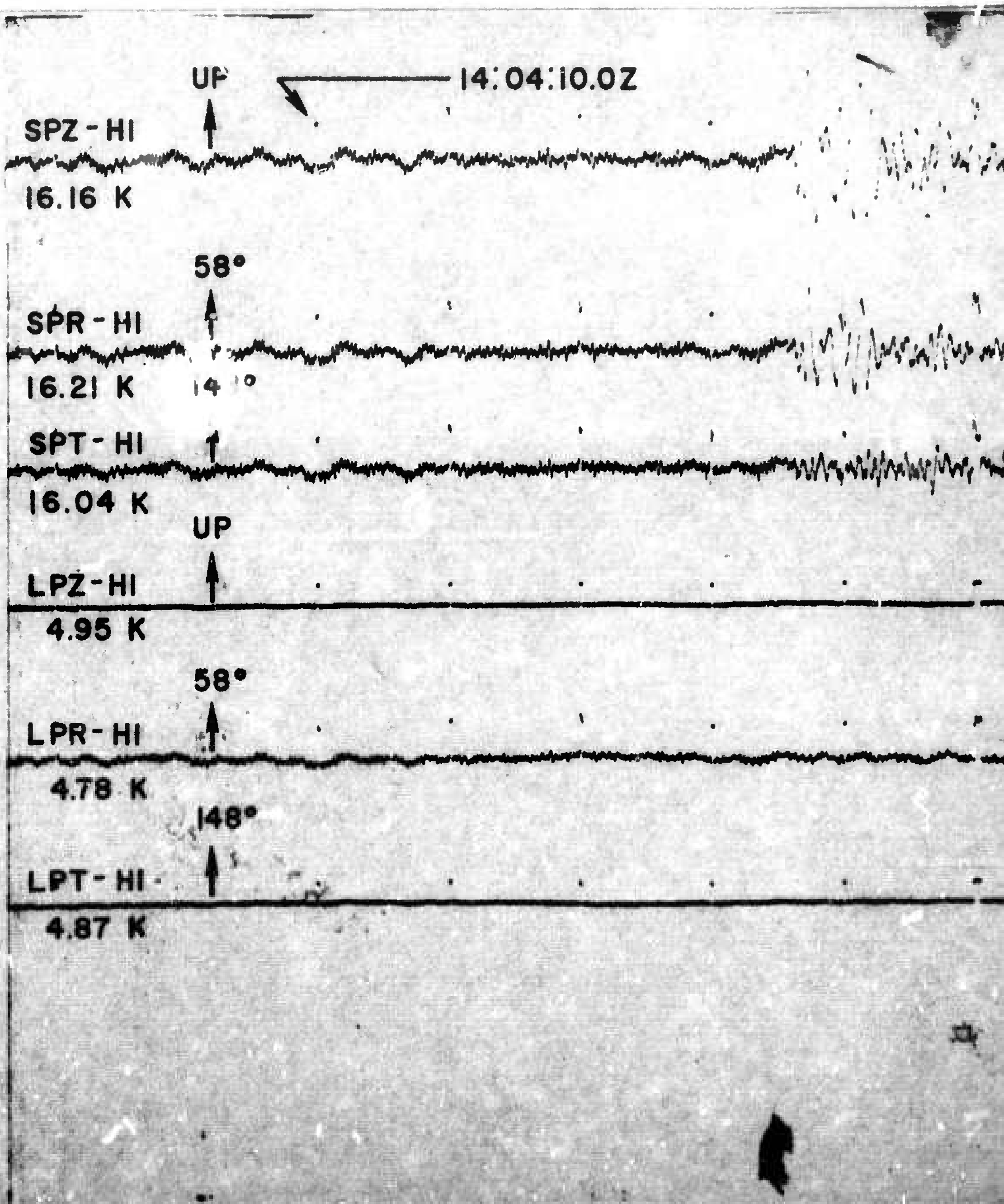
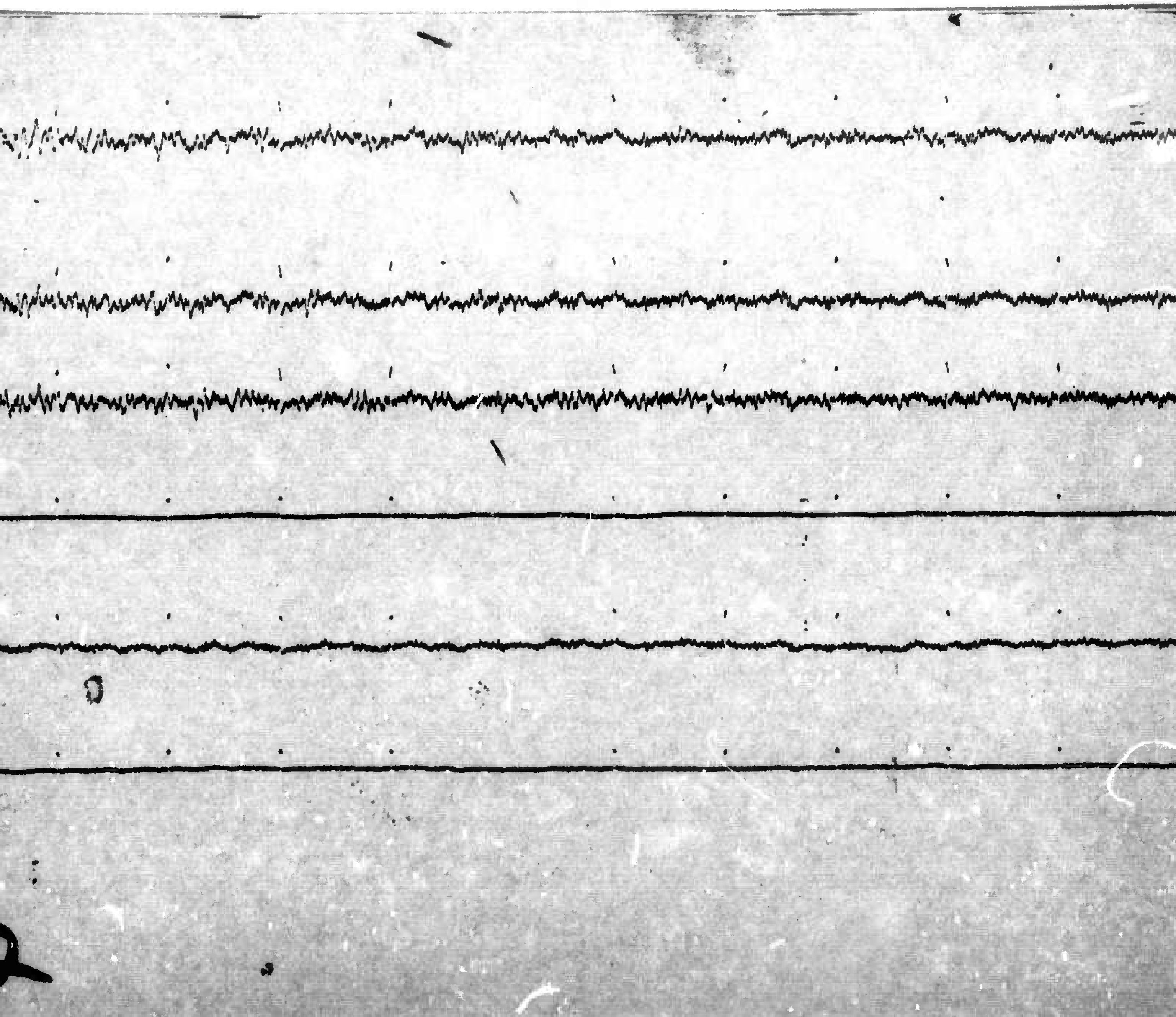
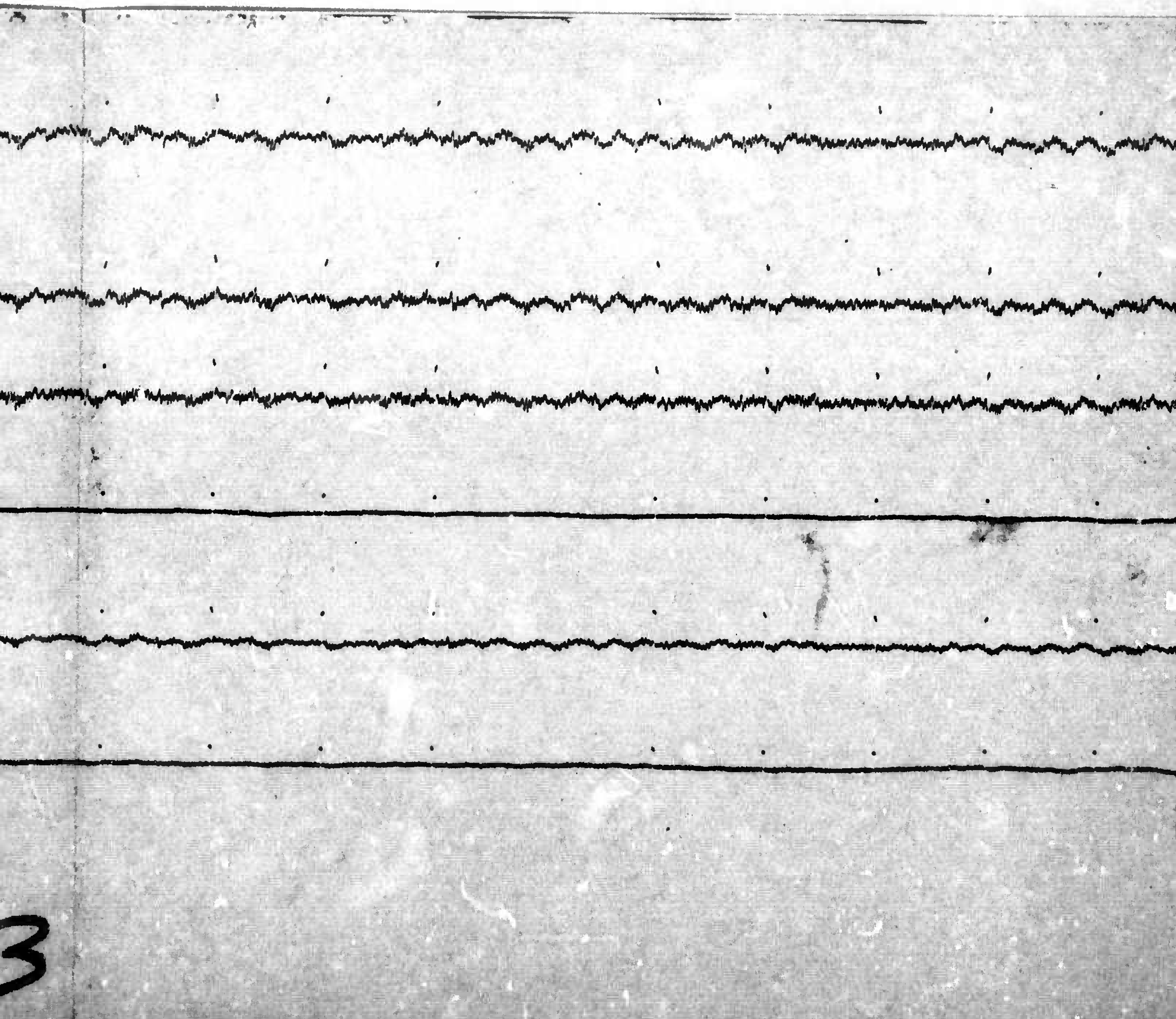
OTCH
ON
LAKE, ONTARIO CANADA
MAY 67
2346 Km



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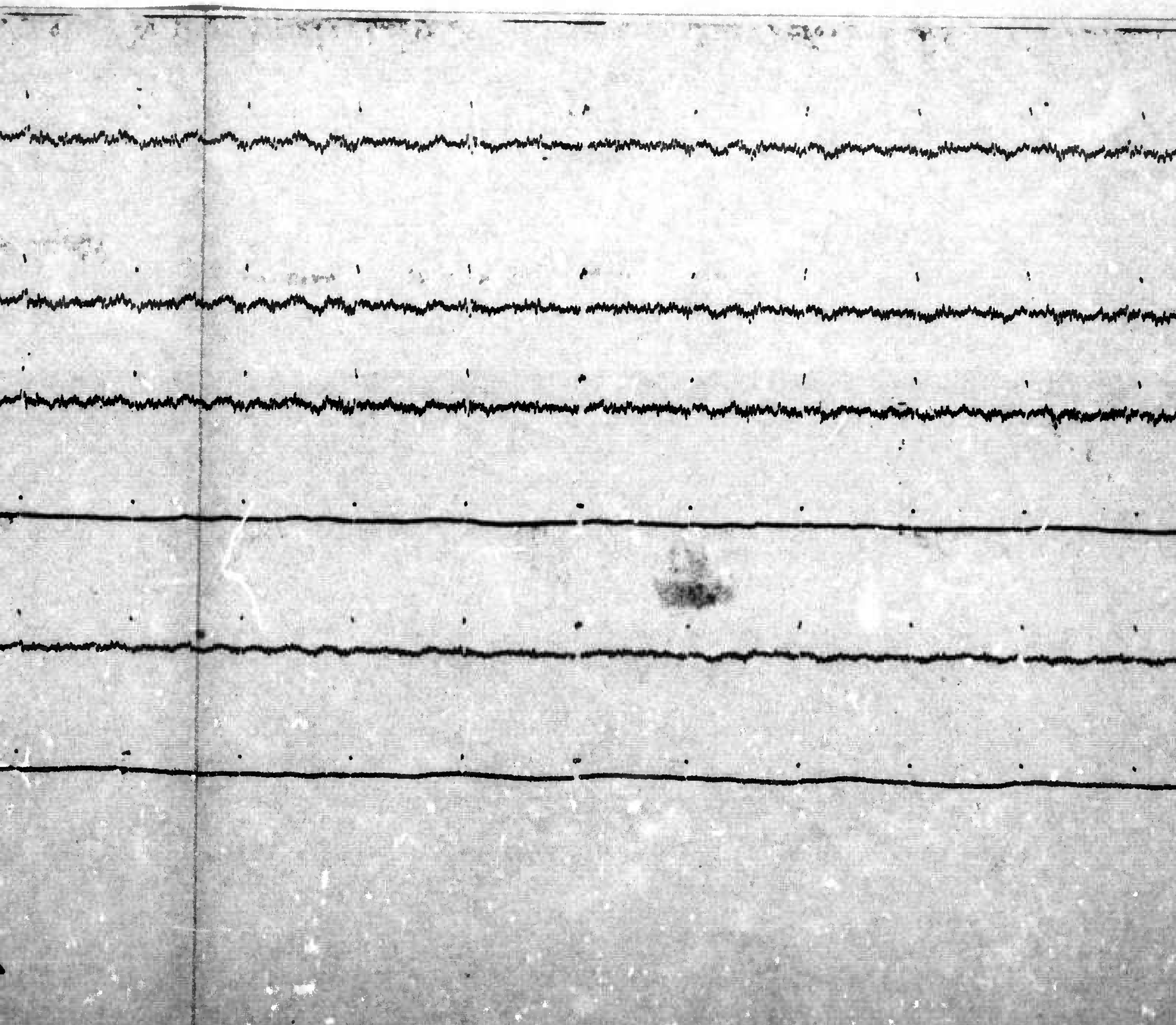

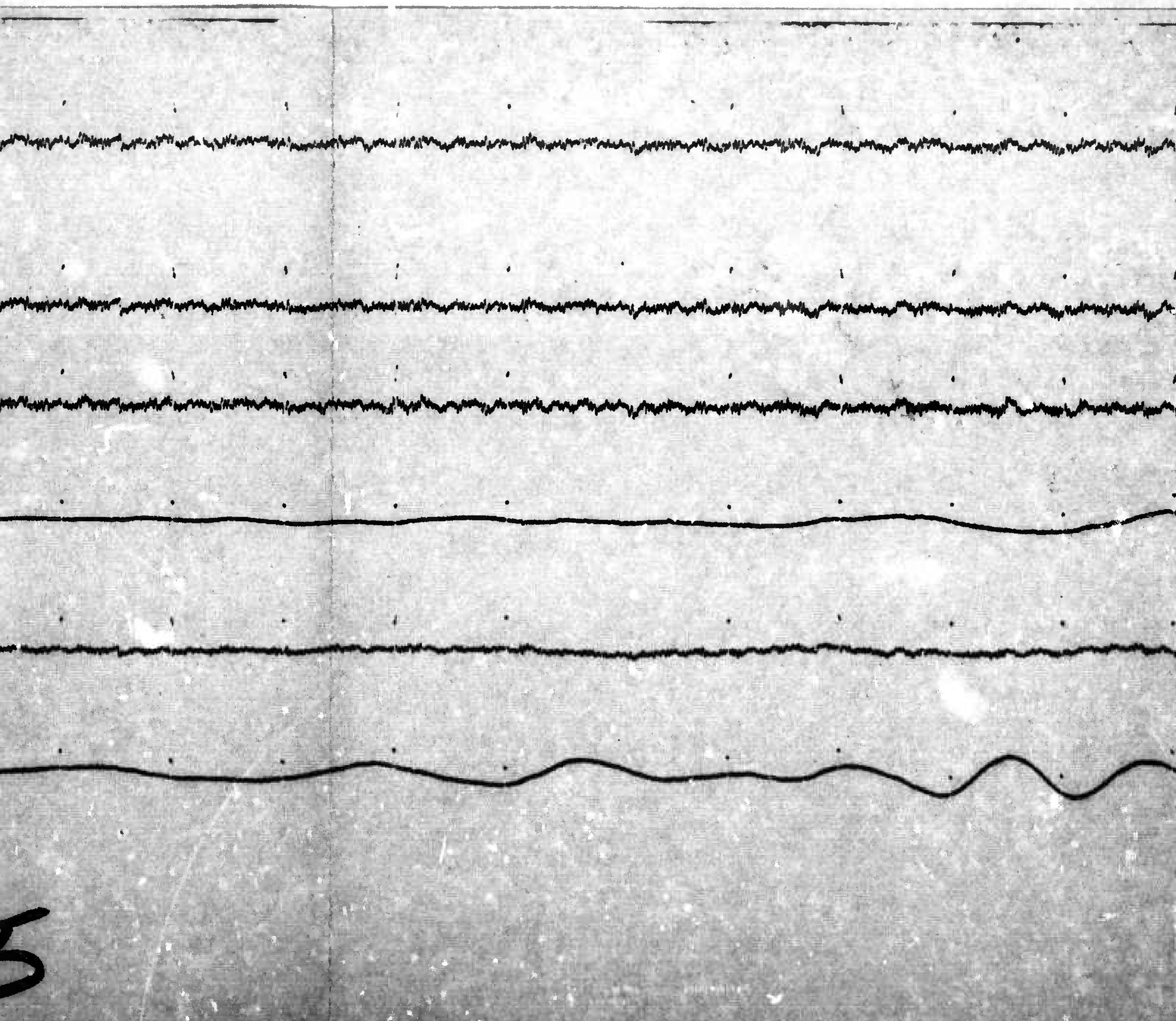
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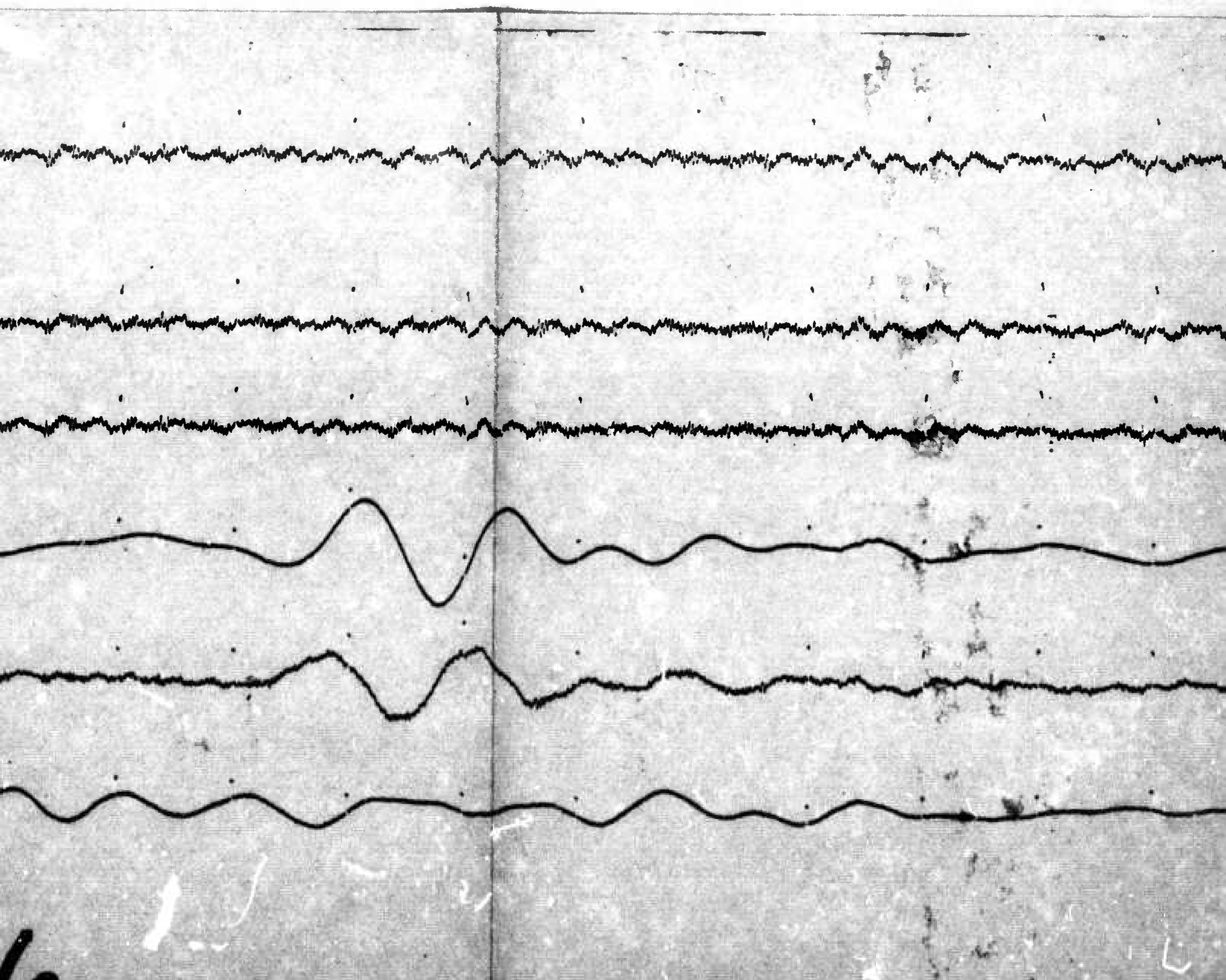

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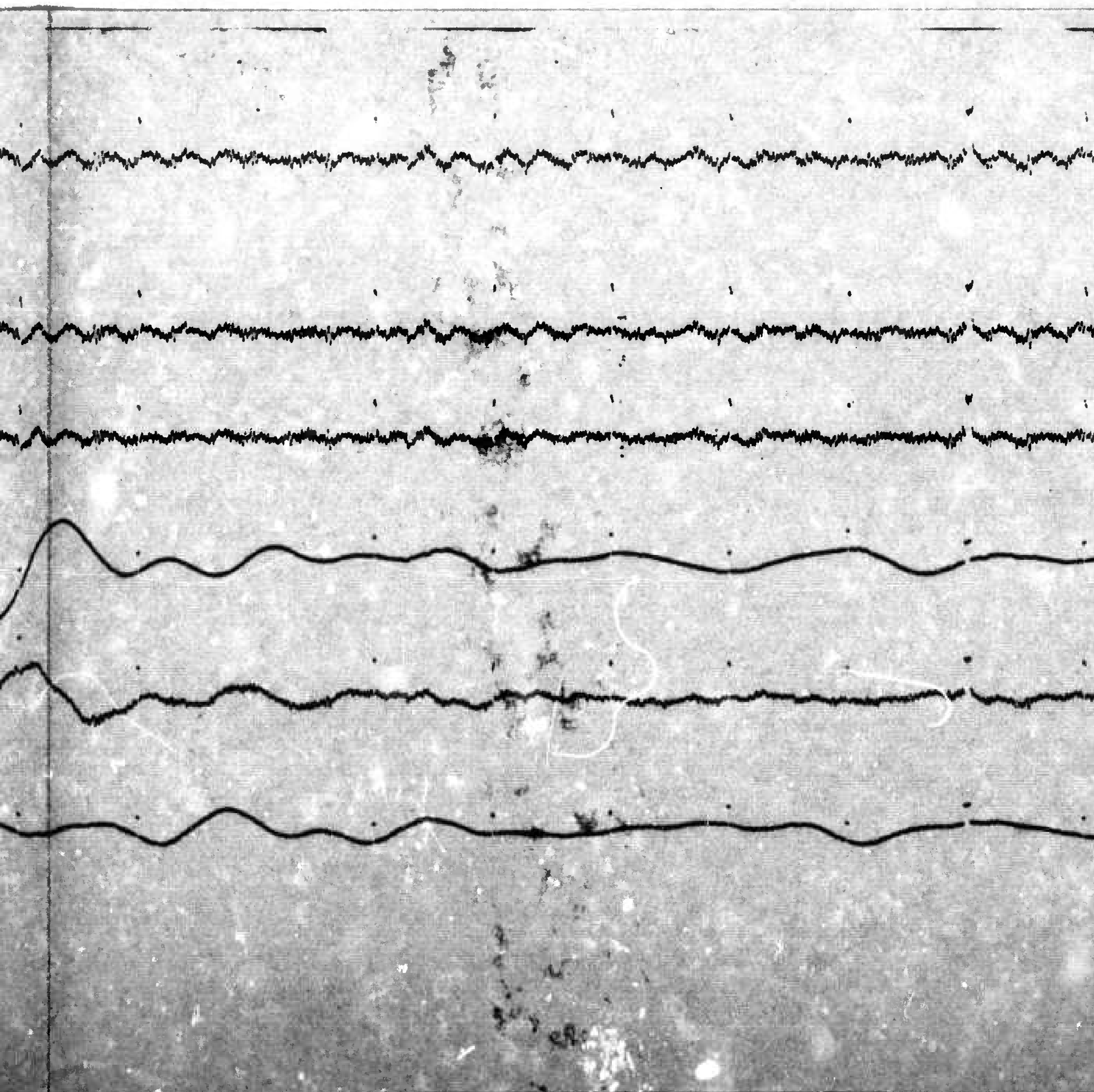

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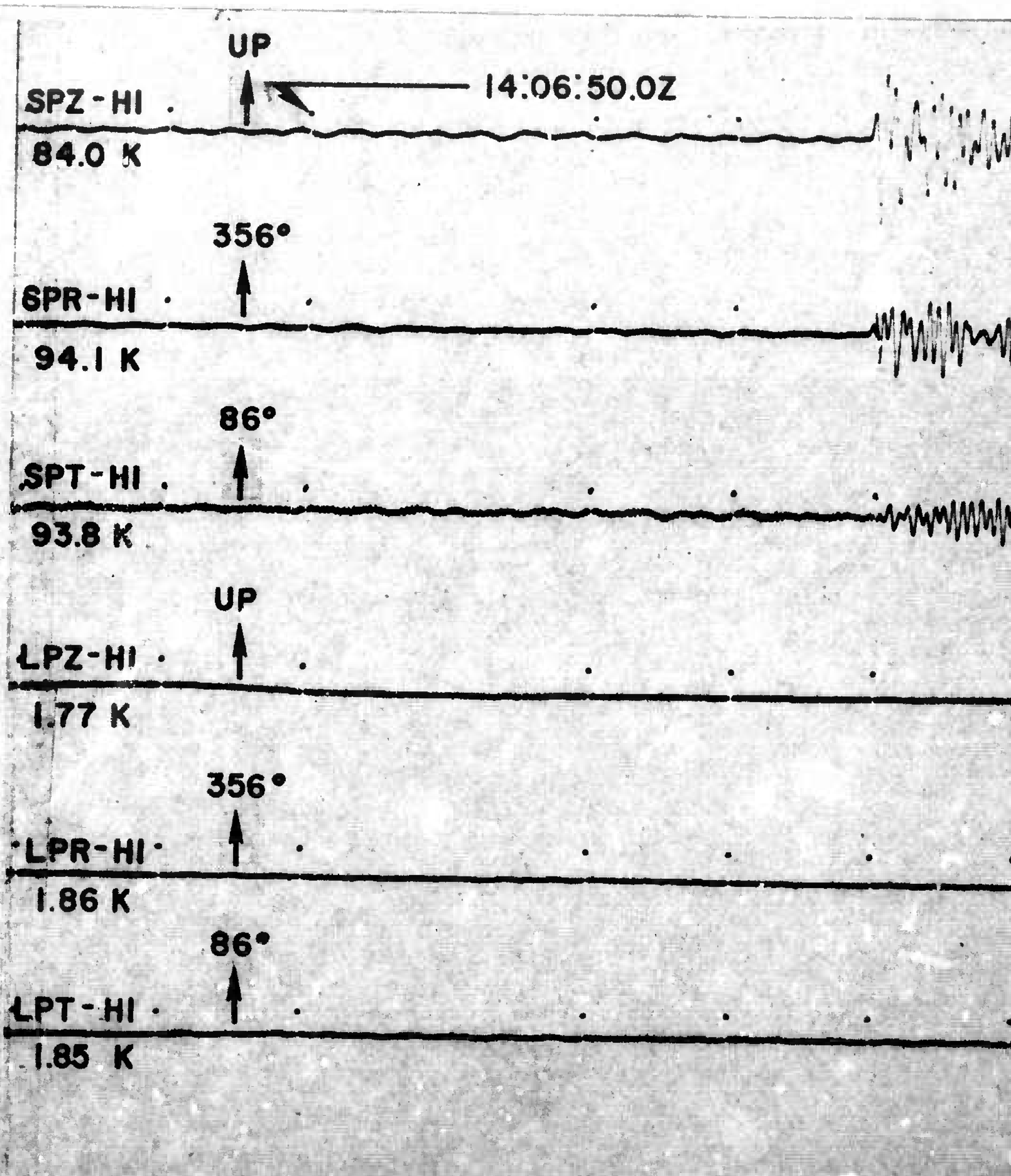
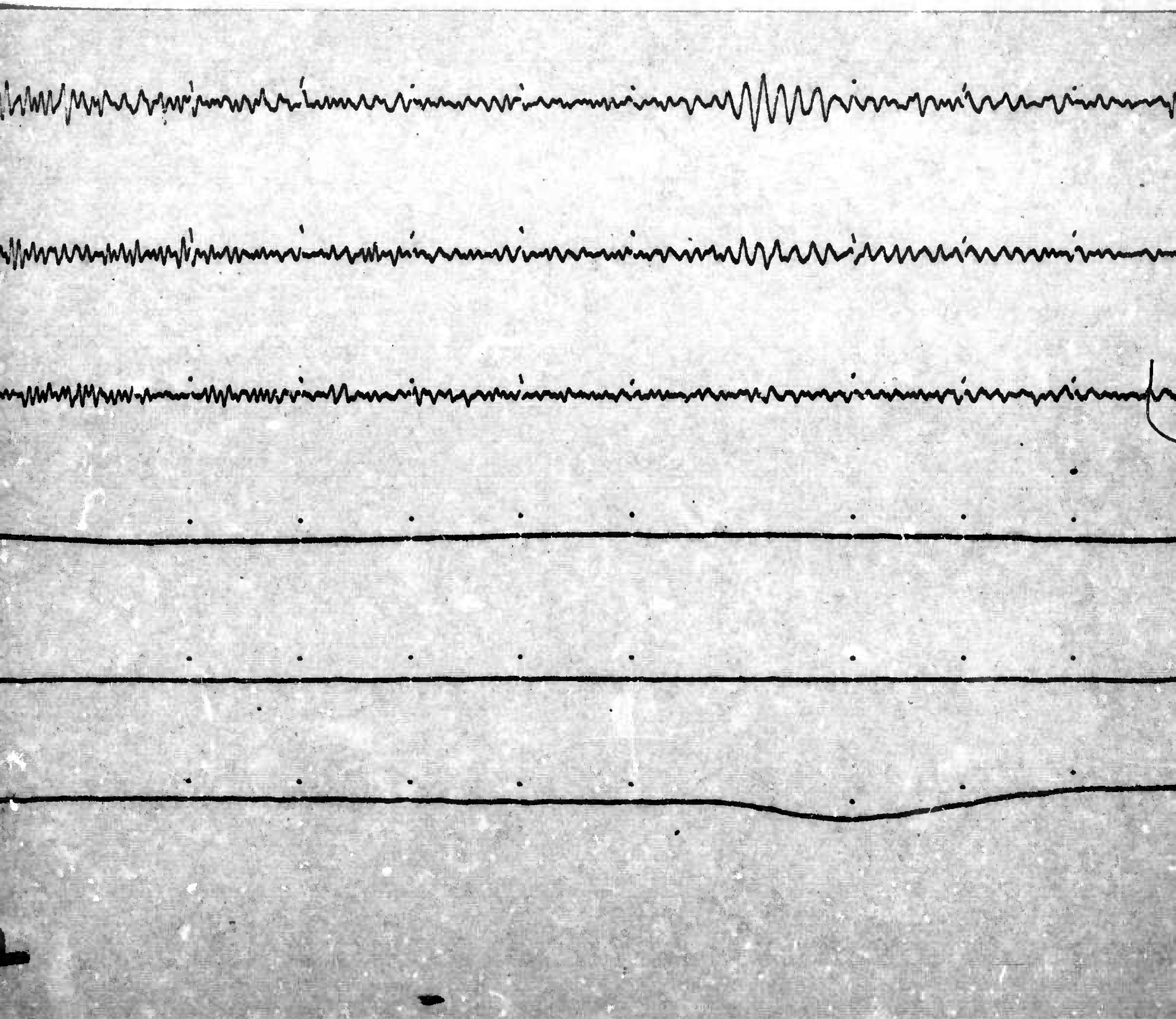
SCOTCH
NP - NT
MOULD BAY, NORTHWEST
TERRITORIES, CANADA
23 MAY 1967
Δ = 4348 Km



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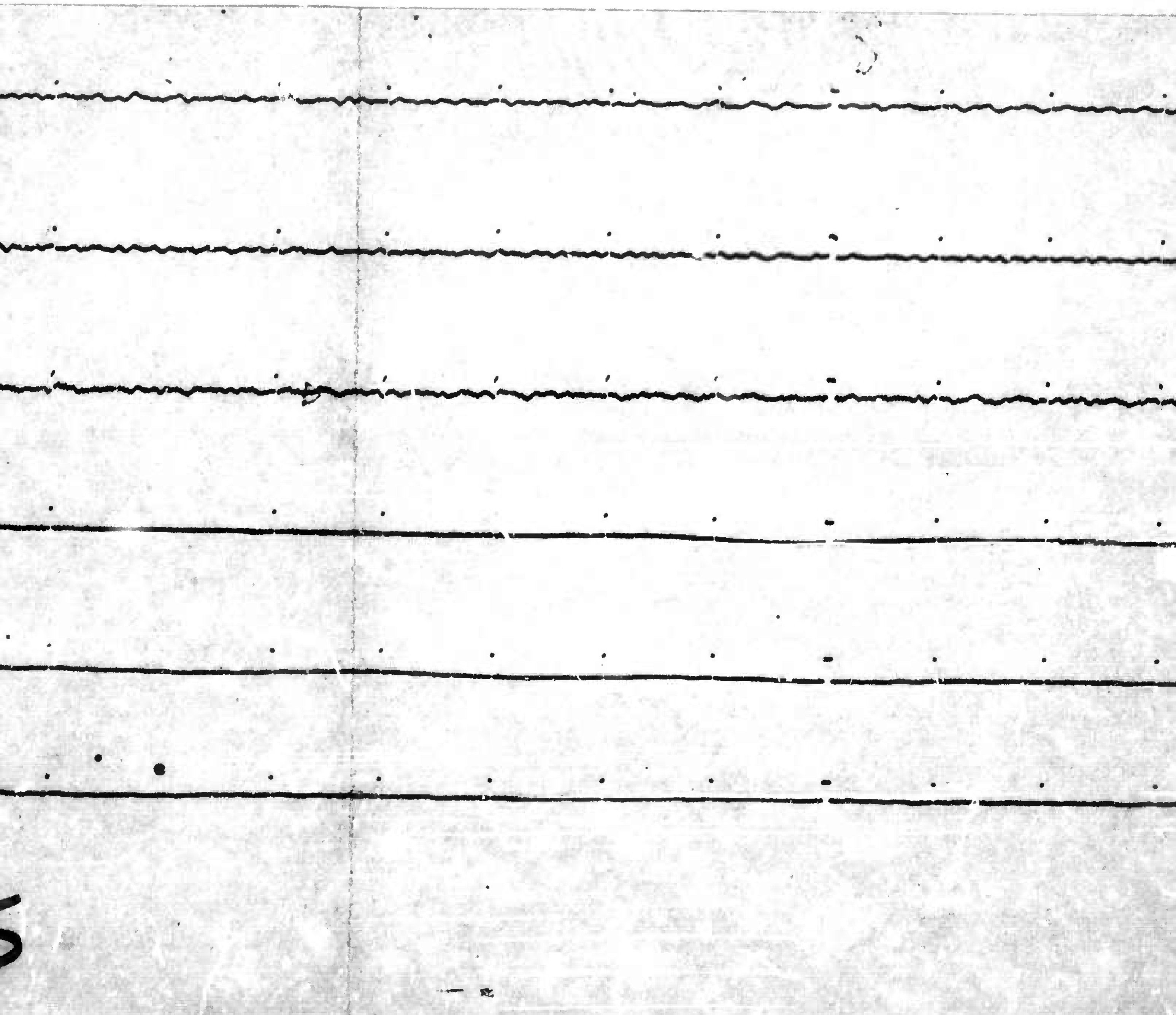

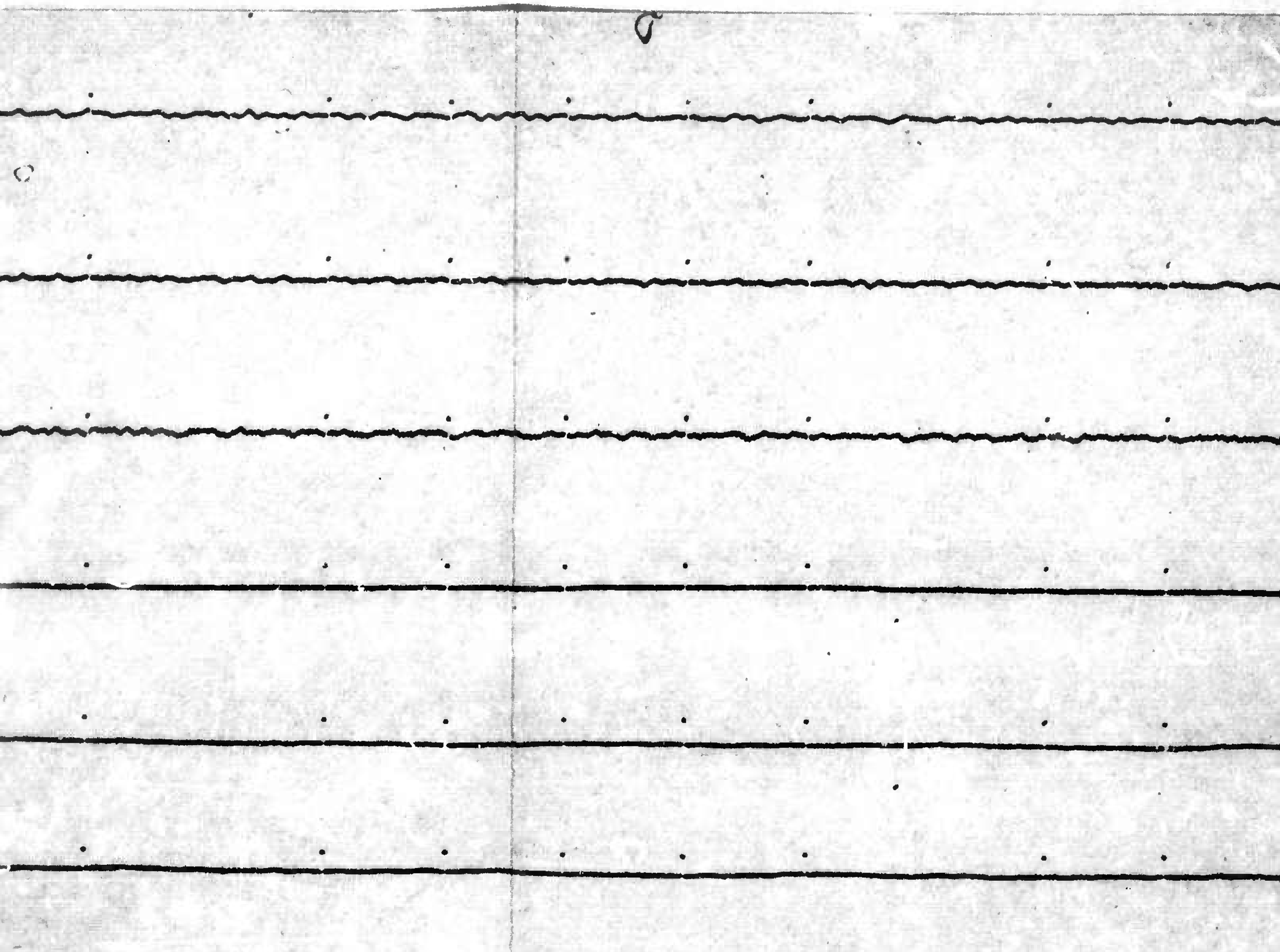

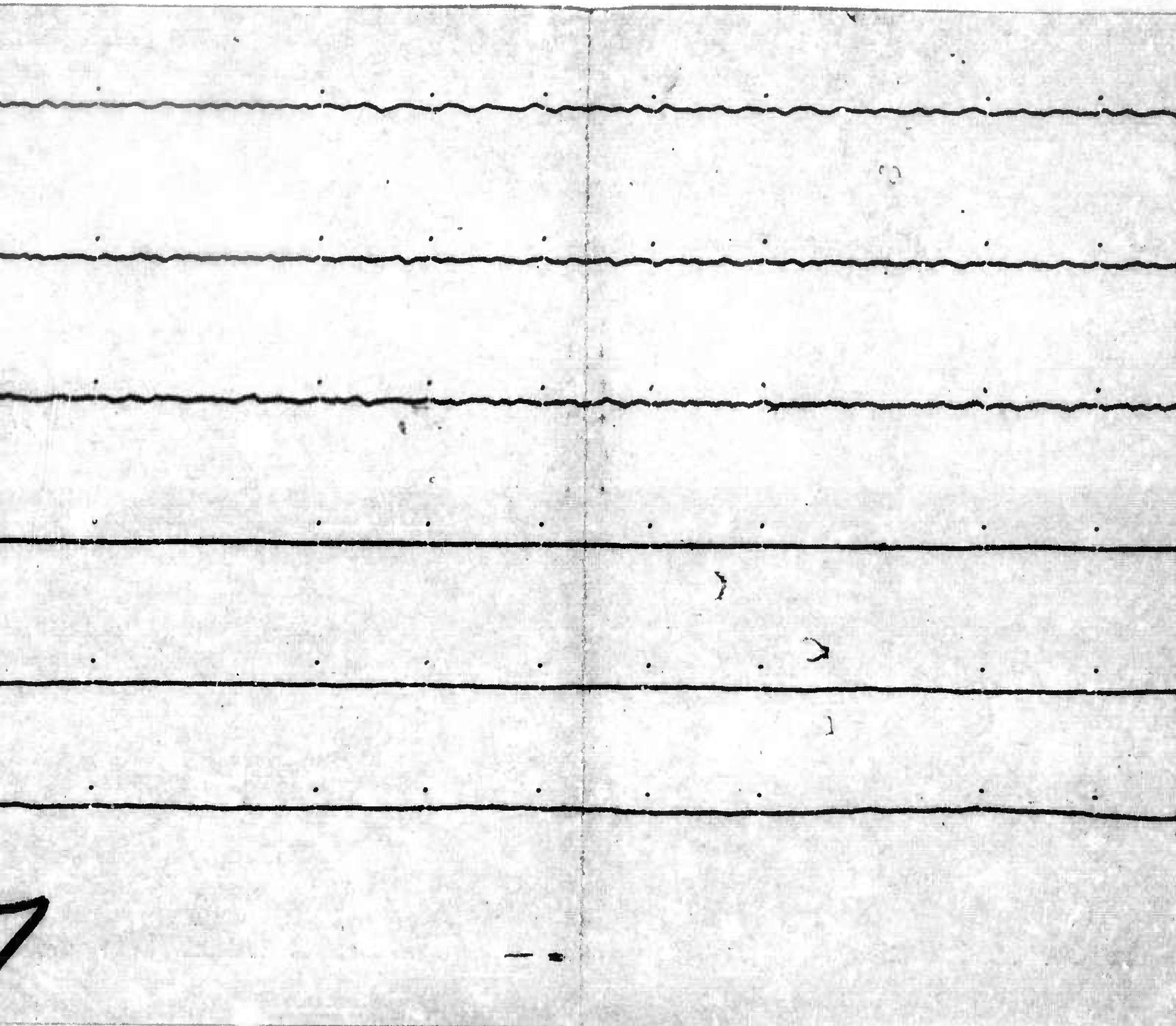

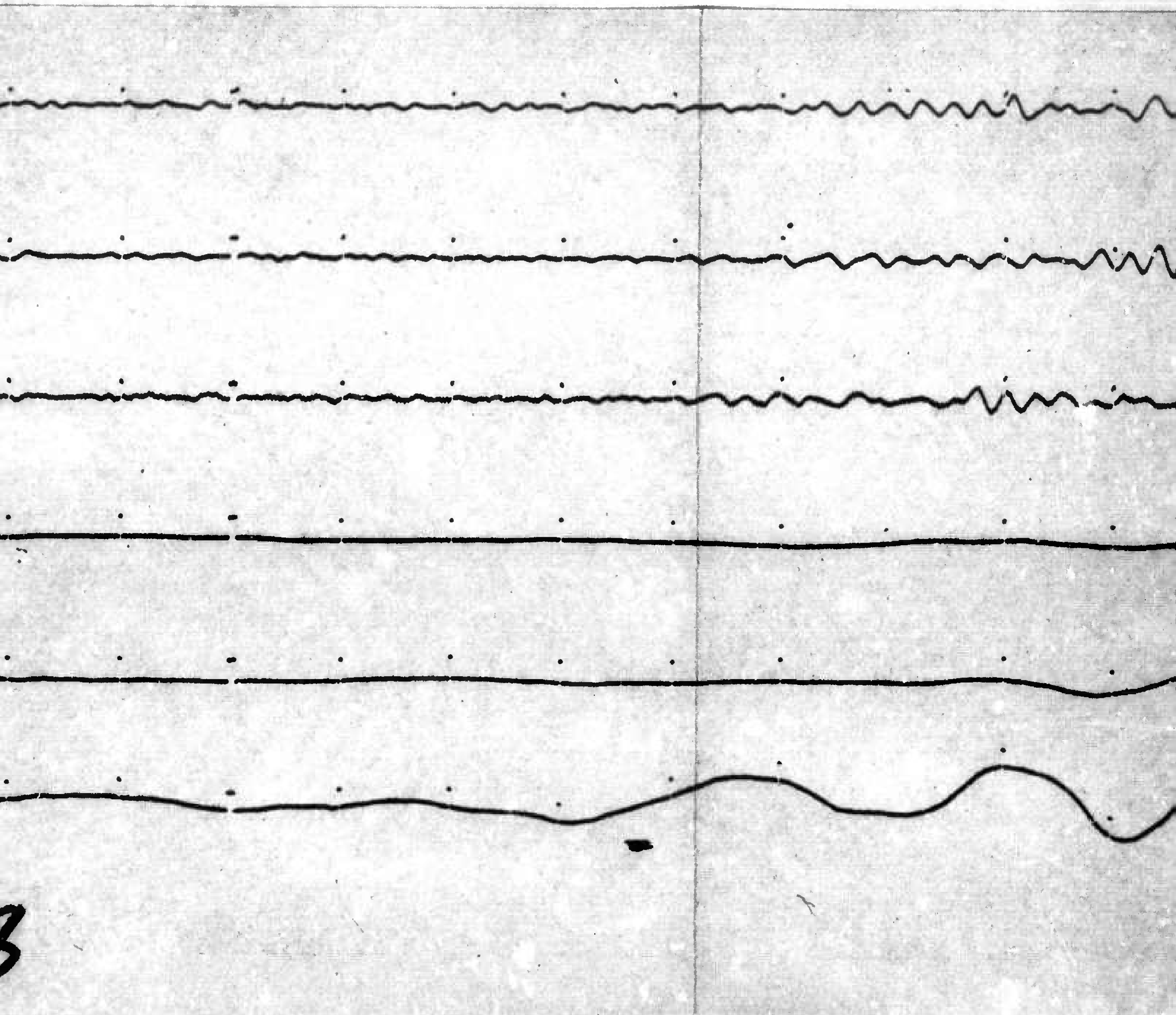
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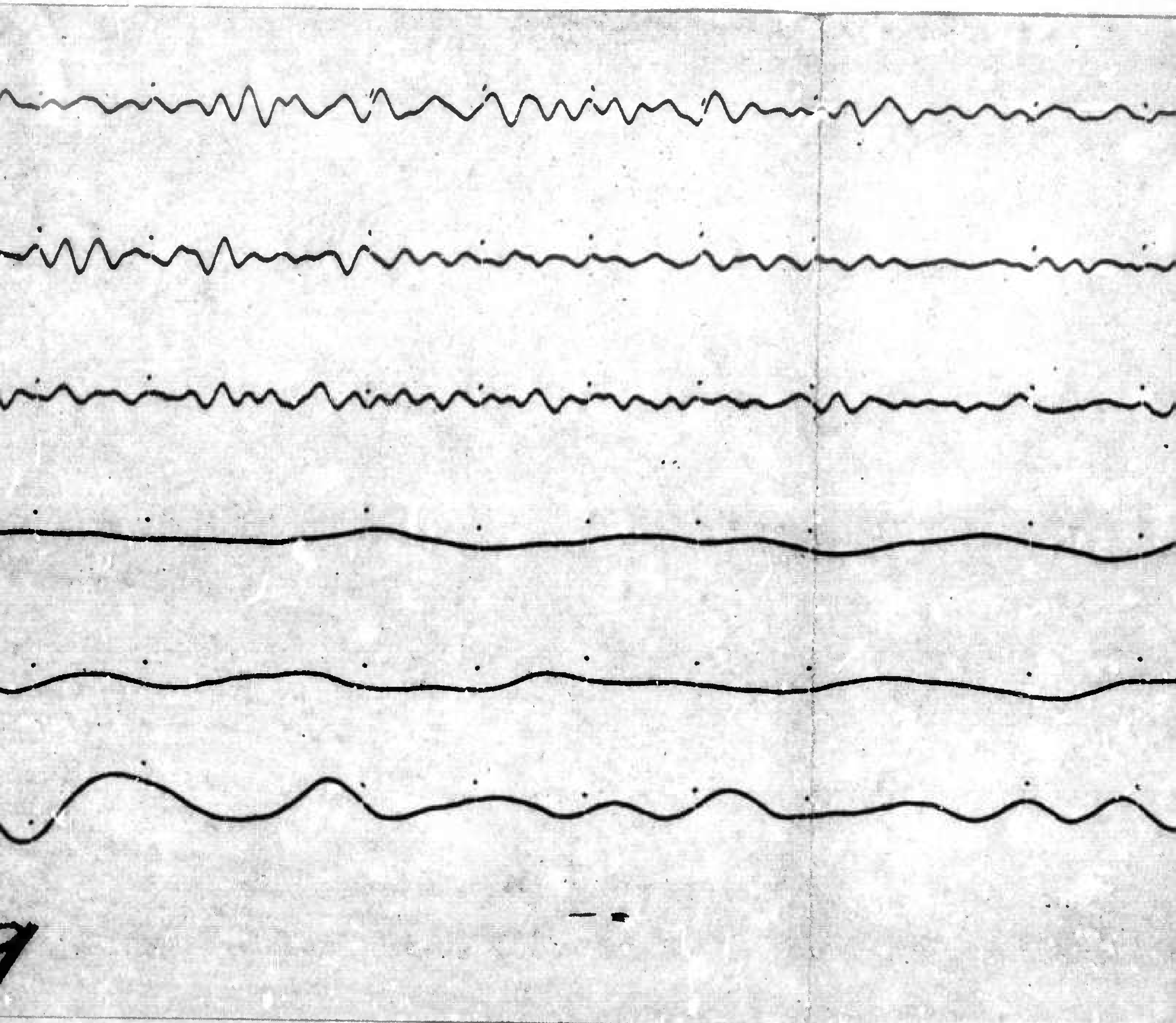

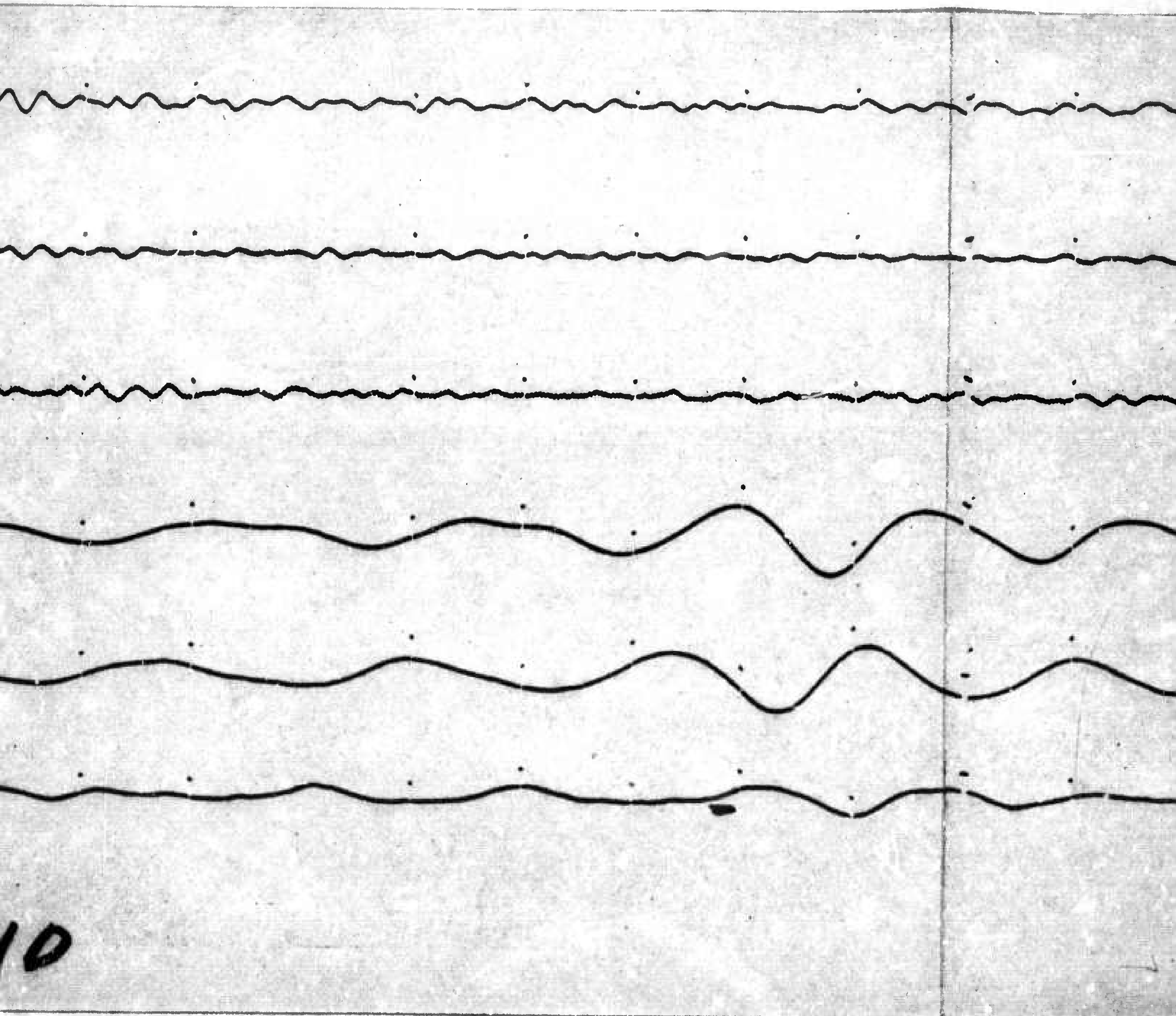

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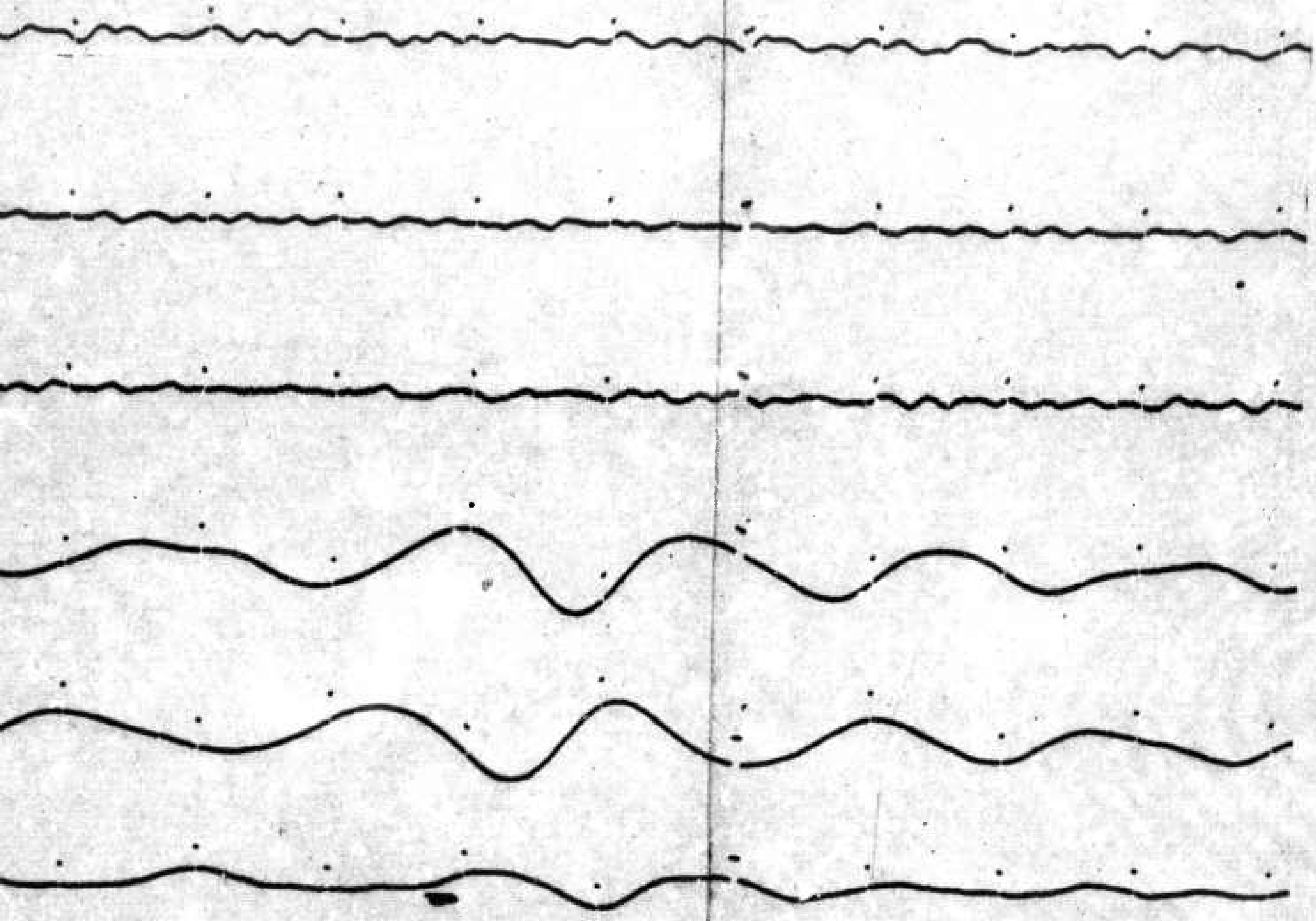

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