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LONG RANGE SEISMIC MEASUREMENTS

FAULTLESS

19 JANUARY 1968

Prepared for

AIR FORCE TECHNICAL APPLICATIONS CENTER

Washington, D. C.

12 APRIL 1968

By

TELEDYNE INDUSTRIES, INC.

Under

Project VELA UNIFORM

Sponsored By

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

LONG RANGE SEISMIC MEASUREMENTS

FAULTLESS

19 January 1968

SEISMIC DATA LABORATORY REPORT NO. 215

AFTAC Project No.:	VELA T/6702
Project Title:	Seismic Data Laboratory
ARPA Order No.:	624
ARPA Program Code No.:	8F10
Name of Contractor:	TELEDYNE INDUSTRIES, INC.
Contract No.:	F 33657-68-C-0945
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P. O. Box 334, Alexandria, Virginia

AVAILABILITY

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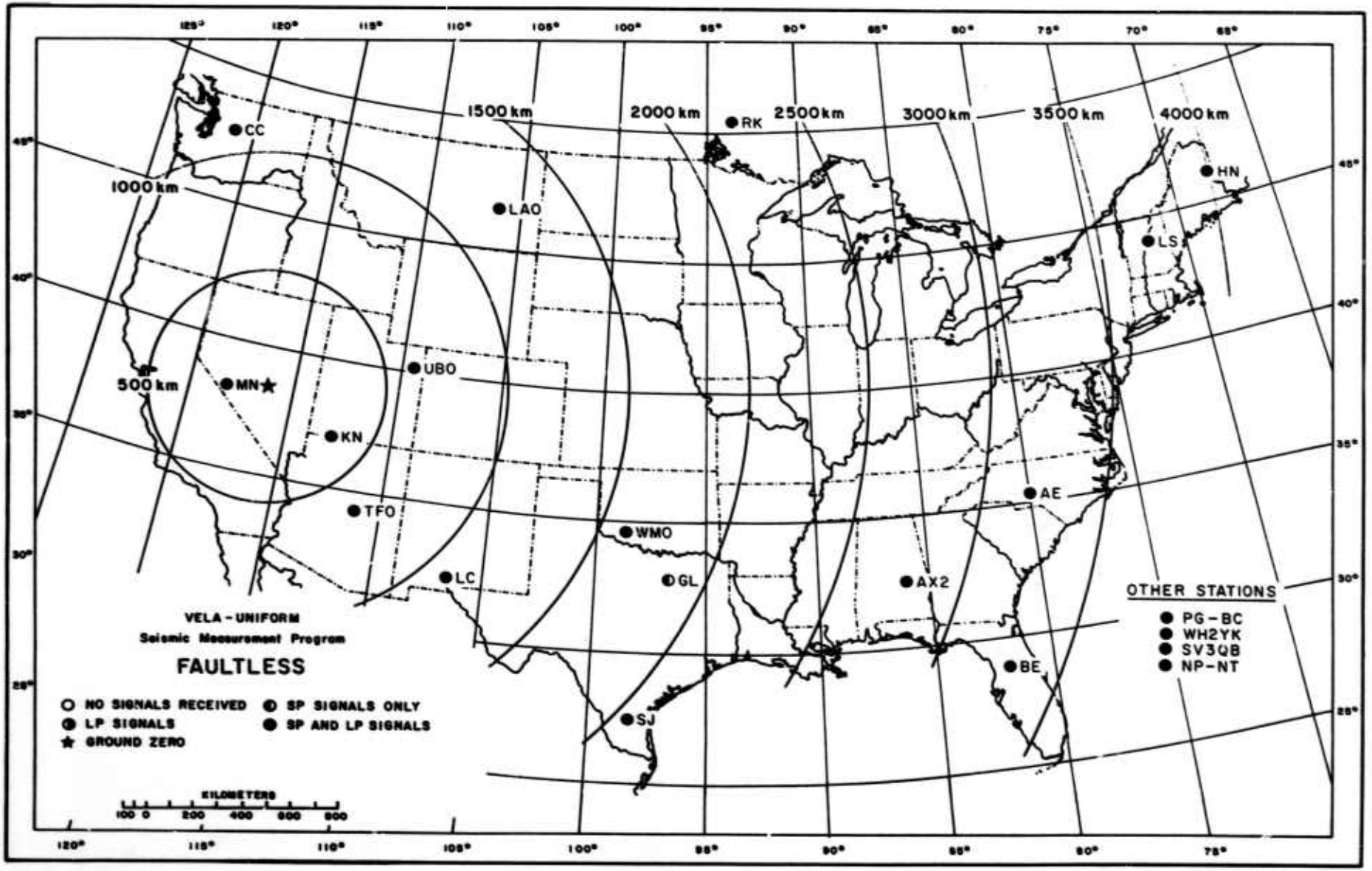
FAULTLESS

EVENT DESCRIPTION

DATE:	19 January 1968	
TIME OF ORIGIN:	18:15:00.1Z	
YIELD:		
MAGNITUDE: UNIFIED:	6.51 ± 0.46	
ADJUSTED:	6.25 ± 0.23	
LOCATION:		
SITE:	Central Nevada Supplemental Test Site UC-1	
	GEOGRAPHIC COORDINATES:	
	Latitude:	38° 38' 03.0" N
	Longitude:	116° 12' 55.0" W
ENVIRONMENT:	GEOLOGIC MEDIMUM:	Tuff (water saturated)
	SURFACE ELEVATION:	6104 ft.
	SHOT ELEVATION:	2904 ft.
	SHOT DEPTH:	3200 ft.
COMPUTED EPICENTER:	ALL STATIONS	
LOCATE: (Herrin 61 Surface)	GEOGRAPHIC COORDINATES:	
	Latitude:	38° 36' 46.8" N
	Longitude:	116° 15' 36.0" W
	TIME OF ORIGIN:	18:15:01.6Z
	DEPTH CONSTRAINED TO:	0 km.
	EPICENTER SHIFT:	3.4 km S 46° W
HYPO I (Herrin 66 Surface)	GEOGRAPHIC COORDINATES:	
	Latitude:	38° 37' 48.0" N
	Longitude:	116 13' 12.0" W
	TIME OF ORIGIN:	18:15:02.2Z
	DEPTH CONSTRAINED TO:	0 km.



Recording Stations and Signals Received

Figure 1

INTRODUCTION

A long range seismic measurement (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 FAULTLESS 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 Table 4. 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) of the BOURBON shot report, SDL Report No. 186, available from DDC as AD 816273.

The procedures used in measuring amplitudes and the unified magnitude are shown in Appendices II(A) and I(B), respectively, of the BOURBON shot report. The distance factors (B) beyond 16° are from Gutenberg and Richter*. For distance less than 16° values were read from a curve in the Gutenberg and Richter paper

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

back to 10° and then extrapolated to 2°, using an inverse cube relationship. An additional magnitude for less than 16° was computed using a method described by Evernden *. (Figure 3)

A standard hypocenter location program for a digital computer was used to determine the location using data from all stations analyzed. 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. An additional location was made using a program called HYPO I. 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. These methods are based on P-wave arrivals with depth constrained to zero.

DATA AND RESULTS (LRSM AND VELA OBSERVATORIES)

The parameters of the FAULTLESS event and a summary of the seismic evaluation is shown on the Event Description page. The operational status of the 20 LRSM stations and observatories is given in Table 1, and illustrated in Figure 1.

Table 2 summarizes the measurements made of the principal phases from the FAULTLESS event at the LRSM and VELA stations. Included are the Pn and P arrival times, the maximum amplitudes (A/T) of the Pn and P motion and other phases as seen on the short-period instruments. Long-period Love and Rayleigh wave

* 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.

motion are also tabulated in (A/T) form. In addition, the individual station Rayleigh wave areas (mm^2) are indicated as measured on the LPZ only. Although reduced to 1K magnification, they have not been normalized to any magnitude. Twenty stations recorded short-period signals. Long-period signals were recorded by nineteen stations.

The unified magnitudes determined from the LRSM and VELA observatories are shown in Figure 2. The average magnitude is 6.51 ± 0.46. The adjusted unified magnitude is 6.25 ± 0.23.

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 FAULTLESS was NP-NT at a distance of 4197 kilometers.

CODE	STATION	DISTANCE (KM)	INST.	MAGNIFICATION (G) PEAK @ 10	PHASE	TRAVEL TIME OBSERVED (H:M:S)		TRAVEL TIME COMPUTED (J-B) (H:M:S)		PERIOD T (SEC)	MAXIMUM AMPLITUDE A/T	MAGNITUDE - 1906 mb	MAGNITUDE - (m) me	AREA (cm^2) LP3
						(MIN)	(SEC)	(MIN)	(SEC)					
NE-NV	Mina, Nevada	170	SP6	8.66	Pn	0	40.4	0	28.79	(0.4)	(36,838)	(6.39)	(6.16)	
			SP6		Pg	0	59.1			---	---			
			SPT	0.27	Lg					1.0	(142,667)			
			LPT		LQ					---	---			
			LP3		LR					---	---			
KA-UT	Kanab, Utah	346	SP3	0.516	Pn	0	50.5	0	51.72	(0.6)	(6030)	(6.64)	(6.37)	
			SP3	0.516	e	0	62.3			(1.0)	(10,135)			
			SPZ	0.197*	Pg	0	(66.3)			0.6	100,543			
			SPT	0.069*	Lg					0.6	(83,267)			
			LPT		LQ					---	---			
			LP3		LR					---	---			---
UTSO	Utah Basin Seismological Observatory, Utah	602	SP3-10	0.94	Pn	1	26.2	1	24.11	(1.3)	(12,241)	(7.67)	(6.36)	
			SPZ-10		Pg	1	(42.1)			---	---			
			SP6	0.96*	Lg					1.4	(14,141)			
			SPB		LQ					---	---			
			LP6	1.0	LQ					(12.0)	(666)			
			LPB	1.1	LQ					(19.0)	(1131)			
			LPZ		LR					---	---			---
TFSO	Texas Forest Seismological Observatory, Arizona	455	SPZ-80	5.6	Pn	1	(30.1)	1	30.66	(0.6)	(566)	(6.33)	(6.15)	
			SPZ-80	6.2	Pg	1	52.5			(1.0)	(4648)			
			SP6	1.1	Lg					1.7	3919			
			SP6	1.1	LQ					1.7	5630			
			LPB		LQ					---	---			
			LP6		LQ					---	---			
			LPZ		LR					---	---			---
CC-WA	Cascade Tunnel, Washington	1068	SP3	2.6	Pn	2	26.2	2	25.13	1.1	2214	7.62	6.16	
			SP3	2.6	e	2	26.7			1.3	3069			
			SPZ	2.6	e	2	35.3			1.0	1607			
			SP3	2.8	Pg	3	(11.9)			1.2	2846			
			SPT	19.1	Lg					1.4	1723			
			LPT		LQ					---	---			
			LP2		LR					---	---			
LC-NM	Los Cruces, New Mexico	1112	SPZ	21.8	Pn	2	30.3	2	26.17	1.25	2246	7.65	6.16	
			SP3	21.9	e	2	42.9			1.1	281			
			SP3	15.6*	Pg	3	06.8			1.2	2204			
			SPT	20.8	Lg					1.6	2656			
			LPT	20.4	LQ					22.0	(259)			
			LP3	2.29	LR					19.0	1039			1896.69
LRO	Suherray, AO-10, Footeee	1212	SPZ		Pn	2	36.7	2	40.34	**	**			
			LPB		LQ					**	**			
			LP6		LQ					**	**			
			LPZ		LR					**	**			**
MRSO	Richite Meteotes Seismological Observatory, Oklahoma	1632	SPZ-6	29.6	P	3	28.6	3	30.76	1.4	893	5.36	8.10	
			SP3-6	2.6	e	3	37.6			1.4	6231			
			SPZ-6	2.6	Pg	4	38.3			1.4	2297			
			LP6	9.5	S	6	24			(16.0)	(58.0)			
			SPE	2.6	Lg					2.0	1736			
			SP6	2.5	Lg					2.0	2778			
			LP6		LQ					---	---			
			LPZ		LR					---	---			---
PG-BC	Prince George, British Columbia, Canada	1777	SPZ	25.7	P	3	46.6	3	47.49	1.2	2194	6.26	6.57	
			SPZ	26.7	e	3	52.9			1.3	3143			
			SPZ	26.7	e	4	36.9			1.4	618			
			SP6	20.4	Lg					2.0	600			
			SPT	26.1	Lg					2.1	996			
			LP6	7.13*	LQ					(16.0)	(702)			
			LPT	[illegible]	LQ					(16.0)	(612)			
			LP3	1.64	LR					(14.0)	(1663)			1576.27
GL-TX	Garland, Texas	1674	SPZ	19.5	P	3	57.6	3	56.61	1.4	1061	6.93		
			SPZ	4.26	e	4	(00.3)			1.3	1630			
			SPZ	4.26	Pg	5	(10.3)			1.3	2665			
			SPT	3.75	Lg					1.6	3904			
SJ-TX	San Jose, Texas	2054	SPZ	8.9	P	4	21.9	4	20.11	(1.6)	(1102)	(6.00)		
			SPZ	26.0	e	4	27.4			1.3	966			
			BPZ	6.0	e	4	34.9			1.4	940			
			SPT	26.0	Lg					2.6	2446			
			LPT	.46	LQ					14.0	2040			
			LP3	.56	LR					14.6	2613			2529.61
GG-OO	Gas Lake, Ontario, Canada	2226	SP3	32.6	P	4	33.9	4	37.32	1.2	601	5.90		
			SP3	32.6	e	4	36.3			1.6	1076			
			SP3	32.6	e	4	36.1			1.2	2003			
			SPZ	32.6	e	4	46.6			1.35	1099			
			SPZ	32.6	PP	4	57.0			1.2	1065			
			SPZ	32.6	e	6	06.4			1.25	1077			
			LPT	27.4	S	8	25			11.5	166			
			SPZ	32.6	e	10	00.7			1.2	160			
			SPT	26.1	Lg					2.0	1104			
			LPT	1.05*	LQ					16.0	349			
			LP3	8.63	LR					14.0	1663			1617.46
WH6YB	Whitehorse, Yukon Territory, Canada	6762	SP3	44.6	P	5	25.3	5	26.77	1.3	850	6.31		
			SPZ	44.6	e	5	33.7			1.1	230			
			LPT	22.8	S	10	11			(12.0)	(136)			
			SPT	41.9	Lg					2.6	603			
			LPT		LQ					---	---			
			LP3	1.56	LR					14.0	2410			2600.53
AZZAL	Blowout City, Alabama	2766	SP3	16.36	P	6	26.6	6	27.26	1.3	1026	6.50		
			SPZ	18.36	e	6	39.7			1.2	596			
			SP3	16.36	PcP	9	00.7			1.2	154			
			SPT	18.5	Lg					2.4	940			
			LPT	1.69	LQ					(20.0)	(261)			
			LP2	1.9	LR					16.5	684			1643.33
AG-GC	Algonaria, North Carolina	3216	SPZ	62.6	P	6	59.7	6	02.76	(1.4)	(300)	(6.06)		
			SP3	62.6	e	6	24.7			1.0	126			
			SP3	62.6	e	6	46.7			1.2	356			
			SP3	62.6	PcP	9	10.1			1.2	203			
			SPT	66.6	Lg					2.4	7716			
			LPZ	.22	LR					(16.0)	(631)			760.70
GS-FL	Gulfview, Florida	3320	SPZ	26.6	P	6	(06.9)	6	11.21	1.46	1263	6.70		
			SPZ	26.6	e	6	22.6			1.4	380			
			SP3	26.6	PP	7	10.6			1.6	667			
			SP3	24.6	PcP	6	12.3			1.0	170			
			LPT	4.86	S	11	06			(16.0)	(31.6)			
			SPT	22.8	Lg					1.6	326			
			SP6	22.78	Lg					1.6	343			
			LPT	4.96	LQ					(19.0)	(34.6)			
			LP6	4.86	LQ					19.0	101			
			LPZ	3.40	LR					16.0	646			1303.66
LG-NH	Lisbon, New Hampshire	3710	SP3	33.06	P	6	(36.9)	5	41.65	1.4	619	6.46		
			SPZ	33.06	e	8	50.6			1.1	161			
			SPT	26.26	Lg					2.2	(724)			
			LP3	1.43	LR					13.6	3216			2269.23
HH-MS	Houlton, Maine	3896	SPZ	33.6	P	7	01.6	7	03.94	(1.1)	(266)	(6.06)		
			SPZ	22.66*	e	7	03.6			(1.1)	(269)			
			SP3	33.6	e	7	06.2			.95	179			
			SP3	33.6	e	7	16.2			1.05	299			
			SP3	33.8	(PcP)	9	26.7			1.2	136			
			SP3	33.6	e	6	32.6			1.1	69.3			
			SPT	47.0	Lg					2.1	363			
			LPT	29.3	LQ					(16.0)	(246)			
			LP3	2.34	LR					(19.0)	(1396)			1247.86
SY3Q6	Schaffarville, Quebec, Canada	4062	SP3	28.4	P	7	07.6	7	10.36	1.4	606	6.44		
			SPZ	26.4	e	7	11.6			1.0	295			
			SP3	26.4	e	7	26.7			1.1	362			
			SPZ	26.4	e	8	(23.3)			1.0	265			
			SPZ	26.4	PcP	9	30.1			1.2	230			
			SP6	26.6	Lg					1.8	408			
			SPT	27.6	Lg					1.6	360			
			LP6	37.4	LQ					(16.0)	(89.4)			
			LPT	33.3	LQ					(16.6)	(126)			
			LPZ	3.16	LR					13.8	6102			1096.82
NP-NT	Mould Bay, Northwest Territories, Canada	4167	SPZ		P	7	16.6	7	18.68	***	***			
			SPZ	229	PP	6	(42.9)			(5.7)	(0077)			
			SPZ	229	PcP	9	33.5			15.48	(633)			
			SPT	221	Lg					(3.0)	(00000)			
			LPT	2.24	LQ					57.6	725			
			LP3	2.69	LR					10.8	5353			3307.68

A/T Hu/sec
( ) Doubtful Values or Phases
* Measurements made from Playouts
** Unreadable on Film; Tape not Available
*** Unreadable on Film; Tape not Received by 10 March 1960
--- Maximum Amplitudes Clipped on Film and Tape

Principal Phases - FAULTLESS
Table 2

Station	Faultless Oist (km)	Greeley Oist (km)	Adjusted Mag_F	Adjusted Mag_G	Mμ/sec (0-P) Lg_F	Lg_G	LQ_F	LQ_G	LR_F	LR_G	AR_F (MM^2)	AR_G (MM^2)
MN-NV	170	198	(6.16)	6.25	(142,857)	100,575	---	---	---	(424,064)	---	142,246
KN-UT	348	320	(6.37)	6.44	(53,261)	125,880	---	---	---	88,101	---	23,333
U8O	602	682	(6.38)	5.96	(14,141)	13,947	(1131)	9800	---	995	---	1057
TFO	655	572	(6.15)	(6.26)	5630	(10,637)	---	2562	---	14,933	---	7306
WMO	1632	1629	6.10	6.30	2778	3028	---	(2030)	---	5563	---	3750
PG-8C	1775	1915	6.57	5.85	996	1154	(702)	4214	(1883)	3115	1579	2400
RK-ON	2228	2346	5.90	(6.40)	1104	757	349	777	1853	1733	1817	2048
WH2YK	2782	2913	6.31	5.62	603	657	---	2348	2410	4348	2601	5223
AX2AL	2786	2796	6.50	6.51	940	(974)	(261)	1137	864	(2472)	1843	5491
AE-NC	3216	3249	(6.09)	6.34	1715	1651	I	1664	(631)	1974	791	1952
8E-FL	3320	3318	6.70	6.41	343	387	101	1088	645	1961	1304	4642
LS-NH	3710	3788	6.49	6.43	(724)	592	I	2225	3215	6246	2269	2682
HN-ME	3996	4082	6.08	6.42	383-	589	(242)	2064	(1399)	898	1748	1535
SV3QB	4082	4195	6.44	(6.21)	408	357	(124)	535	2122	(2957)	1097	1820
NP-NT	4197	4344	---	---	(1088)	793	725	---	1312	1625	3398	3364
All Common Stations, Average			6.30	6.24	15,131	17,465	416	2802	1633	2733	1845	3116
Ratio Faultless / Greeley			1.01		.87		.15		.60		.59	
Distance>1700 KM Average			6.34	6.24	830	791	297	1636	1633	2733	1845	3116
Ratio Faultless / Greeley			1.02		1.05		.18		.60		.59	

--- Clipped On Film and Tape

I INOPERATIVE

Comparison of Signals - FAULTLESS and GREELEY
Table 3

Code	Station	Oistanca (km)	Gaographic Latitude	Gaographic Longitude	Elev. (km)	Computed Azimuth		Installed Azimuth		SP Inst.	LP Inst.
						Epi. Sta.	Sta. Epi.	Radial	Tang.		
MN-NV	Mina, Nevada	170	38° 26' 10" N	118° 08' S3" W	1.S2	263°	82°	308°	38°	L	**
KN-UT	Kanab, Utah	348	37° 01' 22" N	112° 49' 39" W	1.74	120°	302°	9S°	185°	L	**
*UBSO-Z10	Uinta Basin Seismological Observatory, Utah	602	40° 19' 18" N	109° 34' 07" W	1.60	70°	254°	90°	0°	JM	**
*TFSO-Z60	Tonto Forest Seismological Observatory, Arizona	65S	34° 17' 12" N	111° 16' 03" W	1.49	136°	319°	90°	0°	JM	**
CC-WA	Cascada Tunnal, Washington	1089	47° 46' 09" N	121° 0S' 01" W	1.04	340°	1S7°	311°	041°	PS	**
LC-NM	Las Crucas, New Mexico	1112	32° .24' 08" N	106° 3S' 58" W	1.59	126°	311°	133°	223°	S	**
*LAO	Subarray AO-10, Montana	1212	46° 41' 19" N	106° 13' 20" W	0.90	39°	226°	90°	0°	H5	**
*WMSO-Z6	Wichita Mountains Saismological Observatory, Oklahoma	1632	34° 43' 0S" N	98° 3S' 21" W	0.S1	100°	291°	90°	0°	JM	**
*PG-BC	Prince Gaorge, British Columbia, Canada	1775	S3° S9' 50" N	122° 31' 23" W	0.91	346°	162°	110°	200°	L	**
GL-TX	Garland, Texas	1874	32° S8' 20" N	96° 38' 06" W	0.17	104°	295°	110°	200°	PS	
SJ-TX	San Jose, Taxas	2064	27° 36' 43" N	98° 18' 46" W	0.11	121°	311°	131°	221°	PS	**
RK-ON	Red Laka, Ontario, Canada	2228	S0° S0' 20" N	93° 40' 20" W	0.37	45°	241°	58°	148°	S	**
WH2YK	Whitenorse, Yukon Tarritory, Canada	2782	60° 41' 41" N	134° S8' 02" W	0.85	338°	143°	32S°	55°	L	**
AX2AL	Alexandria City, Alabama	27B6	32° 46' 38" N	86° 07' 48" W	0.21	94°	292°	112	202	P5	**
AE-NC	Albamarle, North Carolina	3216	3S° 26' 01" N	80° 03' S2" W	0.18	8S°	287°	107	197	PS	**
*BE-FL	Ballaviaw, Florida	3320	28° S4' 19" N	82° 03' S2" W	0.02	99°	298°	208	298	PS	**
LS-NH	Lisbon, New Hampshire	3710	44° 14' 18" N	71° 5S' 21" W	0.29	66°	276°	96	186	PS	**
HN-ME	Houlton, Maine	3996	46° 09' 43" N	67° S9' 09" W	0.21	62°	276°	93°	183°	S	**
*SV3QB	Scheffarvilla, Quebec, Canada	4082	S4° 48' 39" N	66° 4S' 00" W	0.58	47°	26S°	139°	229°	S	**
NP-NT	Mould Bay, Northwast Tarritorias, Canada	4197	76° 15' 08" N	119° 22' 18" W	0.06	3S9°	176°	3S6°	86°	JMZ S	**

* Saismomaters Not Oriantad Toward N.T.S.

L = Larga Benioff HS = Hall Saars

S = Small Benioff P5 = Gaotech Portabla 5ystam

JM = Johnson - Mathason ** = Long Period Instrumants at Site

Recording Site Information - FAULTLESS
Table 4

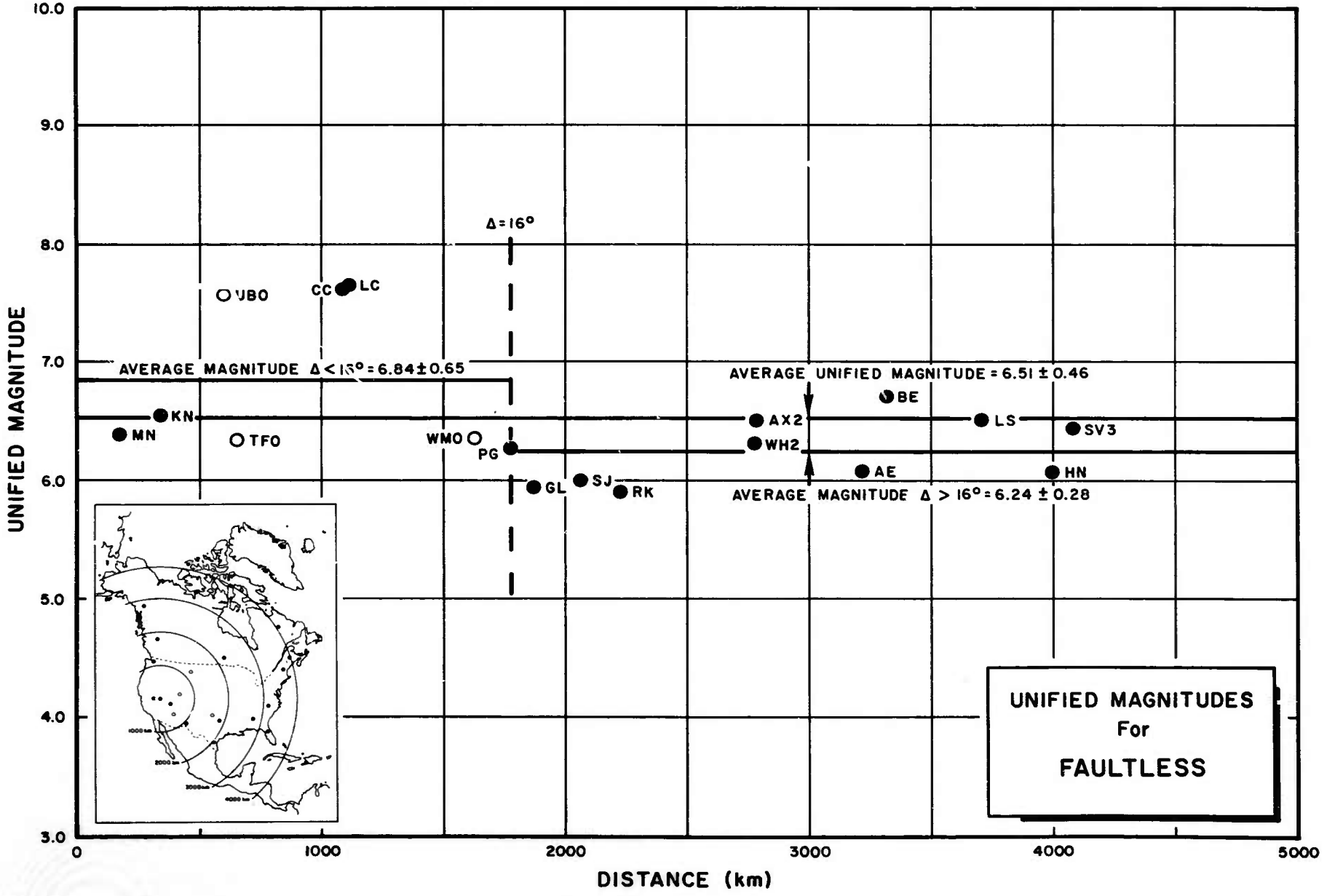

10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
UNIFIED MAGNITUDE
0
1000
2000
3000
4000
5000
DISTANCE (km)
Δ=16°
UBO
CC
LC
AVERAGE MAGNITUDE Δ<16°=6.84±0.65
KN
MN
TFO
WMO
PG
GL
SJ
RK
AVERAGE UNIFIED MAGNITUDE = 6.51 ± 0.46
BE
AX2
LS
SV3
WH2
AE
HN
AVERAGE MAGNITUDE Δ > 16° = 6.24 ± 0.28
UNIFIED MAGNITUDES
For
FAULTLESS

Figure 2

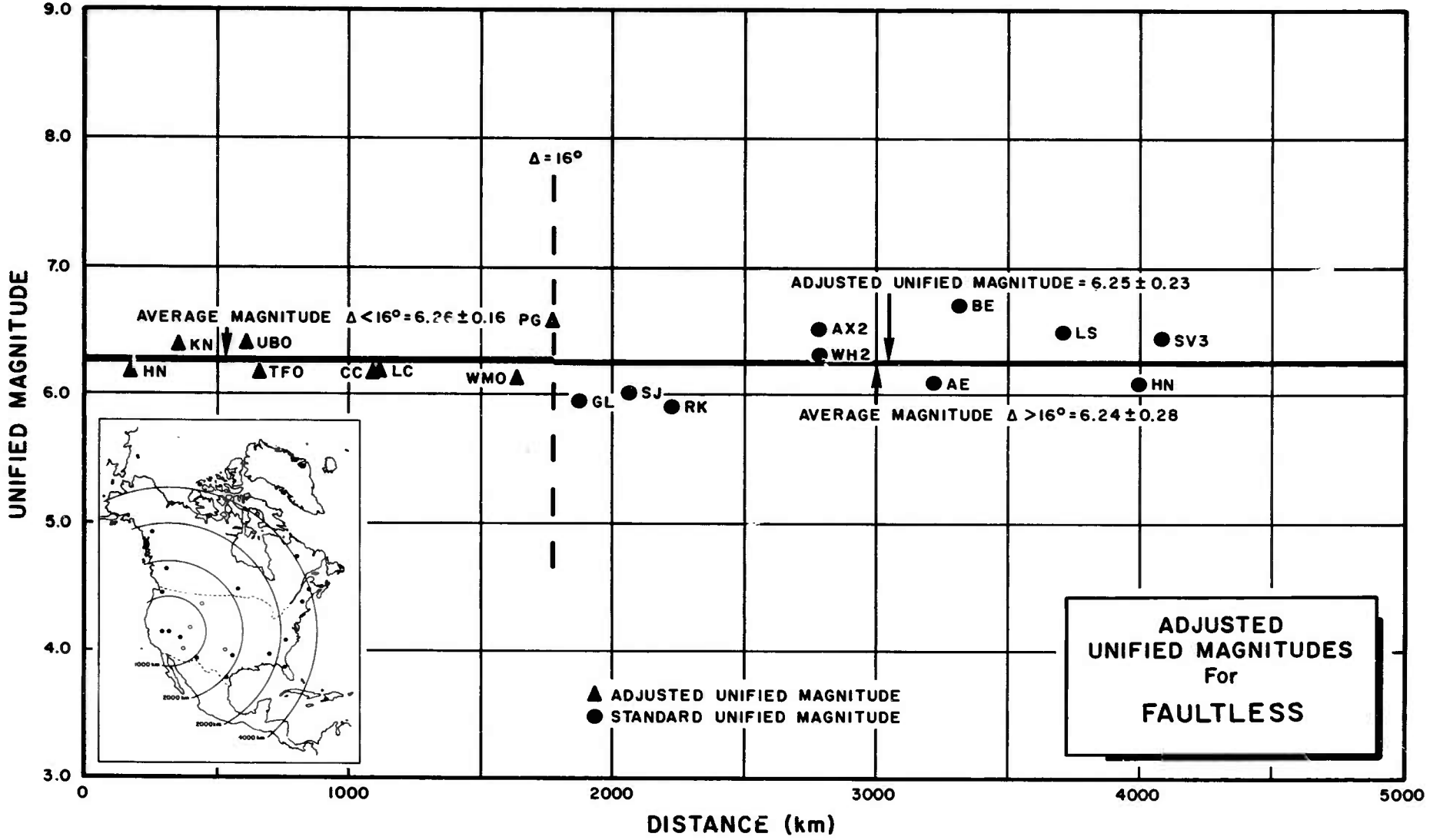

9.0
8.0
7.0
6.0
5.0
4.0
3.0
UNIFIED MAGNITUDE
0
1000
2000
3000
4000
5000
DISTANCE (km)
Δ = 16°
AVERAGE MAGNITUDE Δ <16° = 6.26 ± 0.16
ADJUSTED UNIFIED MAGNITUDE = 6.25 ± 0.23
AVERAGE MAGNITUDE Δ >16° = 6.24 ± 0.28
KN
UBO
HN
TFO
CC
LC
WMO
PG
GL
SJ
RK
AX2
WH2
BE
LS
SV3
AE
HN
▲ ADJUSTED UNIFIED MAGNITUDE
● STANDARD UNIFIED MAGNITUDE
ADJUSTED
UNIFIED MAGNITUDES
For
FAULTLESS

Figure 3

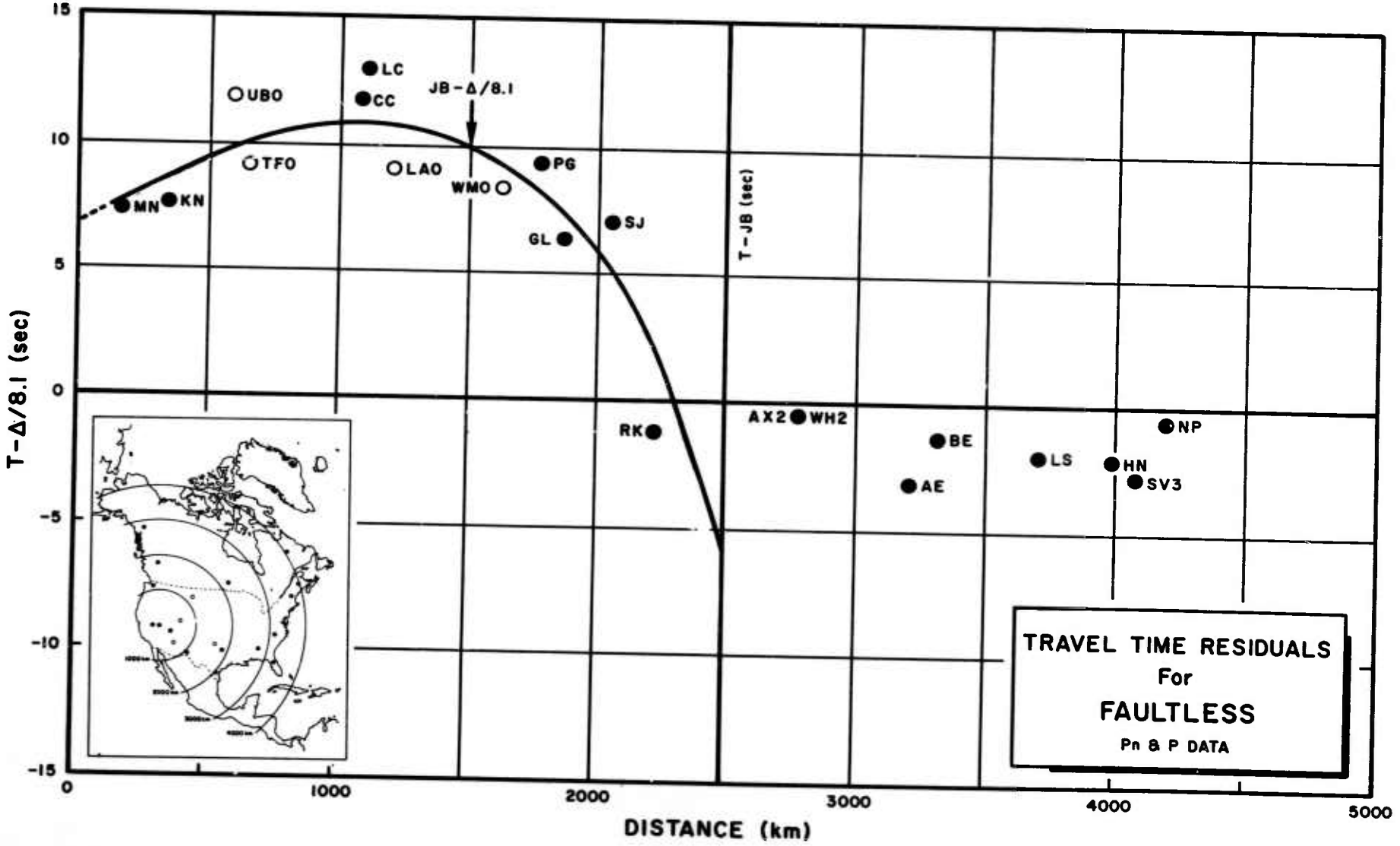

15
10
5
0
-5
-10
-15
T-Δ/8.1 (sec)
0
1000
2000
3000
4000
5000
DISTANCE (km)
T-JB (sec)
JB-Δ/8.1
UBO
LC
CC
TFO
LAO
WMO
PG
MN
KN
GL
SJ
RK
AX2
WH2
BE
AE
LS
HN
NP
SV3
TRAVEL TIME RESIDUALS
For
FAULTLESS
Pn & P DATA

Figure 4

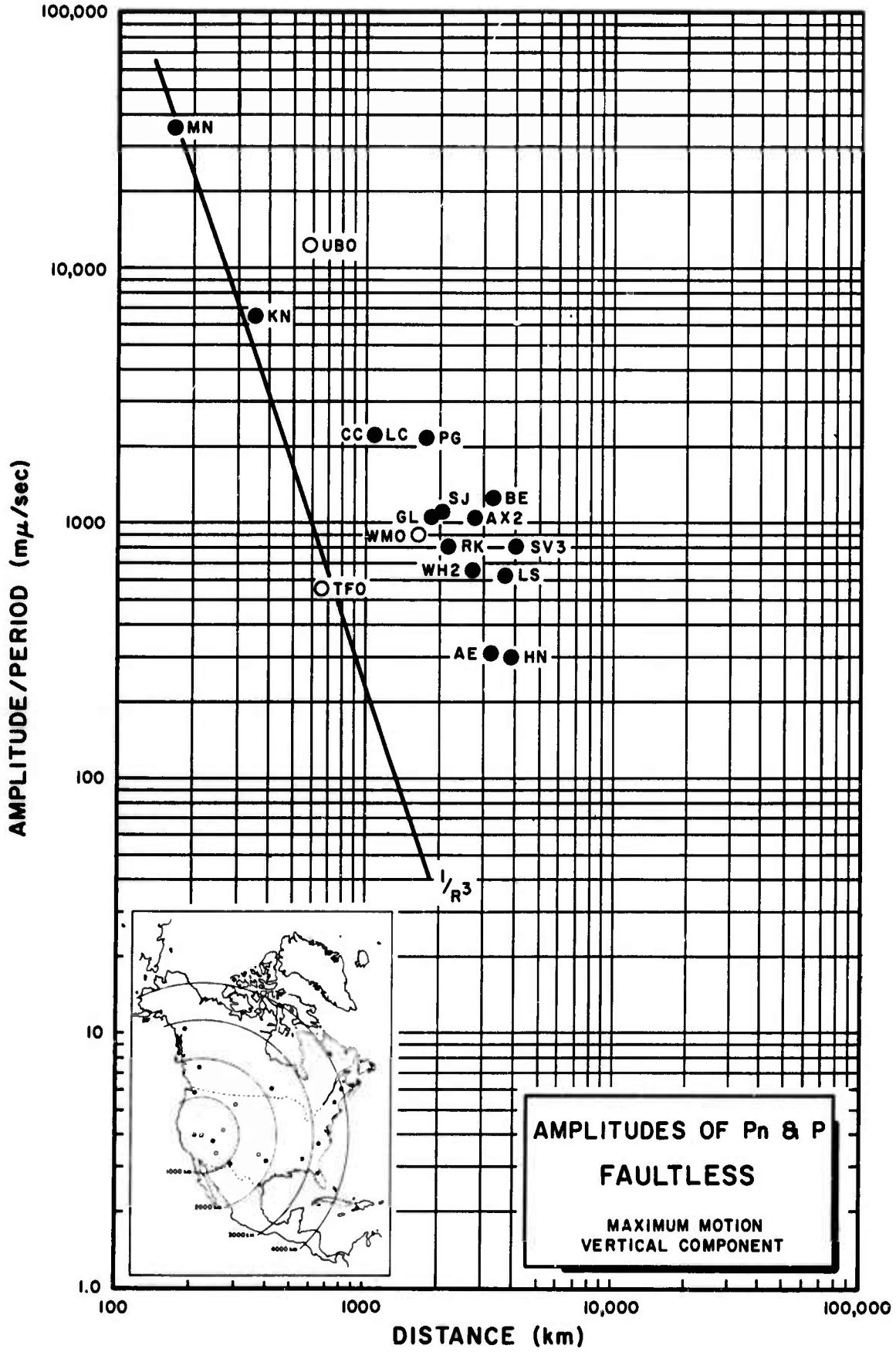

100,000
10,000
1000
100
10
1.0
AMPLITUDE/PERIOD (mμ/sec)
MN
UBO
KN
CC
LC
PG
SJ
BE
GL
AX2
WMO
RK
SV3
WH2
LS
TFO
AE
HN
1/R3
100
1000
10,000
100,000
DISTANCE (km)
AMPLITUDES OF Pn & P
FAULTLESS
MAXIMUM MOTION
VERTICAL COMPONENT

Figure 5

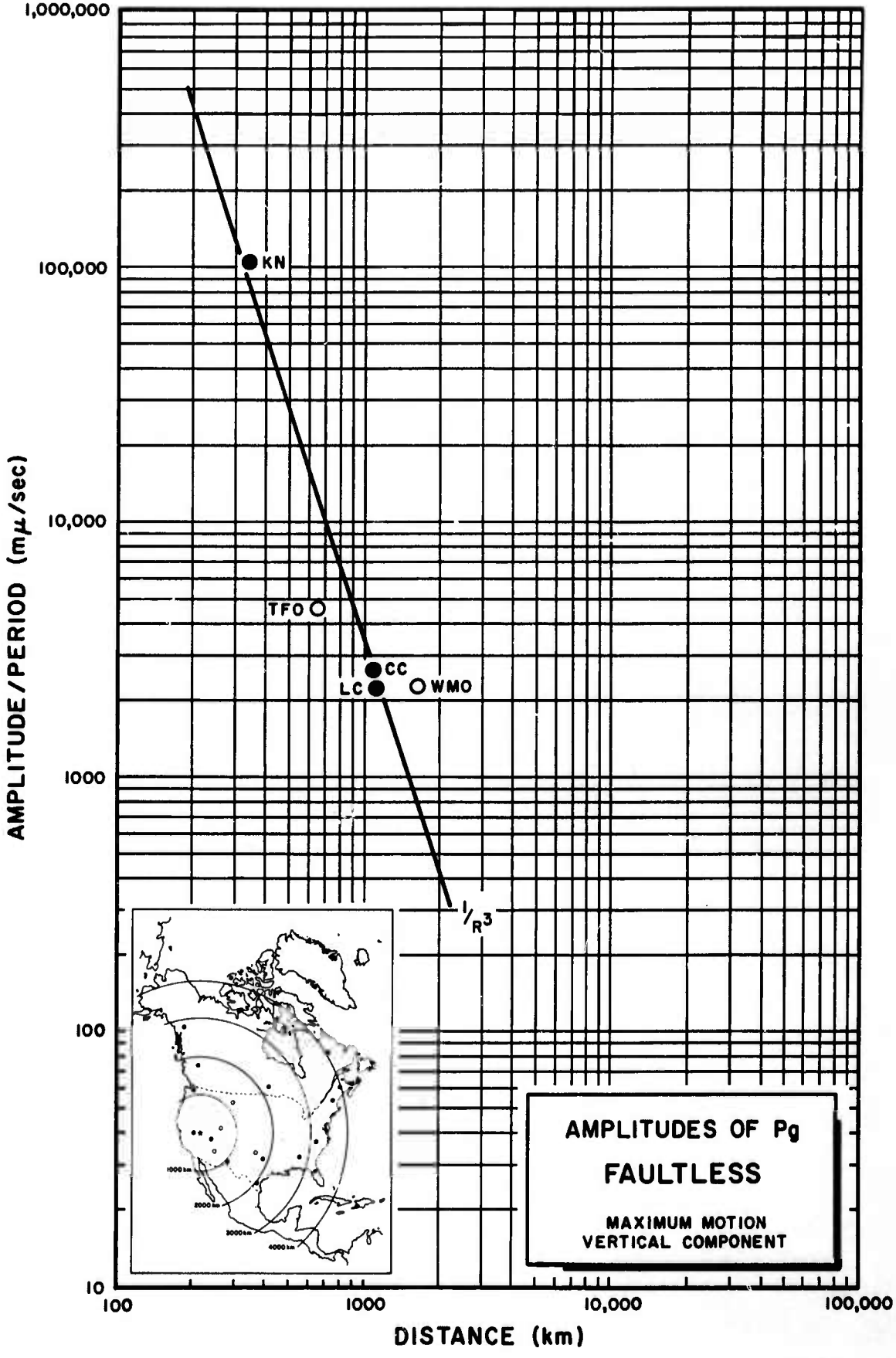

1,000,000
100,000
10,000
1000
100
10
AMPLITUDE/PERIOD (mμ/sec)
KN
TFO
CC
LC
WMO
1/R3
100
1000
10,000
100,000
DISTANCE (km)
AMPLITUDES OF Pg
FAULTLESS
MAXIMUM MOTION
VERTICAL COMPONENT

Figure 6

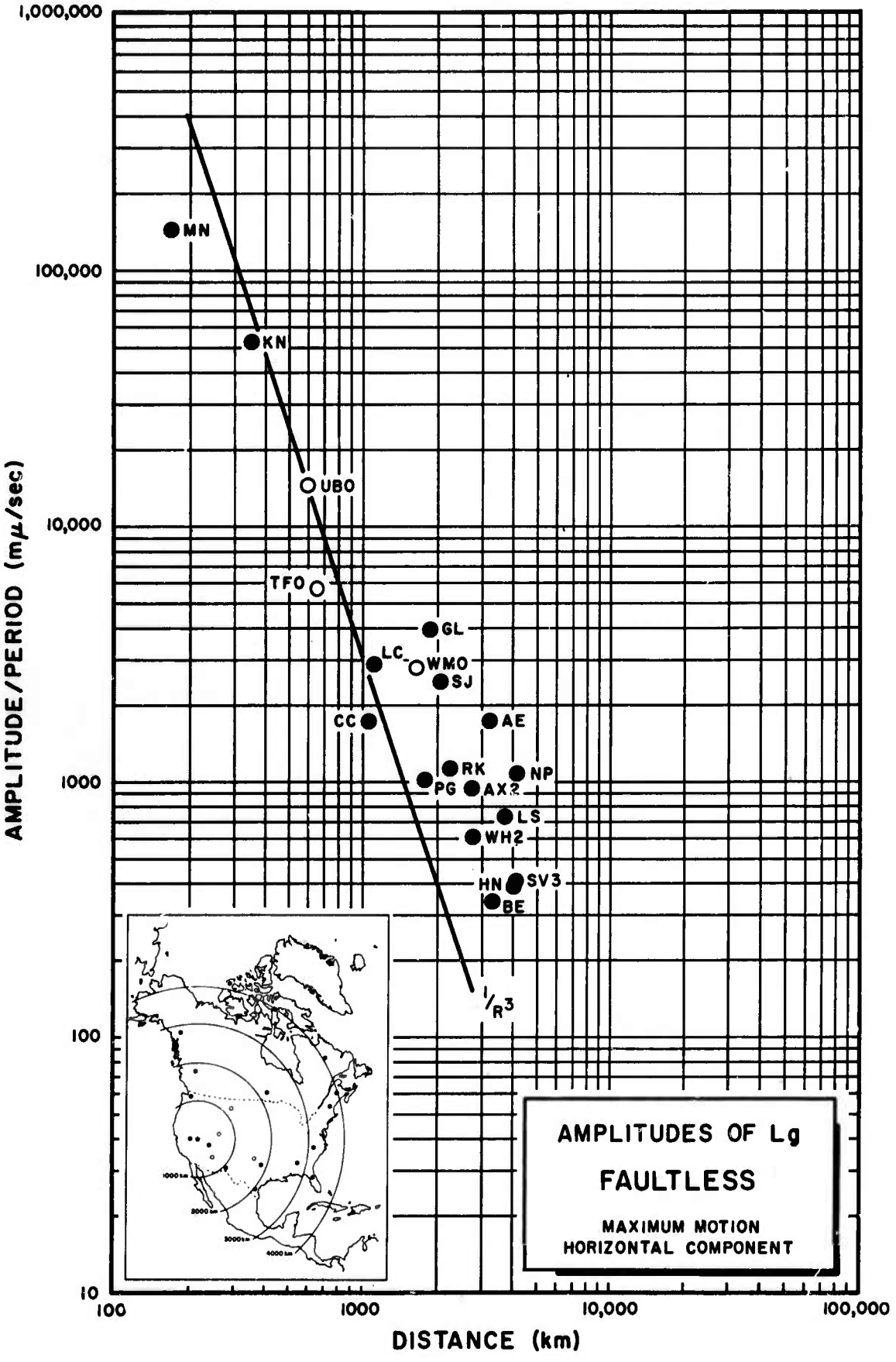

1,000,000
100,000
10,000
1000
100
10
AMPLITUDE/PERIOD (mμ/sec)
MN
KN
UBO
TFO
GL
LC
WMO
SJ
CC
AE
RK
NP
PG
AX2
LS
WH2
HN
SV3
BE
1/R3
100
1000
10,000
100,000
DISTANCE (km)
AMPLITUDES OF Lg
FAULTLESS
MAXIMUM MOTION
HORIZONTAL COMPONENT

Figure 7

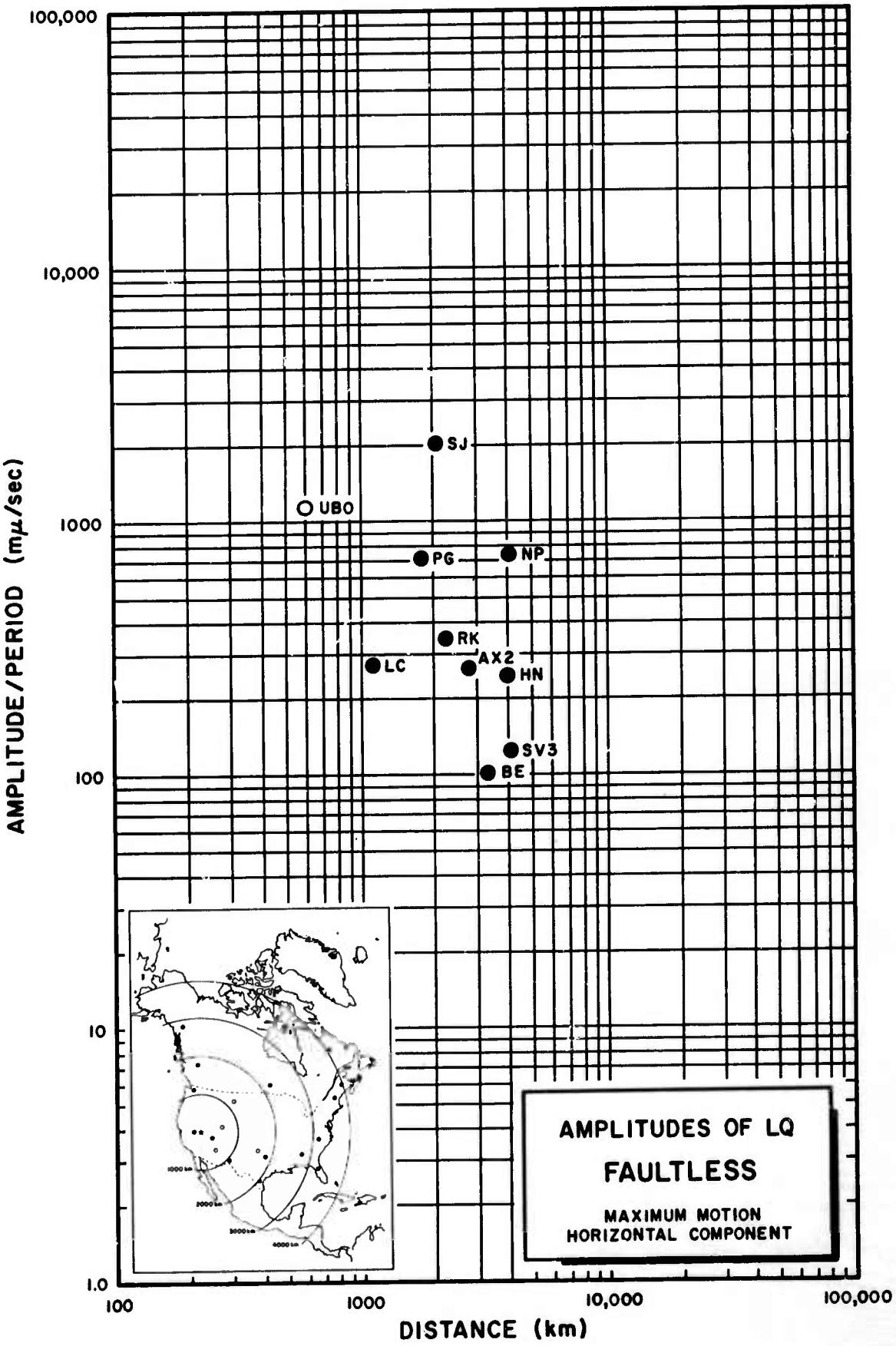

100,000
10,000
1000
100
10
1.0
AMPLITUDE/PERIOD (mμ/sec)
SJ
UBO
PG
NP
RK
AX2
LC
HN
SV3
BE
100
1000
10,000
100,000
DISTANCE (km)
AMPLITUDES OF LQ
FAULTLESS
MAXIMUM MOTION
HORIZONTAL COMPONENT

Figure 8

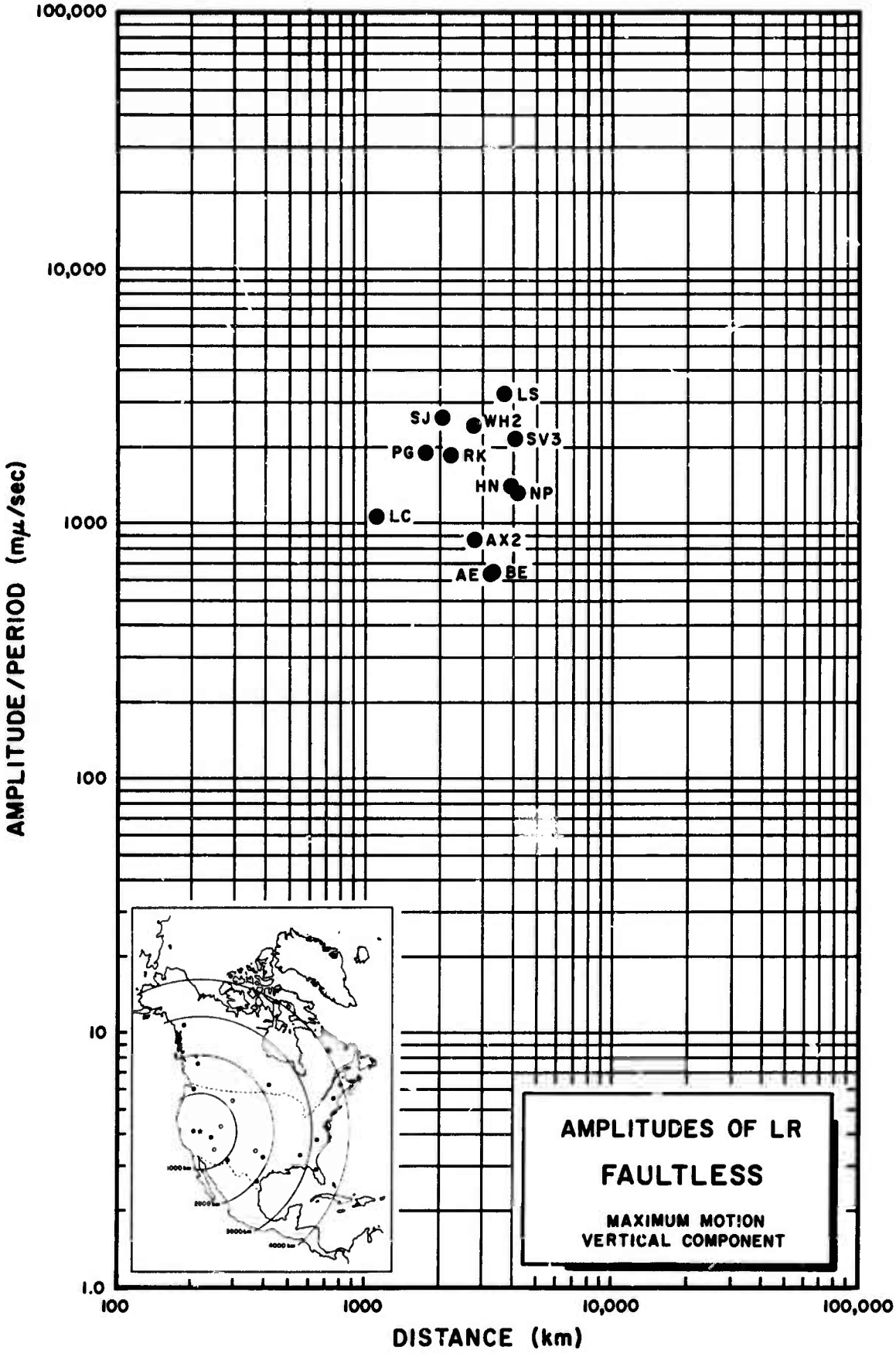

100,000
10,000
1000
100
10
1.0
AMPLITUDE/PERIOD (mμ/sec)
LS
SJ
WH2
SV3
PG
RK
HN
NP
LC
AX2
AE
BE
100
1000
10,000
100,000
DISTANCE (km)
AMPLITUDES OF LR
FAULTLESS
MAXIMUM MOTION
VERTICAL COMPONENT

Figure 9

Unclassified

Security Classification

DOCUMENT CONTROL DATA - R&D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

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ALEXANDRIA, VIRGINIA

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Unclassified

2b GROUP

3 REPORT TITLE

Long Range Seismic Measurements - FAULTLESS

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

Scientific

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

Clark, Don M.; Moore, Edward W.; Nelson, Duane D.

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
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11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
	ADVANCED RESEARCH PROJECTS AGENCY NUCLEAR TEST DETECTION OFFICE WASHINGTON, D. C.

13 ABSTRACT

An analysis of seismological data was made 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.

14. KEY WORDS

Seismic Magnitude
Seismic Travel-Time
Seismic Amplitude
Vela-Uniform
Nuclear Tests

Unclassified

Security Classification

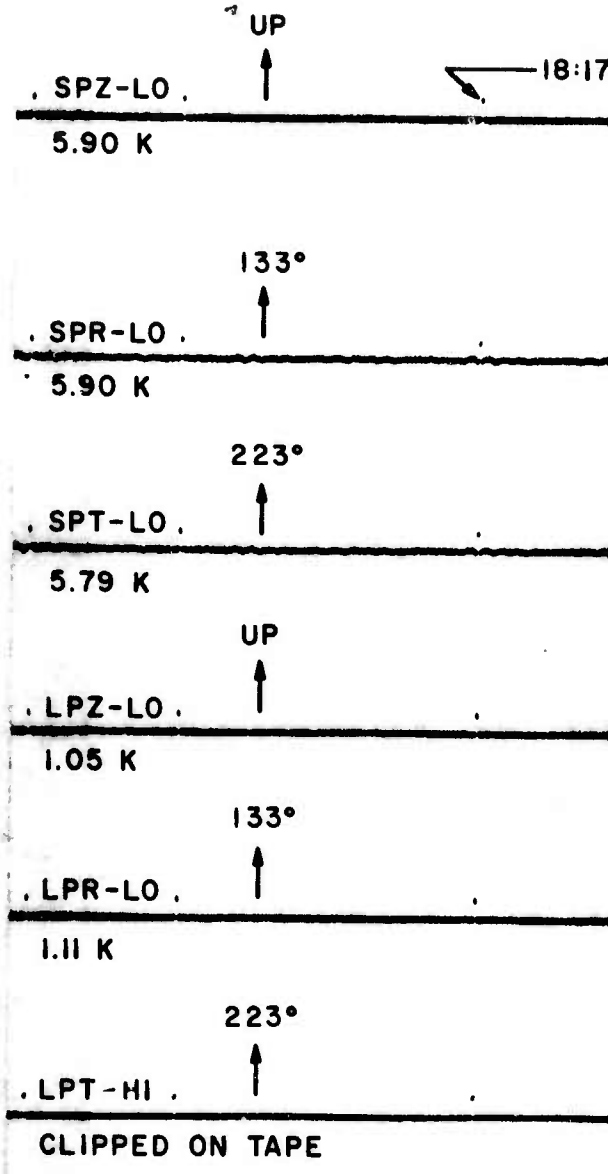
FAULTLESS

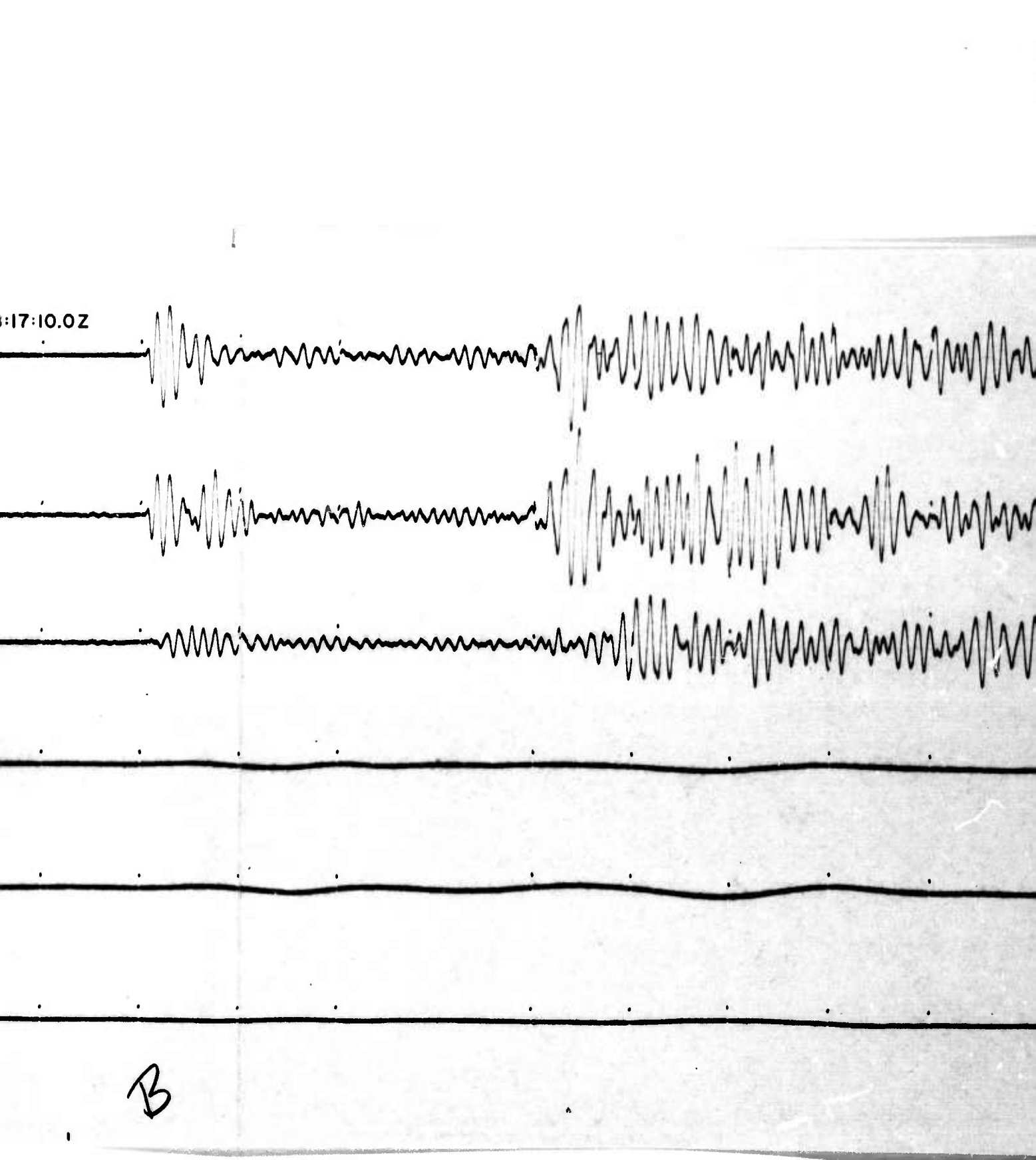
LC-NM

LAS CRUCES, NEW MEXICO

19 JANUARY 1968

Δ = 1112 km

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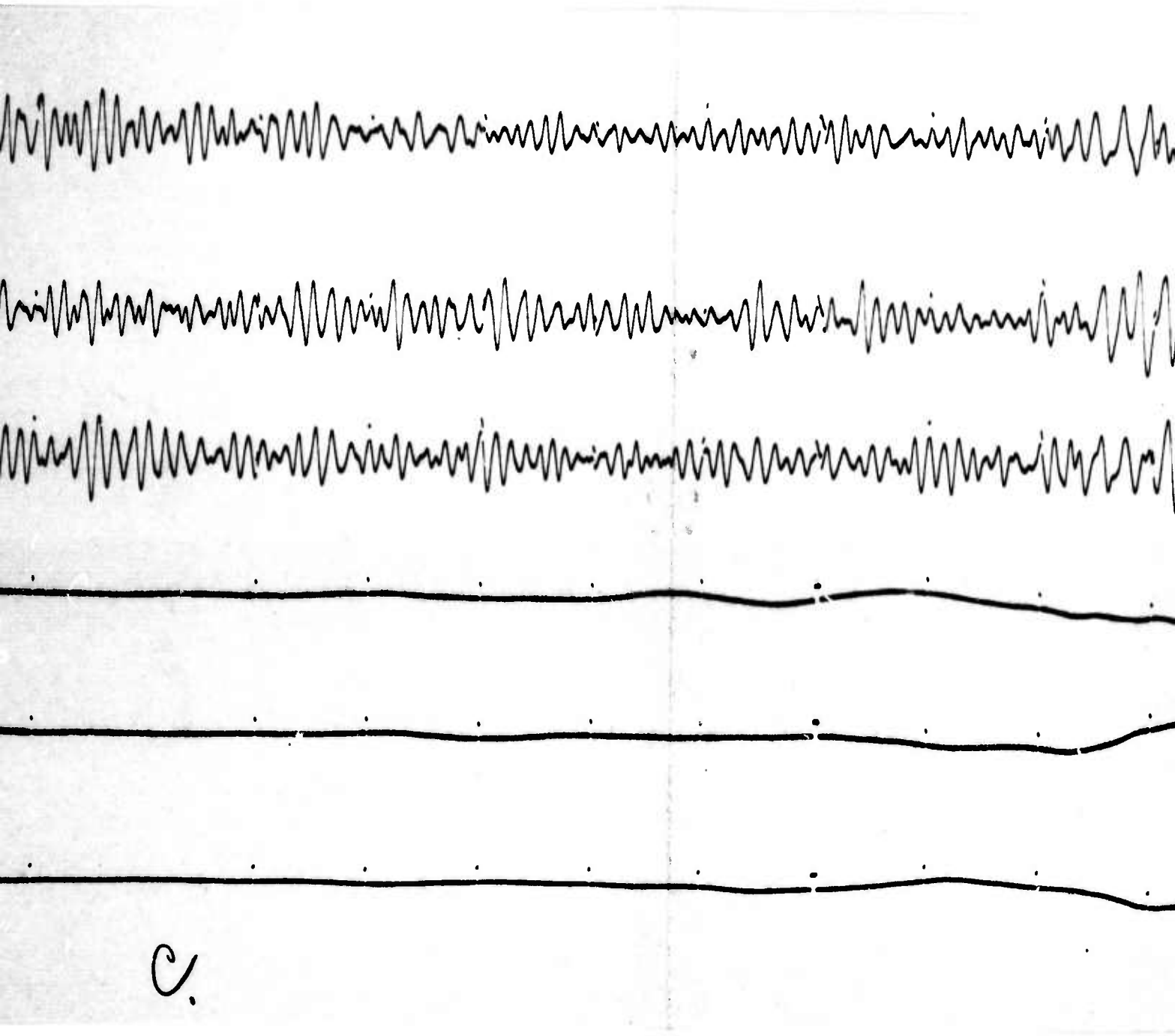

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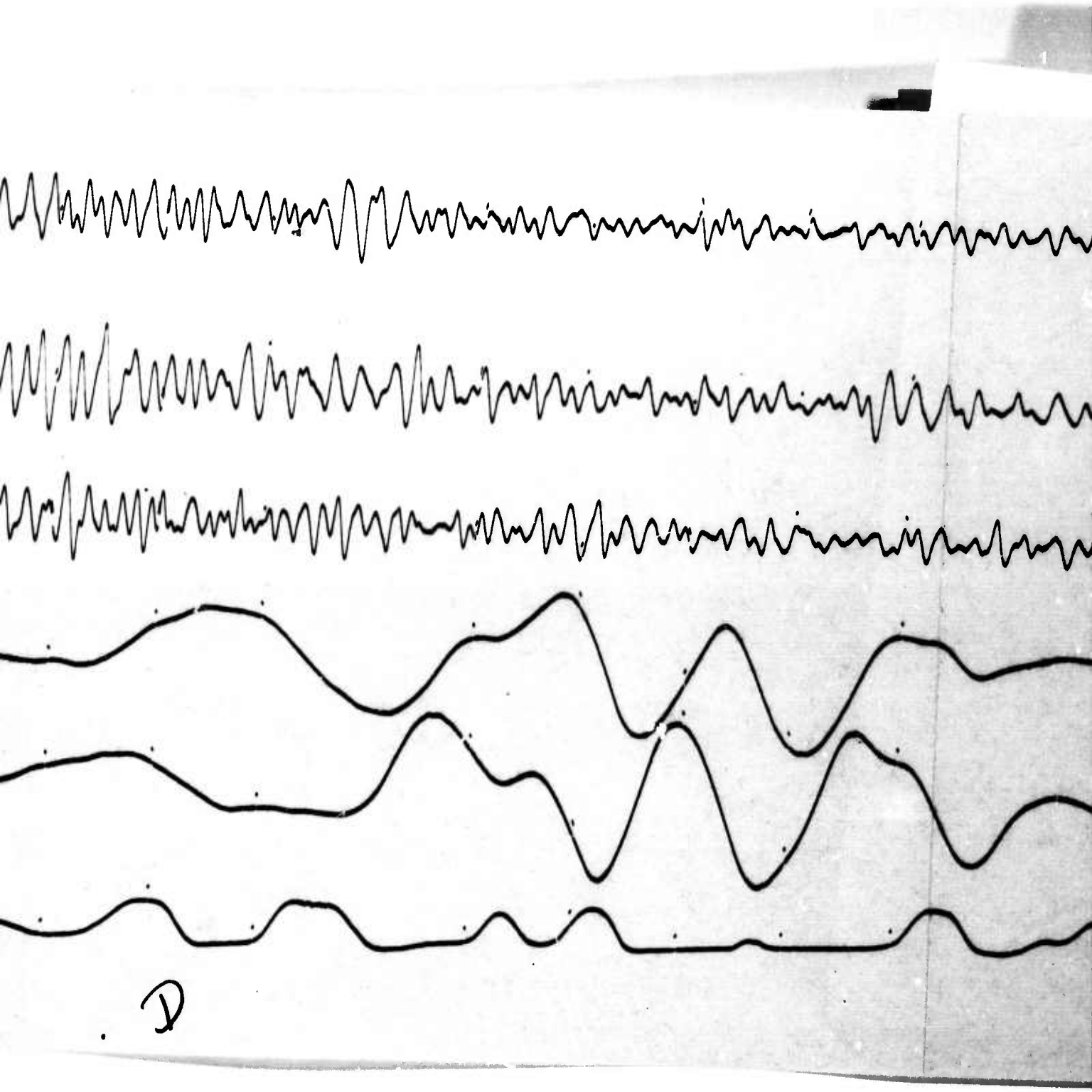
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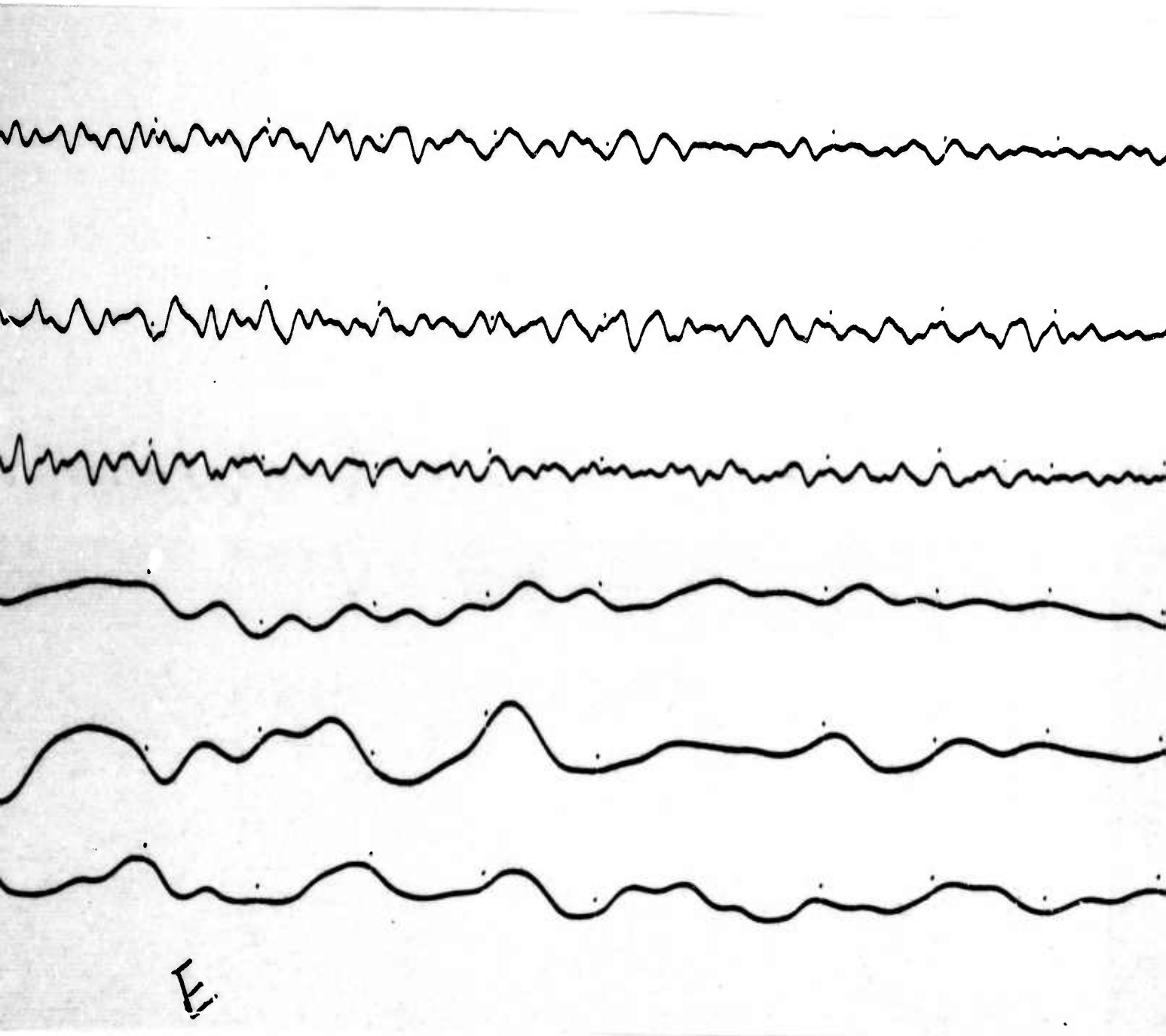
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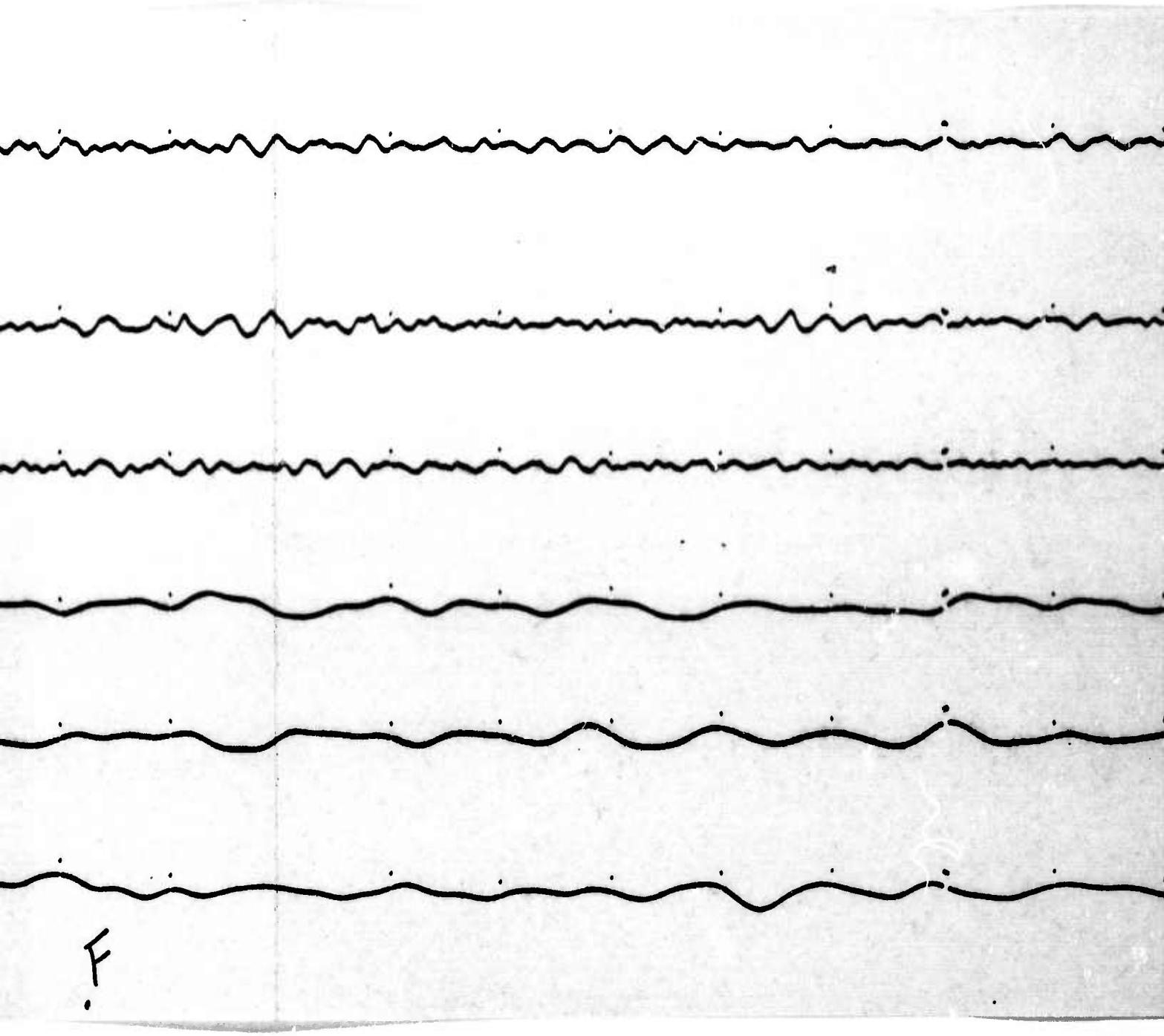
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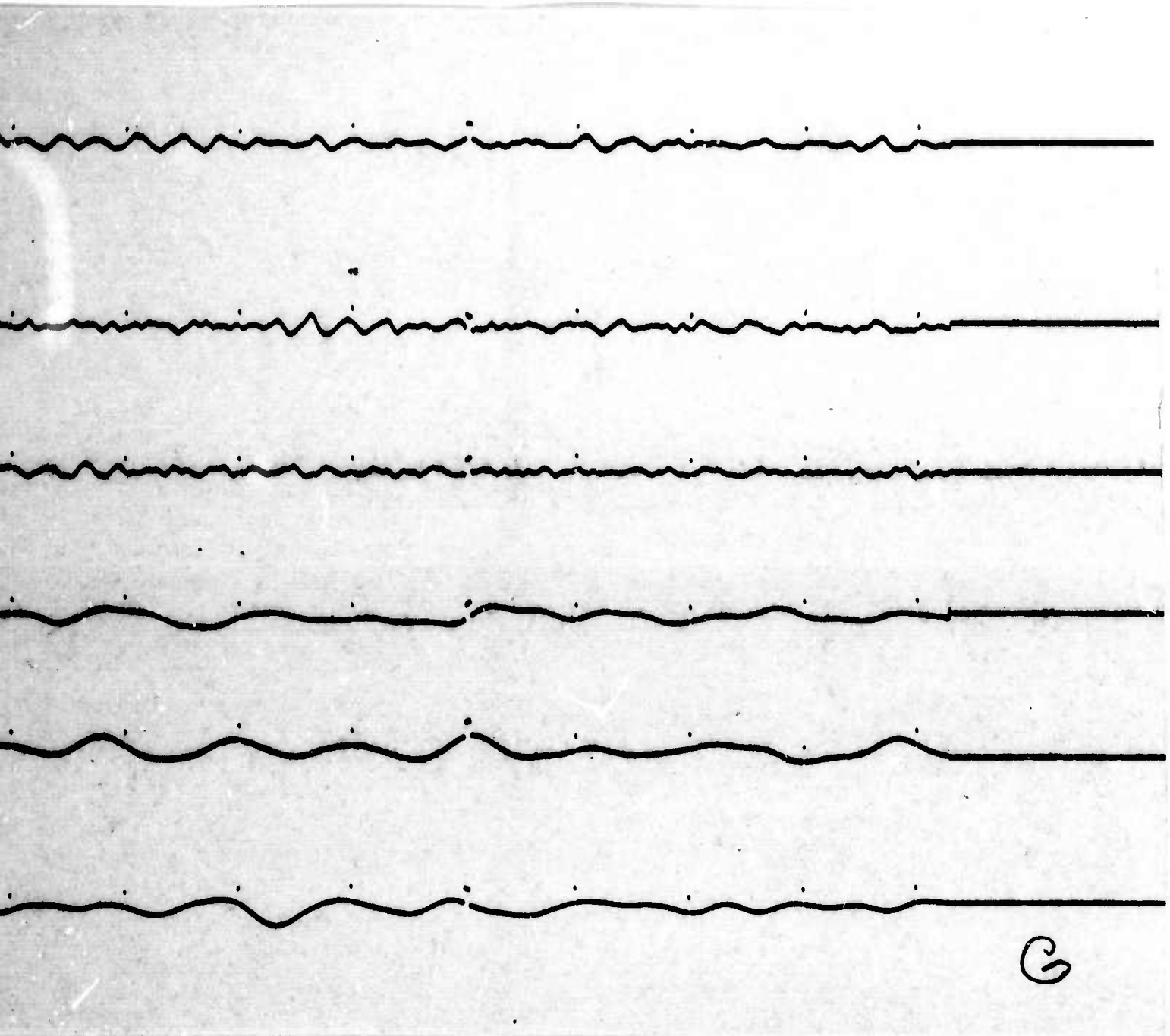

G

FAULTLESS

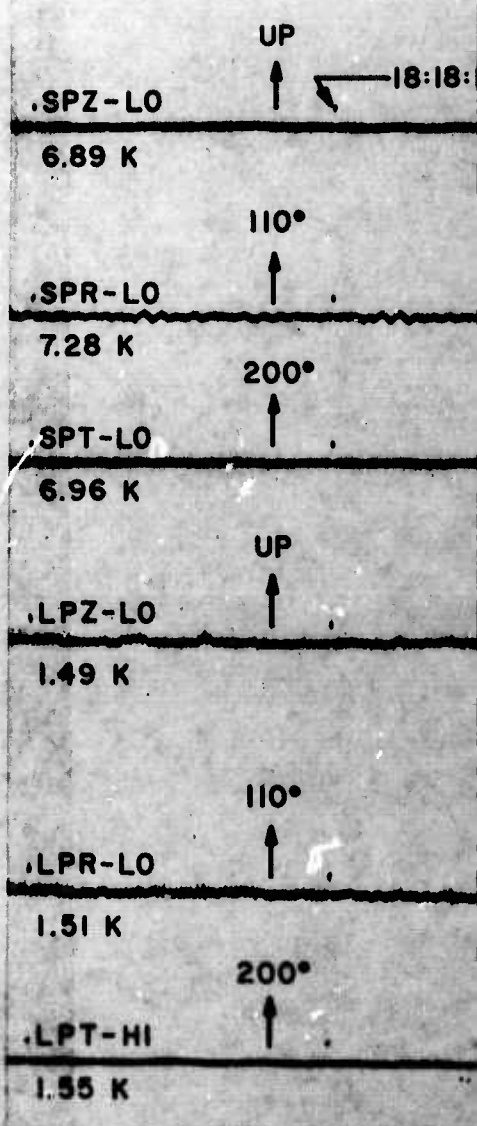
PG-BC

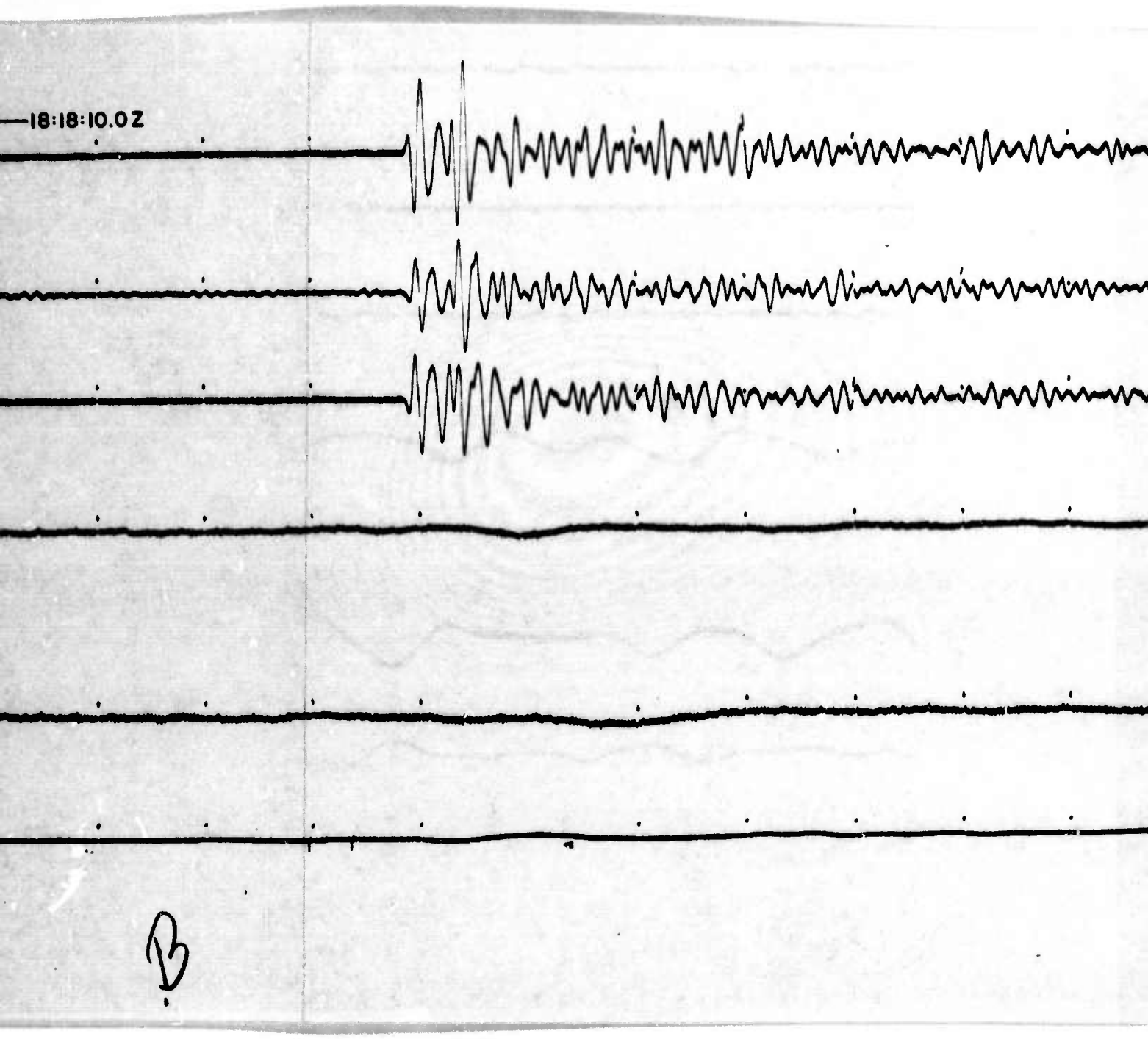
PRINCE GEORGE, BRITISH COLUMBIA, CANADA

19 JANUARY 1968

Δ = 1775 km

A

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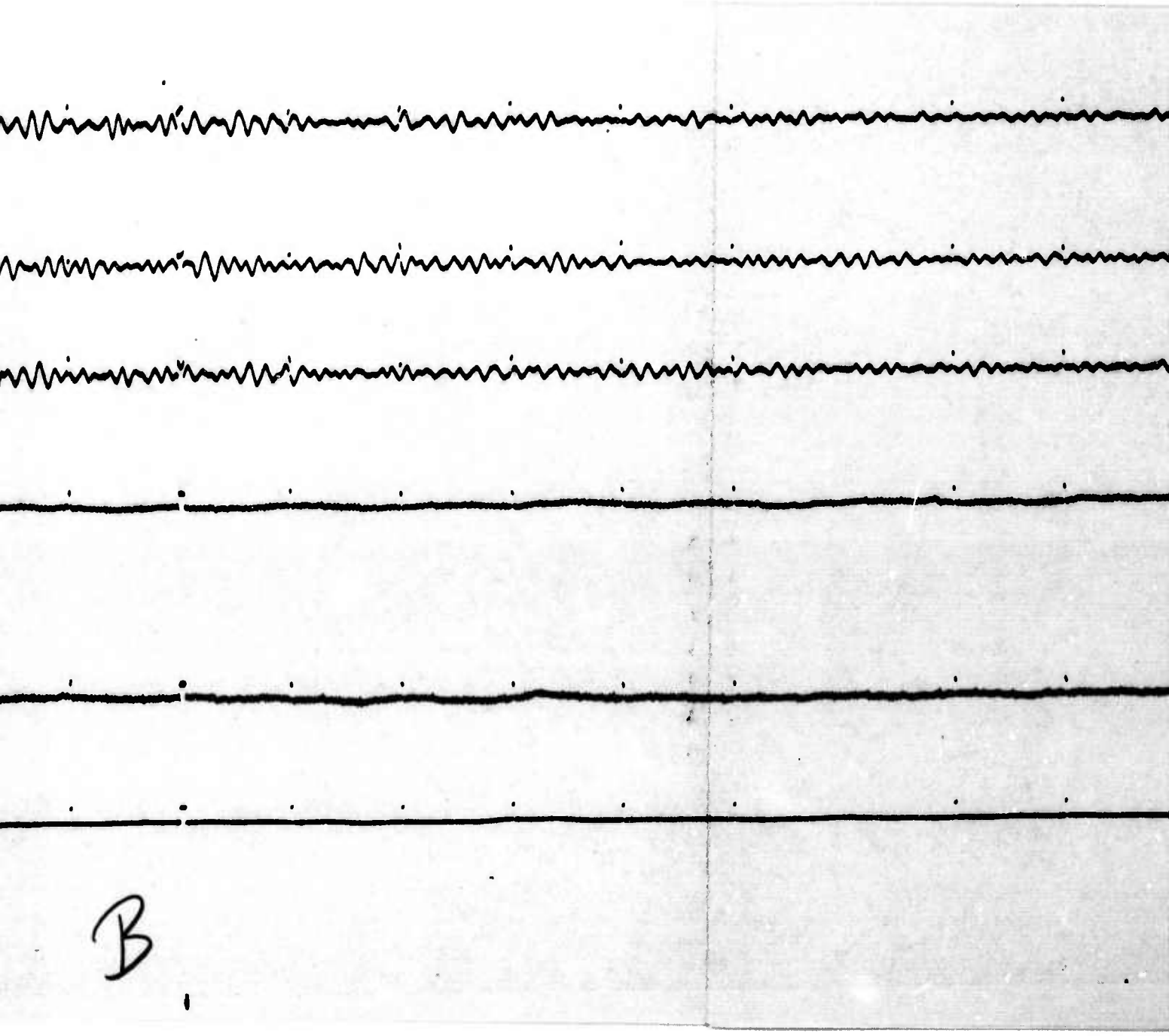
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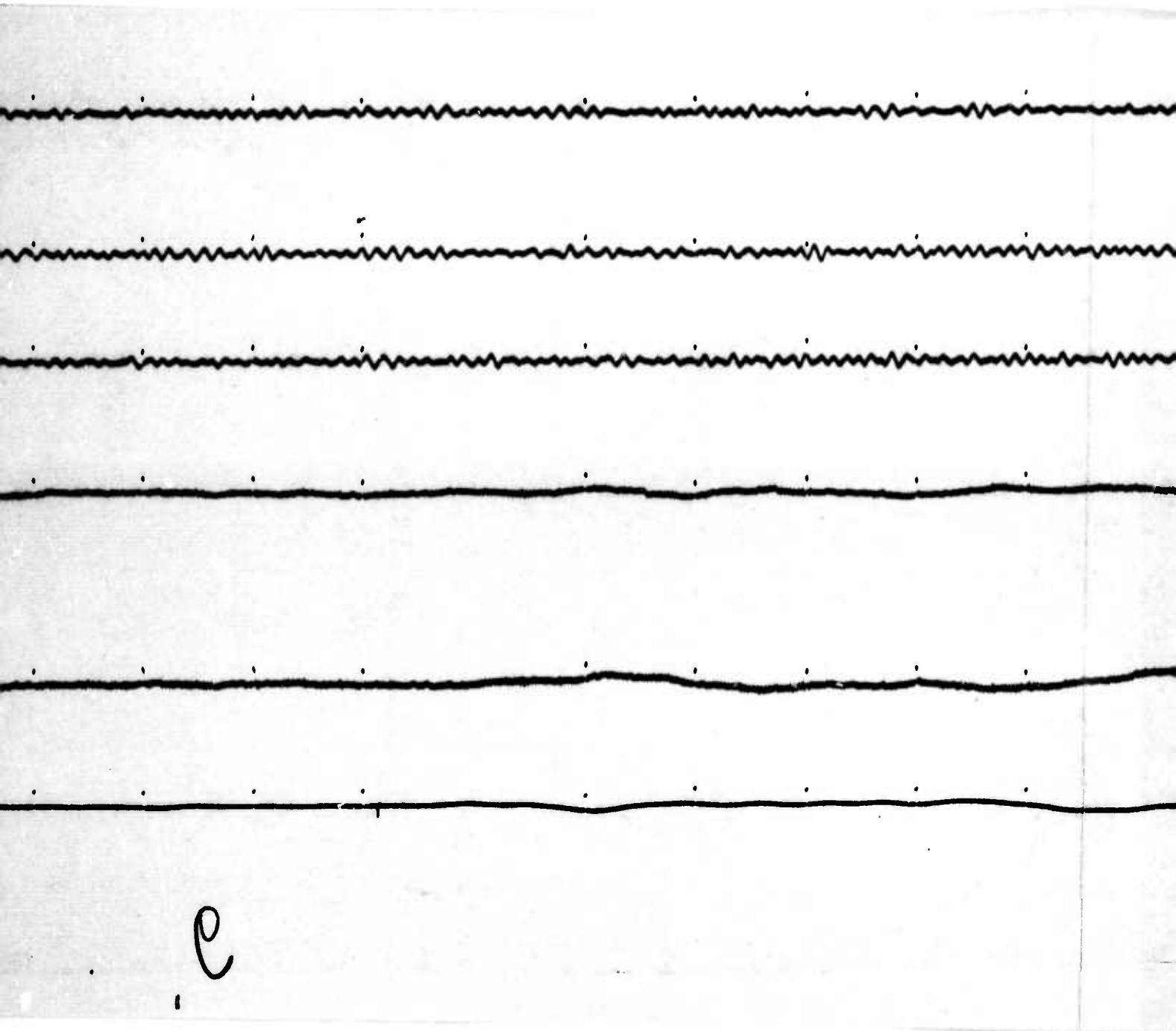
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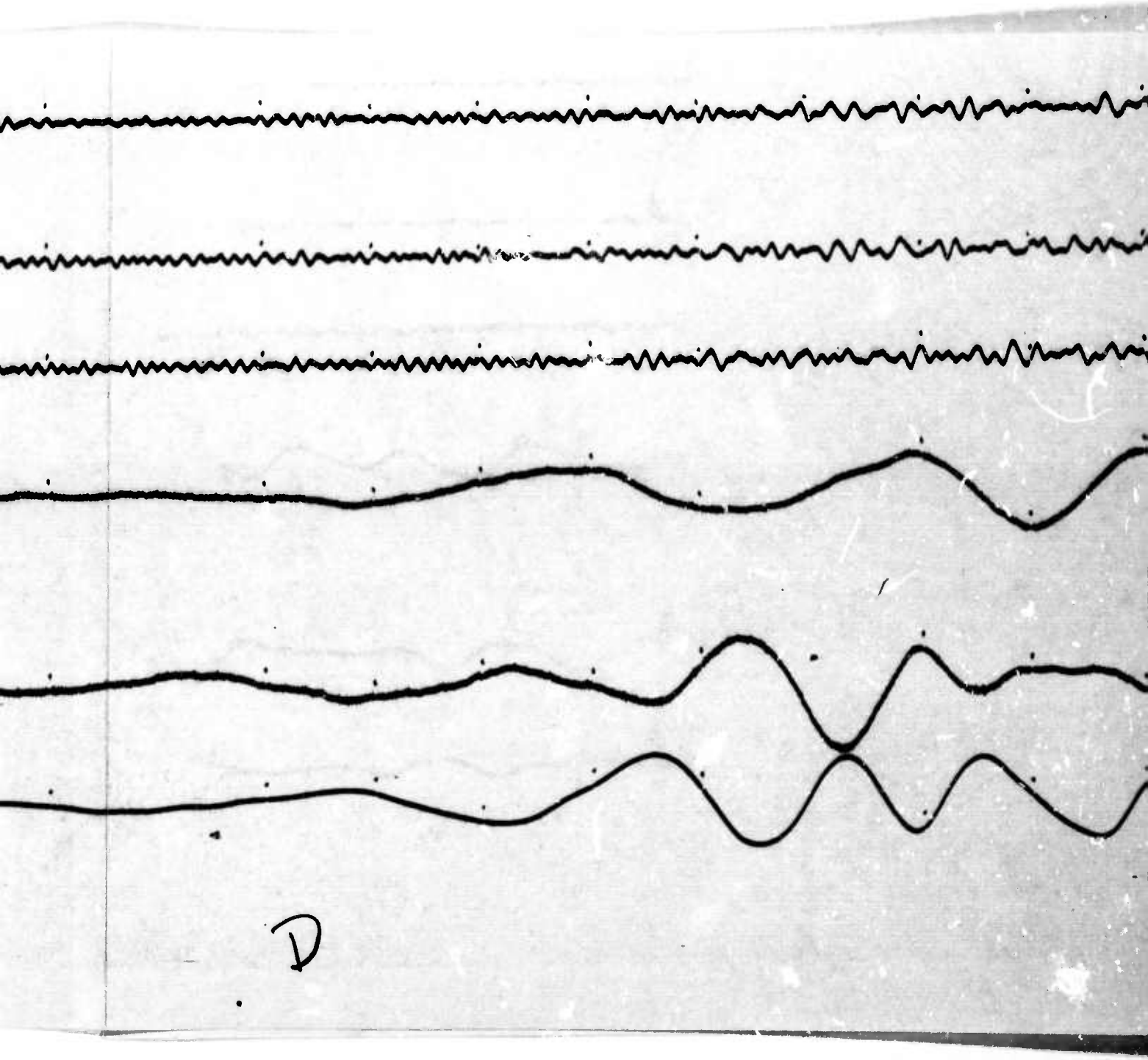
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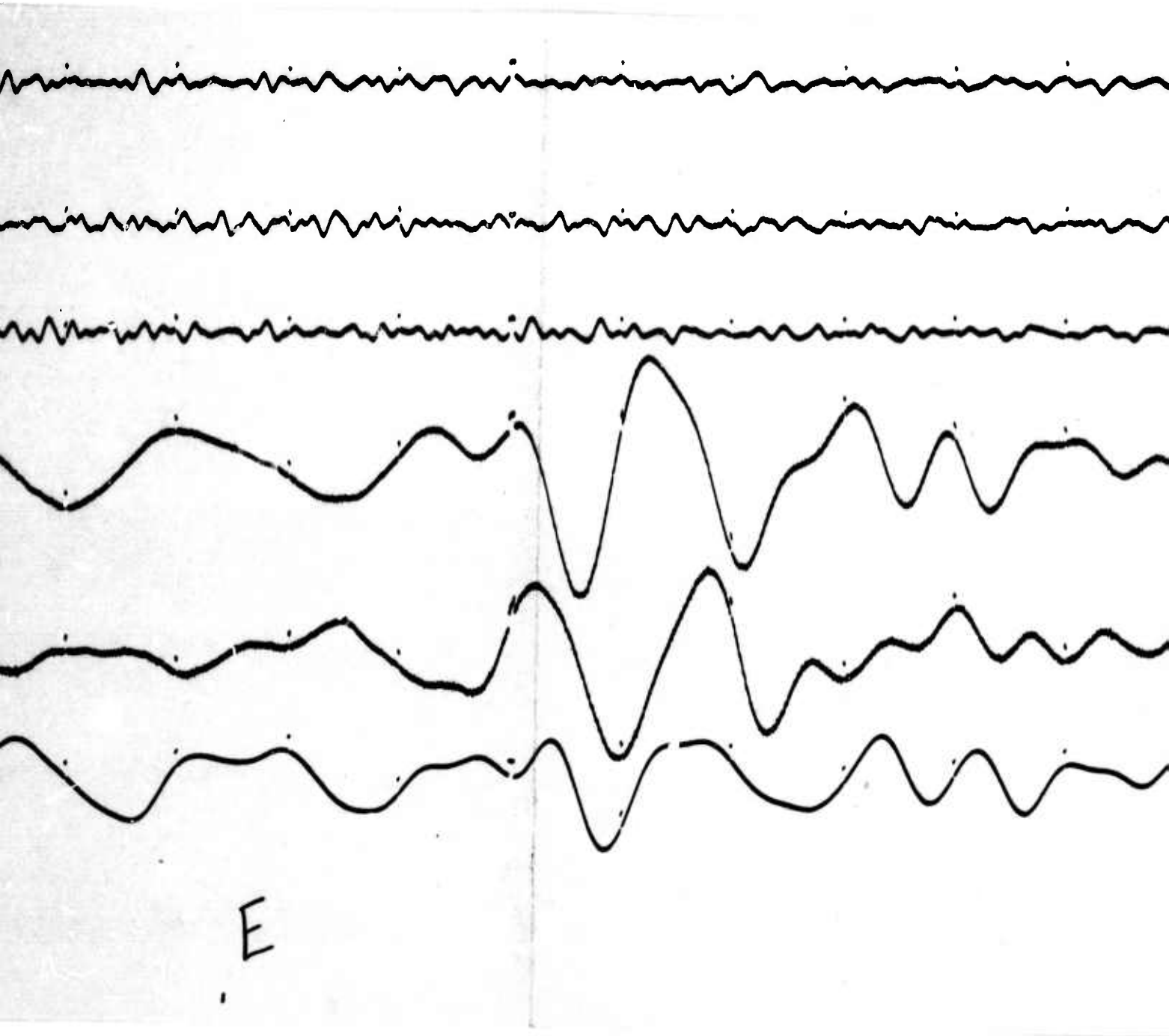
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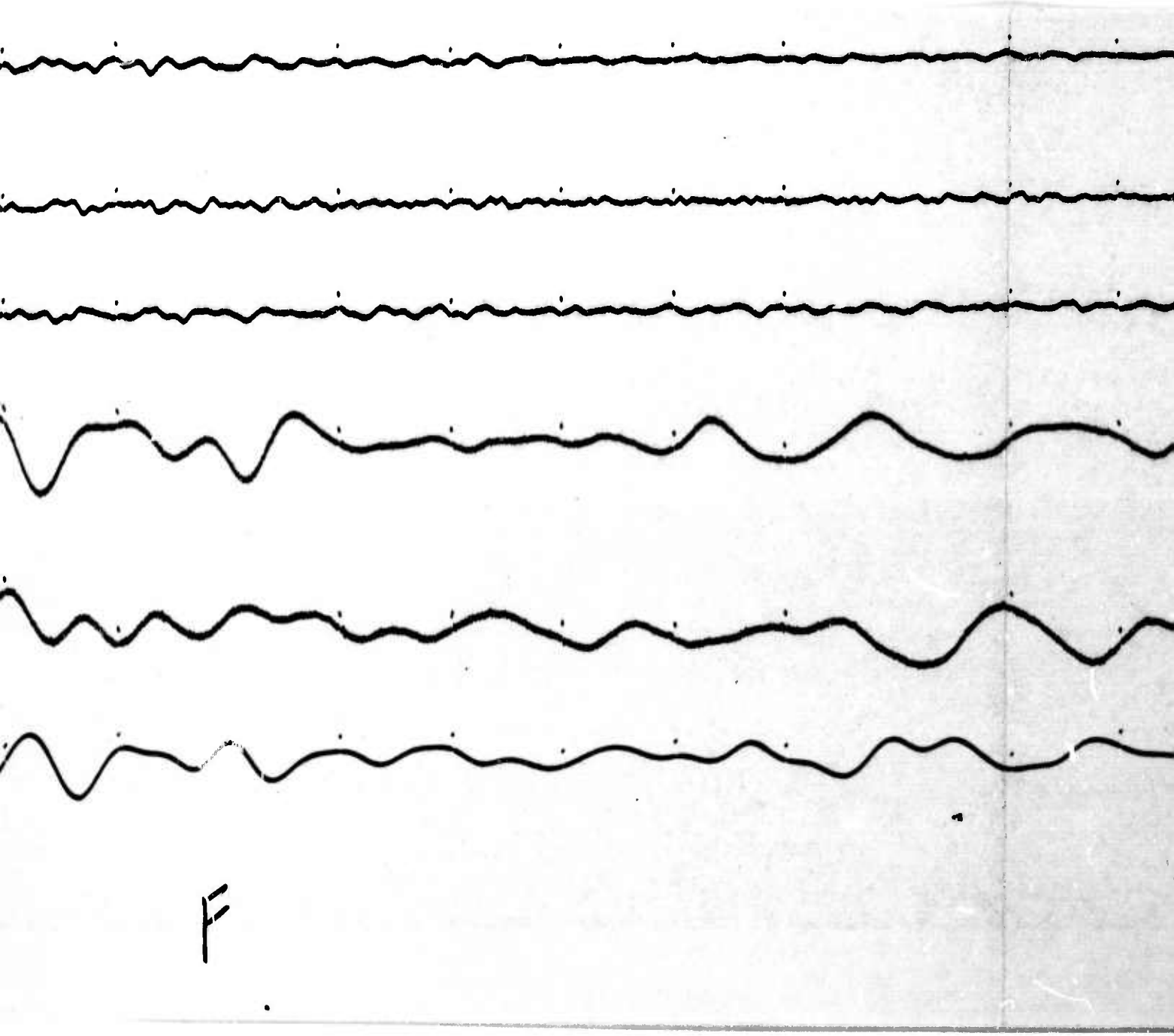

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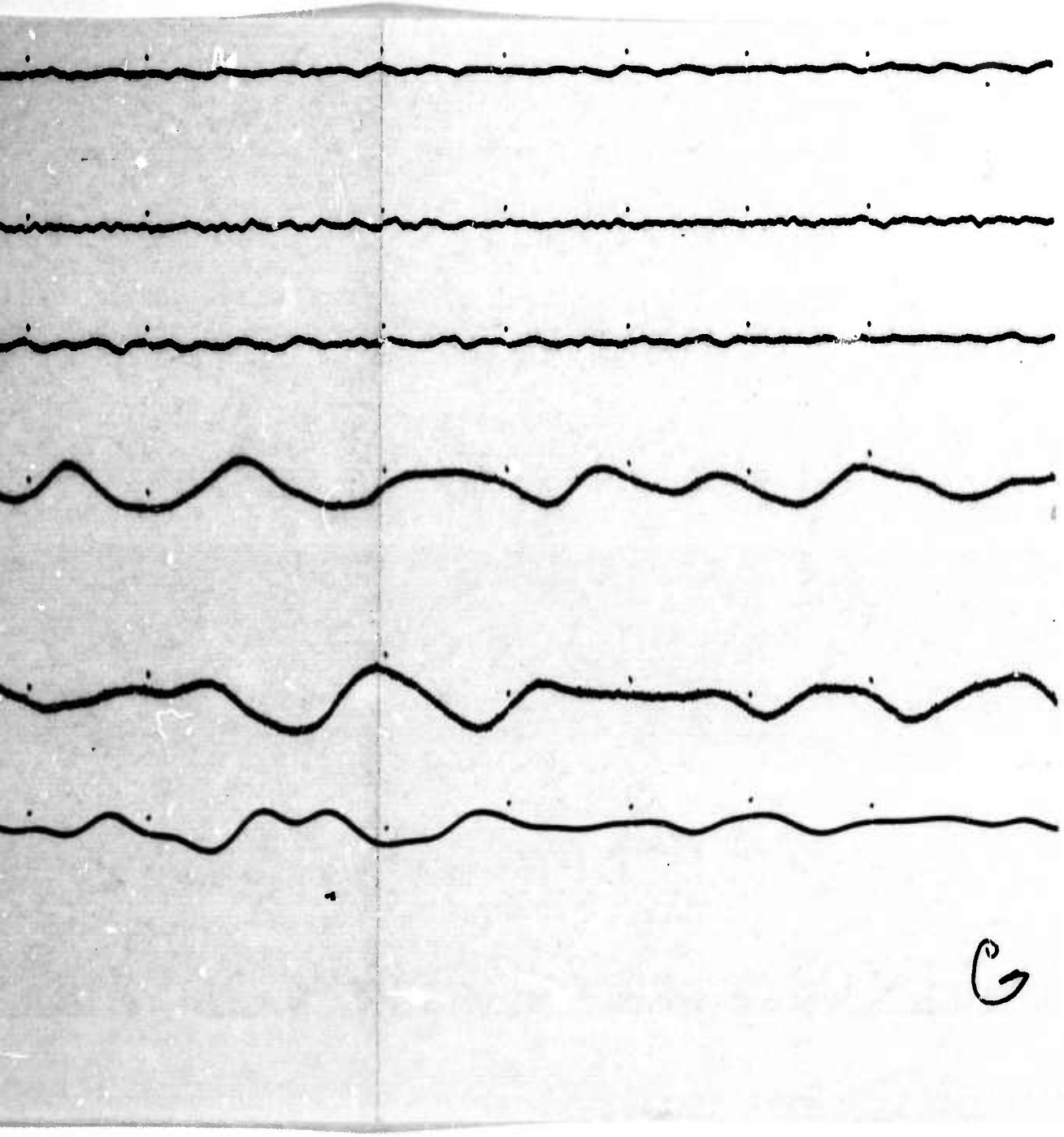
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FAULTLESS

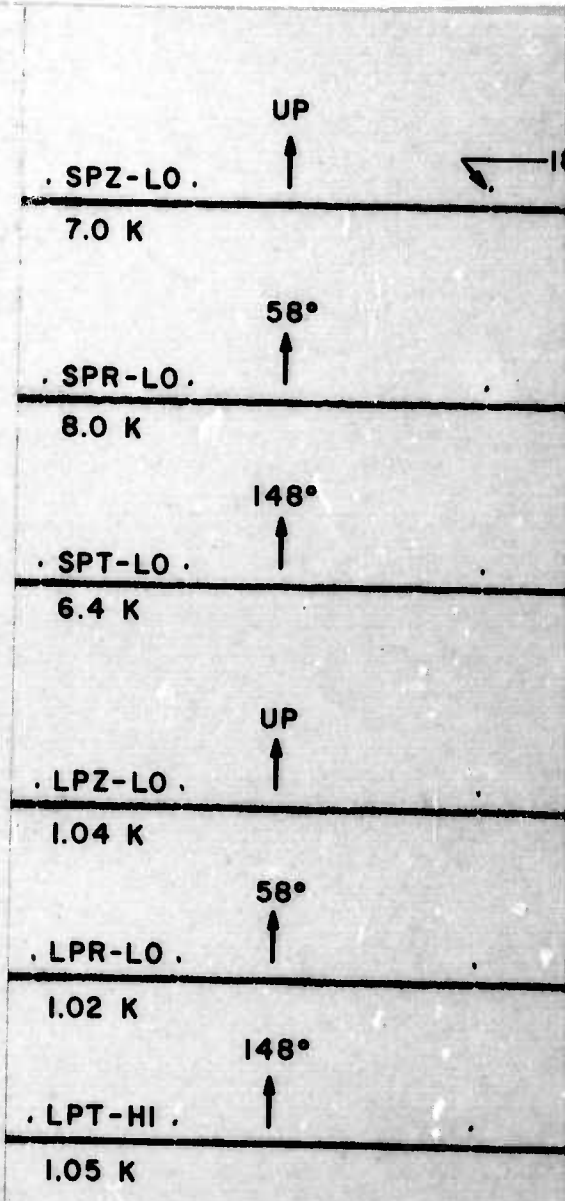
RK-ON

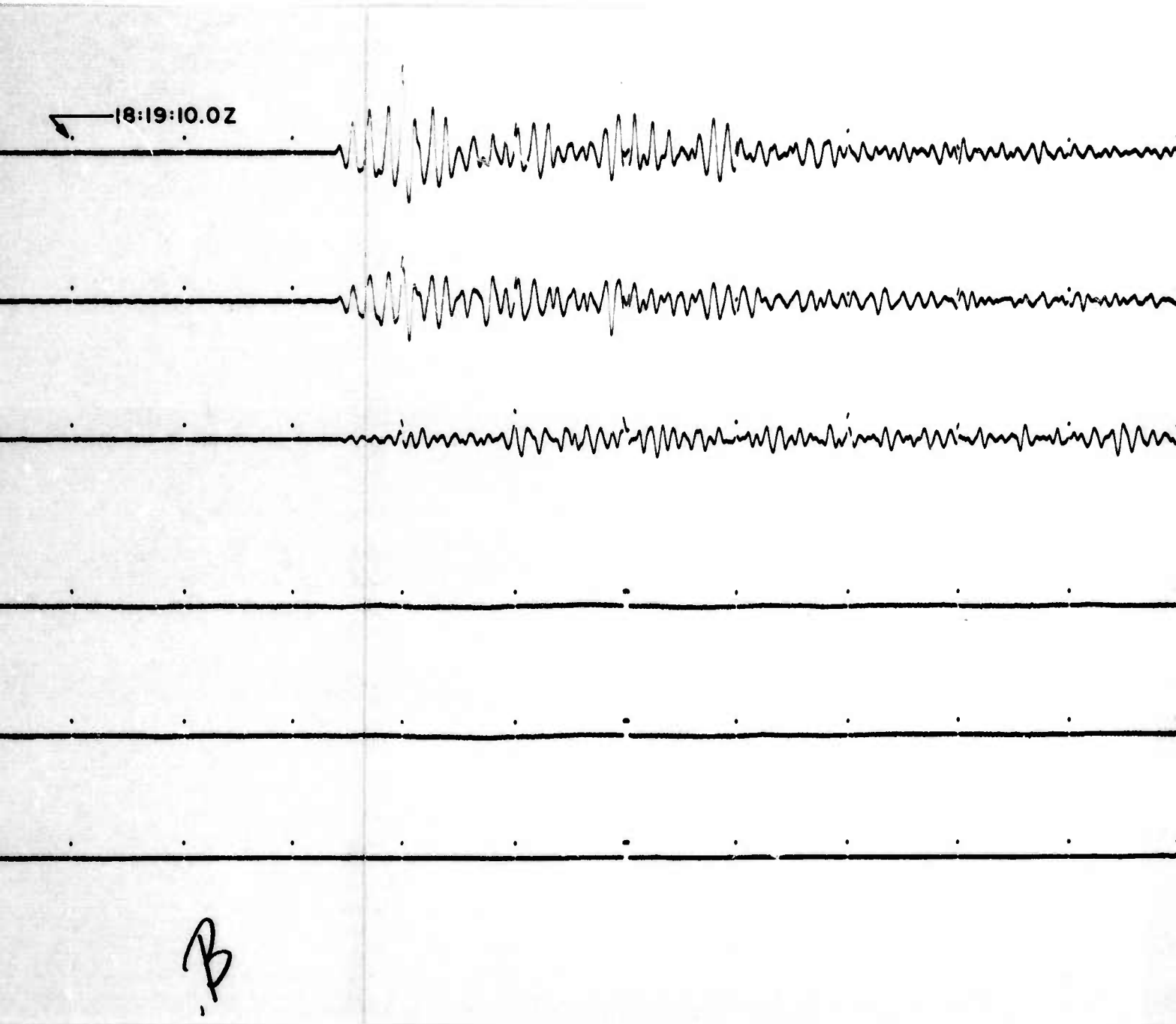
RED LAKE, ONTARIO, CANADA

19 JANUARY 1968

Δ = 2228 km

A

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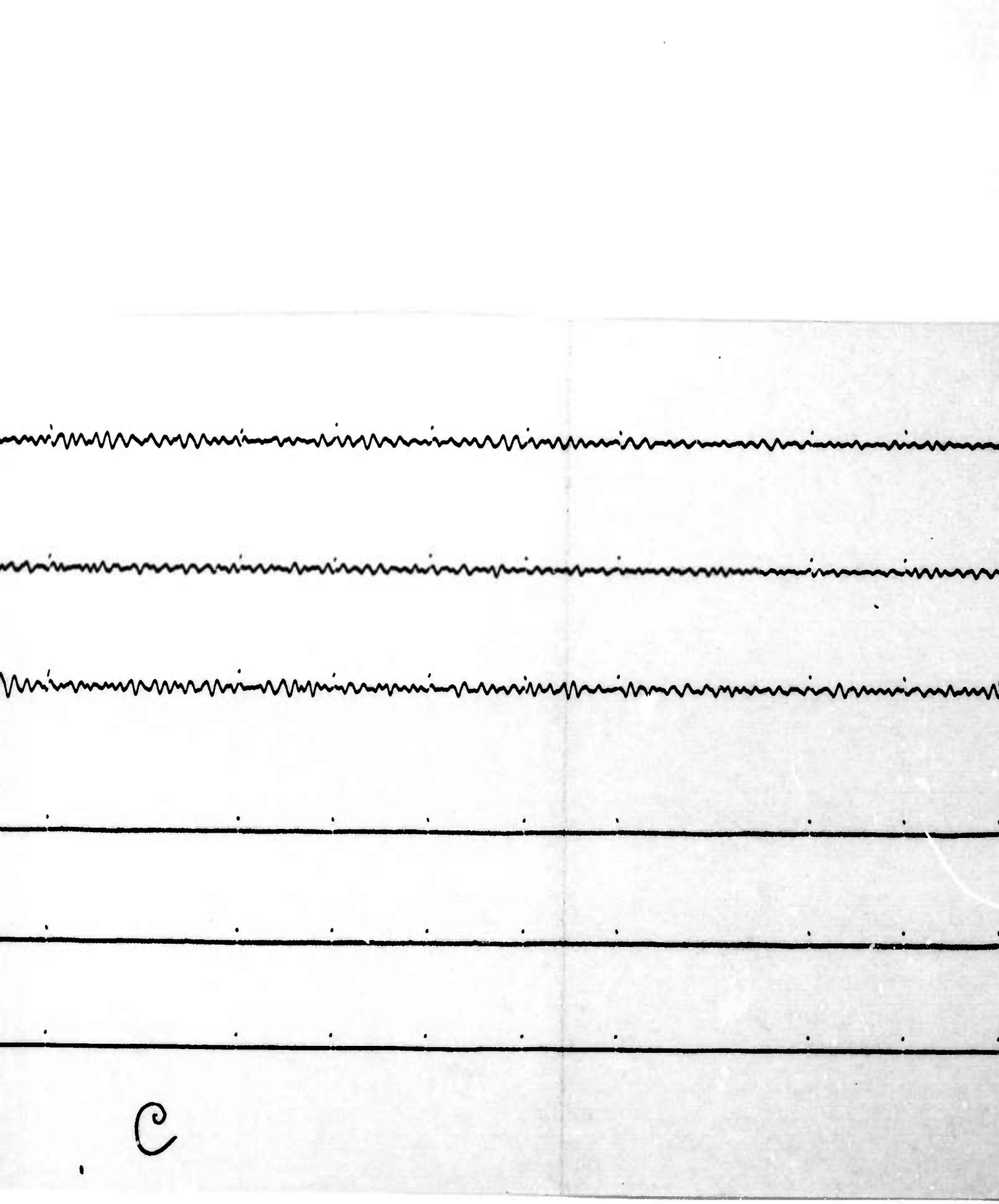
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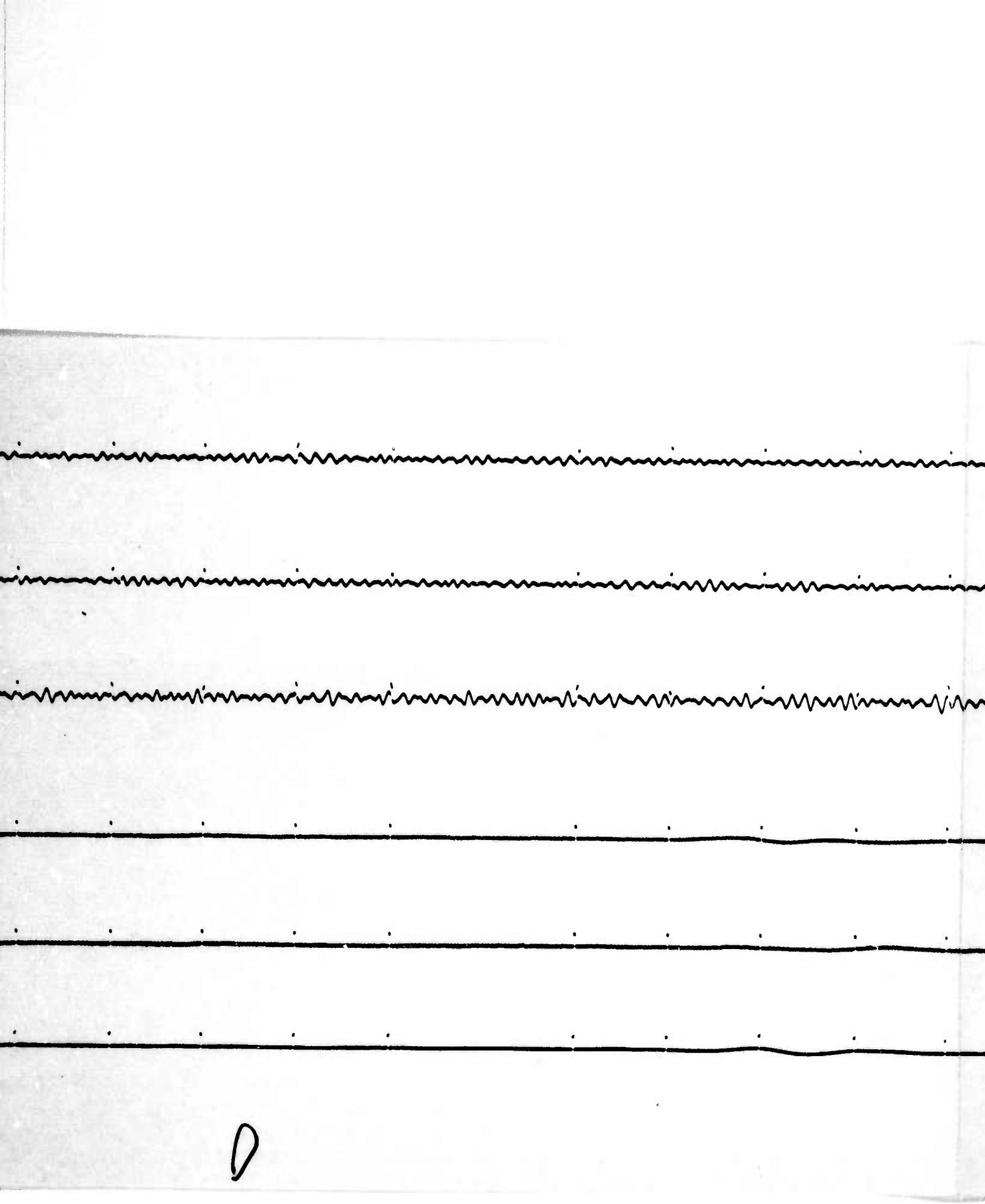
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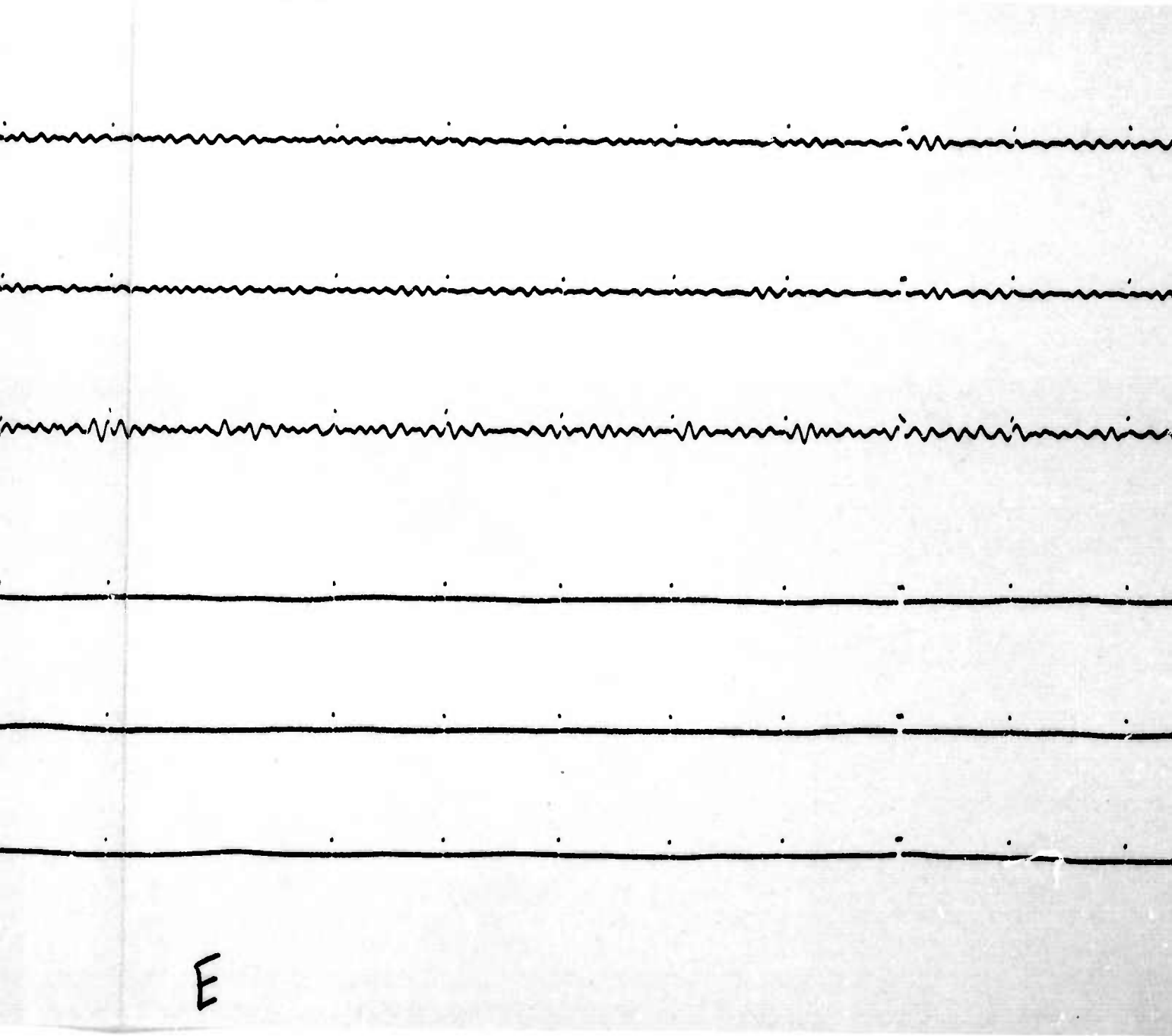
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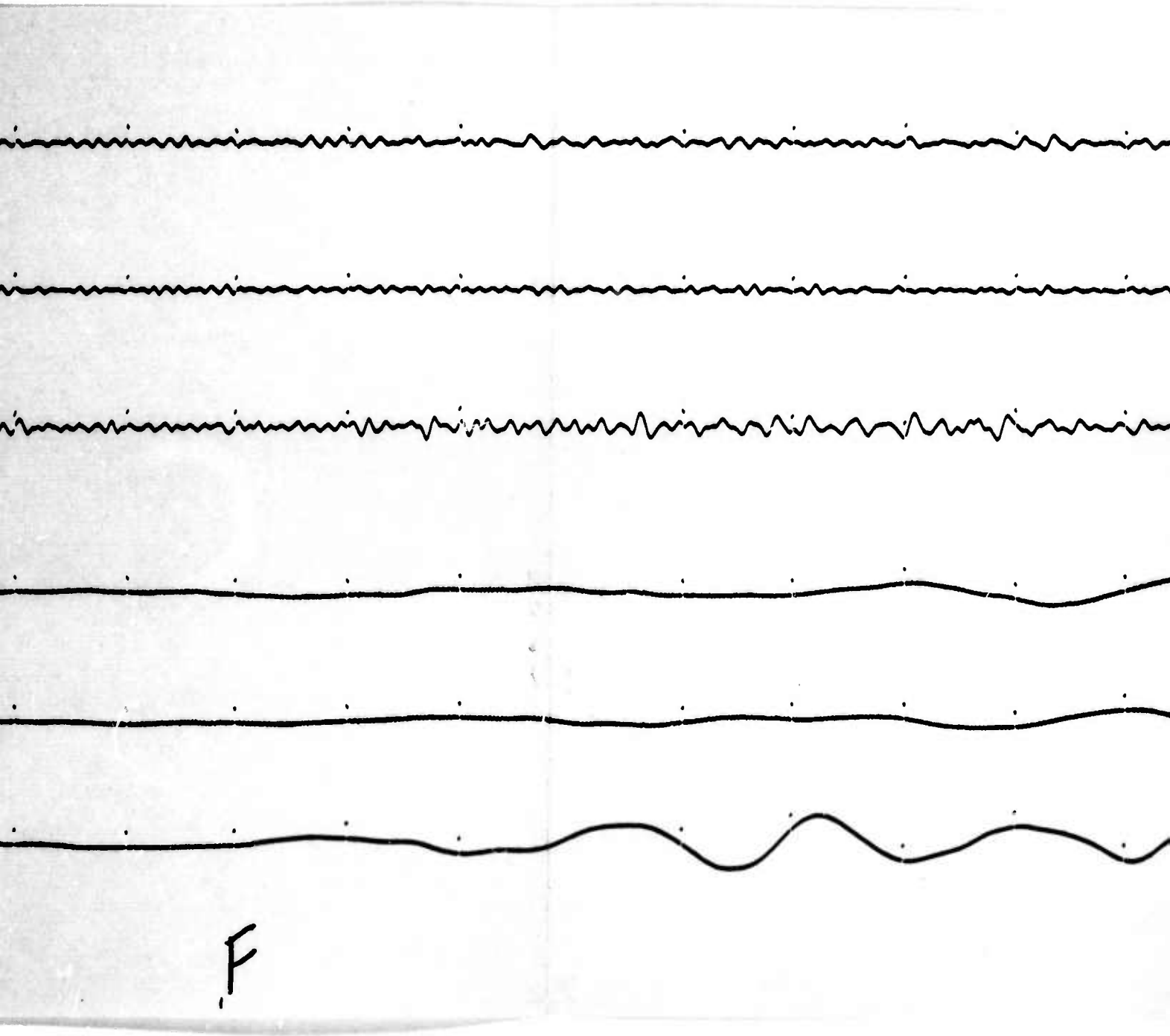

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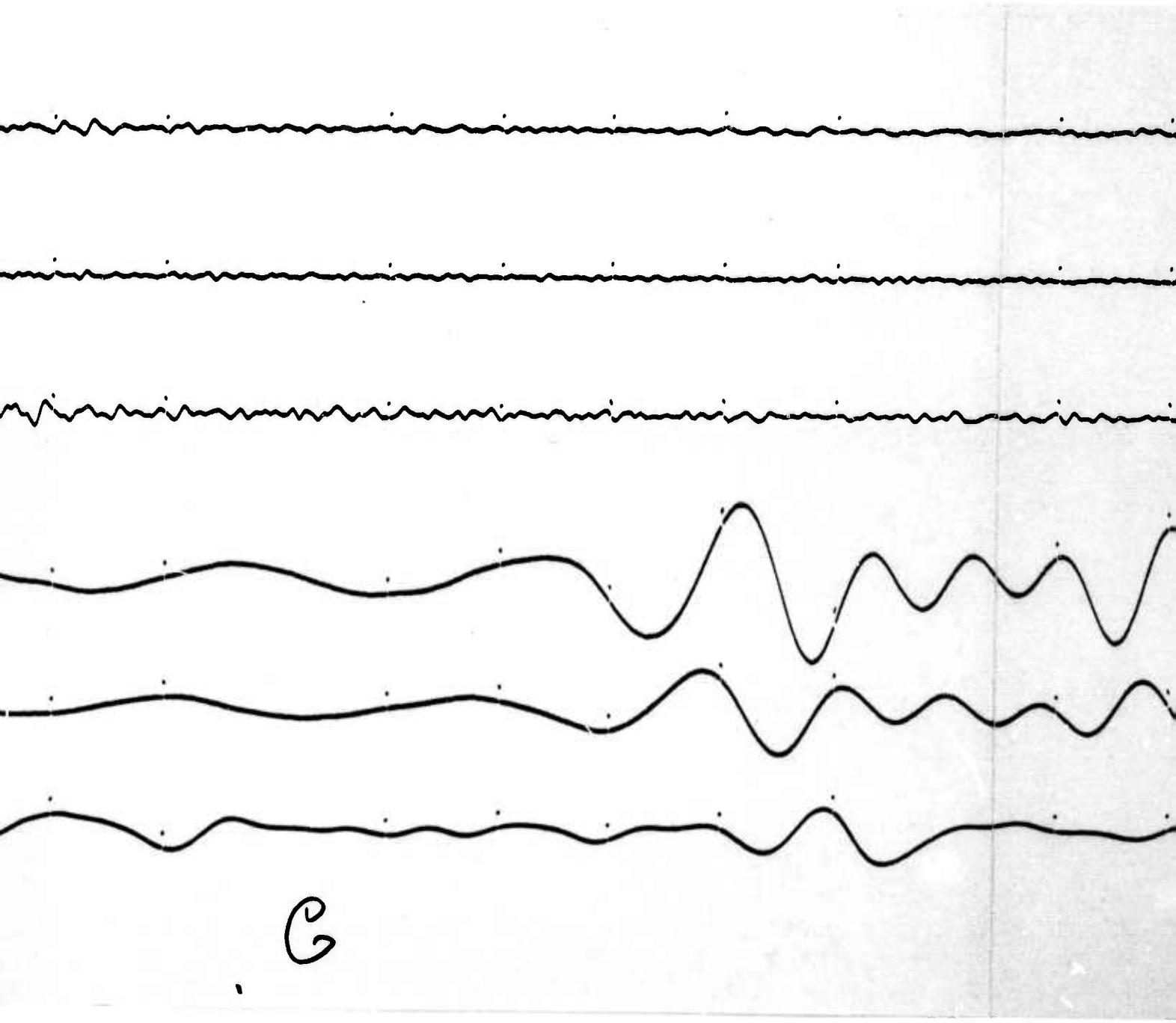
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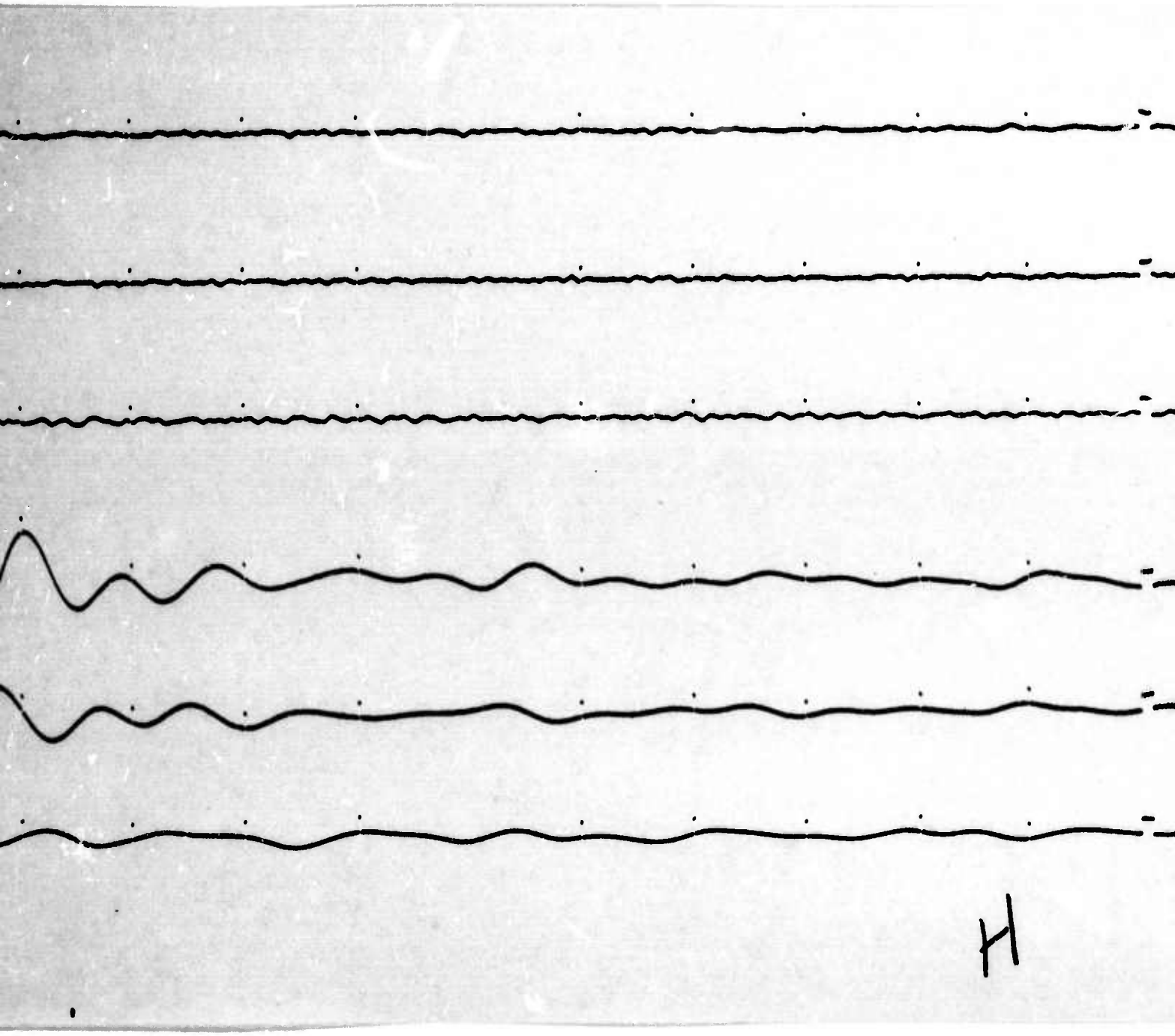
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FAULTLESS

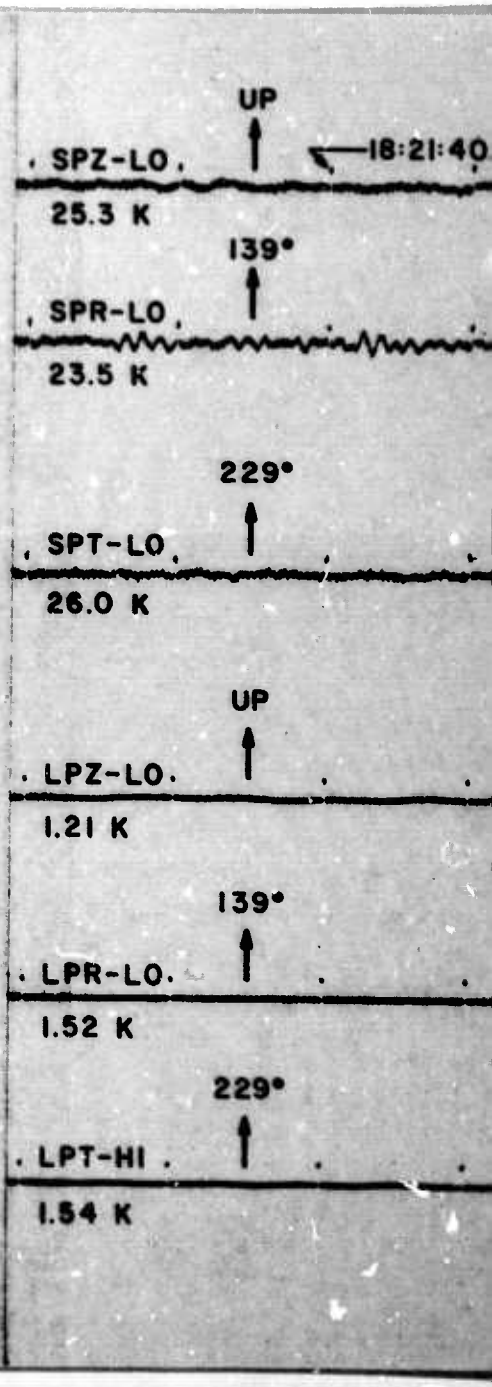
SV3QB

SCHEFFERVILLE, QUEBEC, CANADA

19 JANUARY 1968

Δ = 4082 km

A



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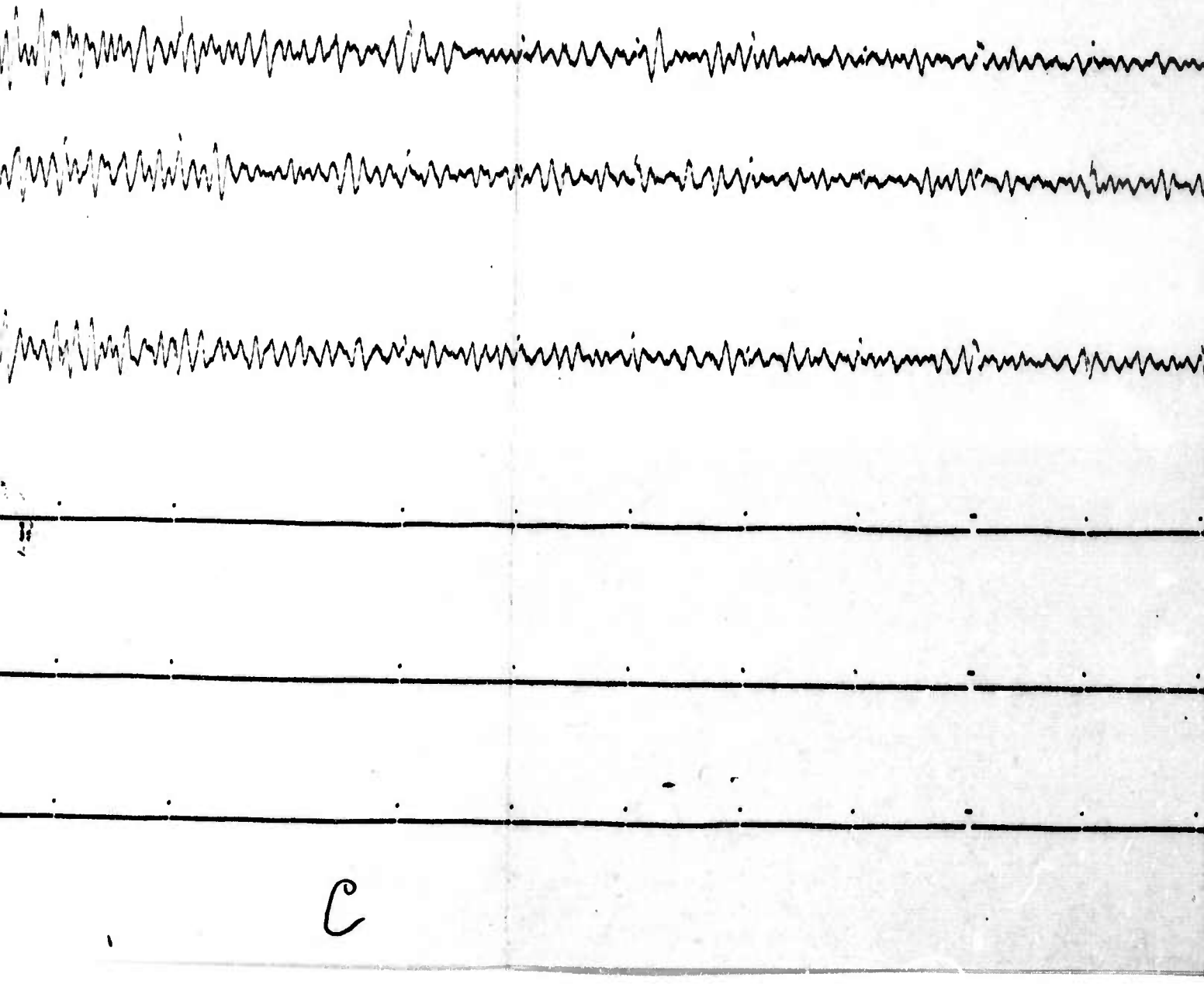

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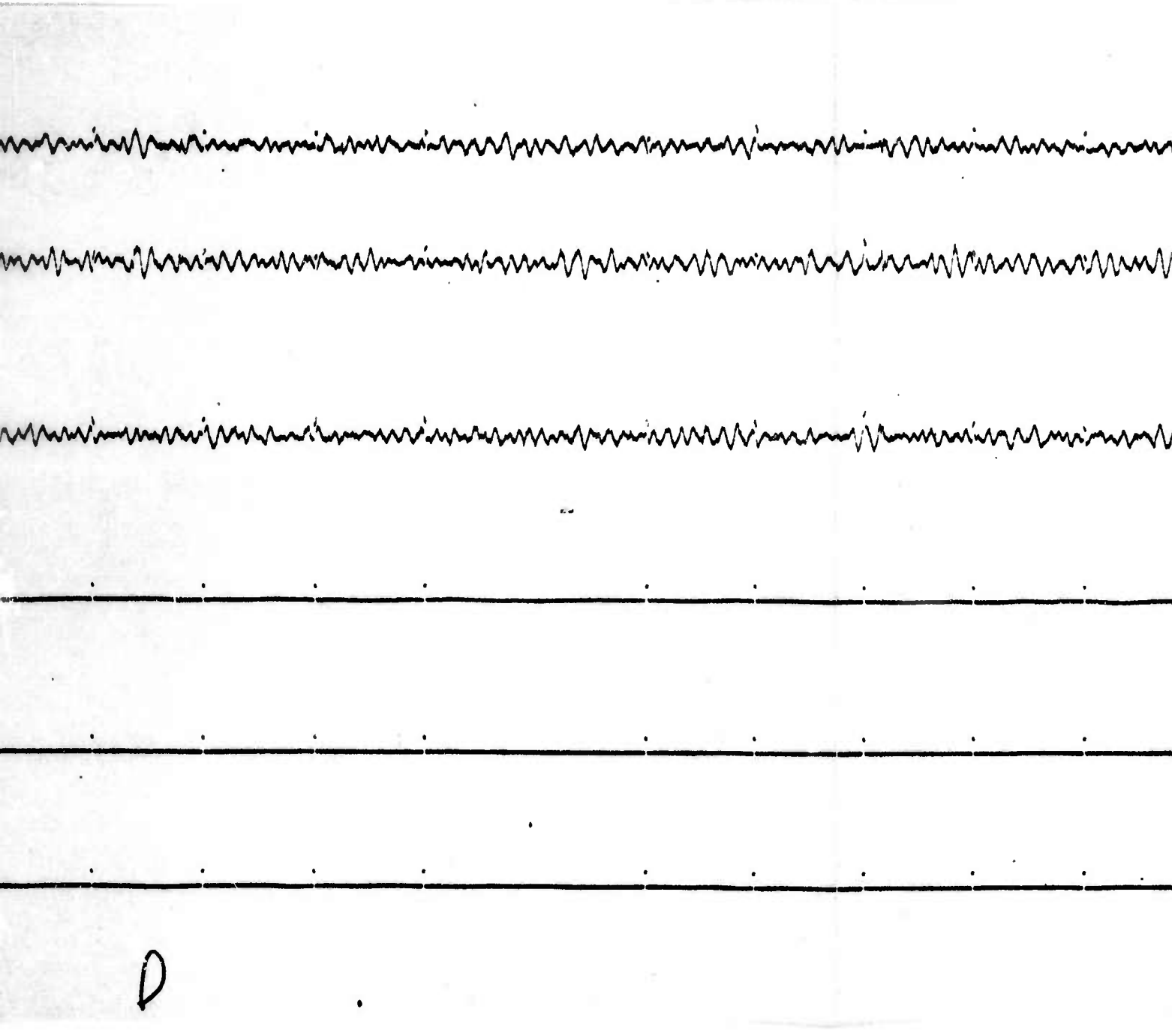
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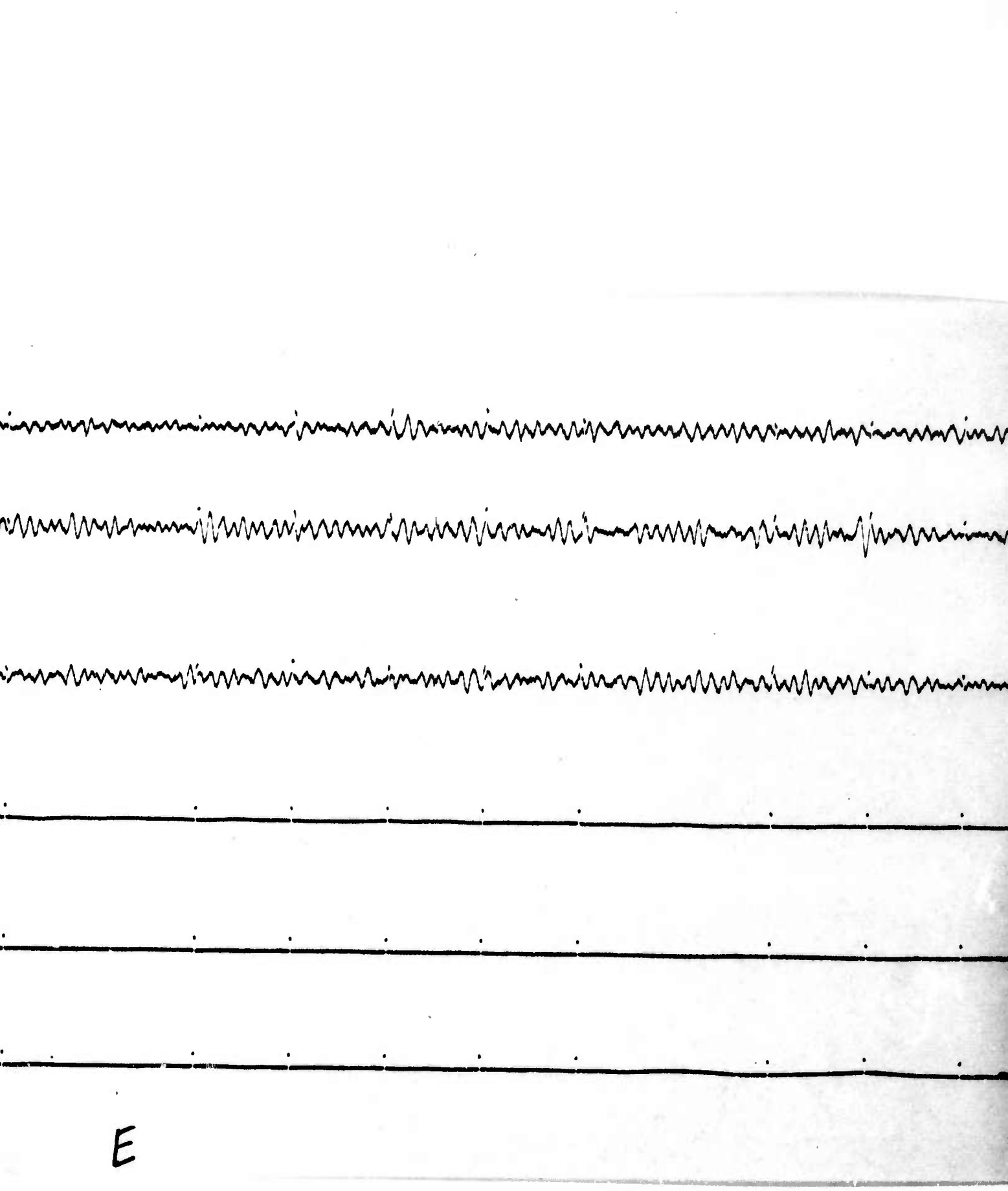
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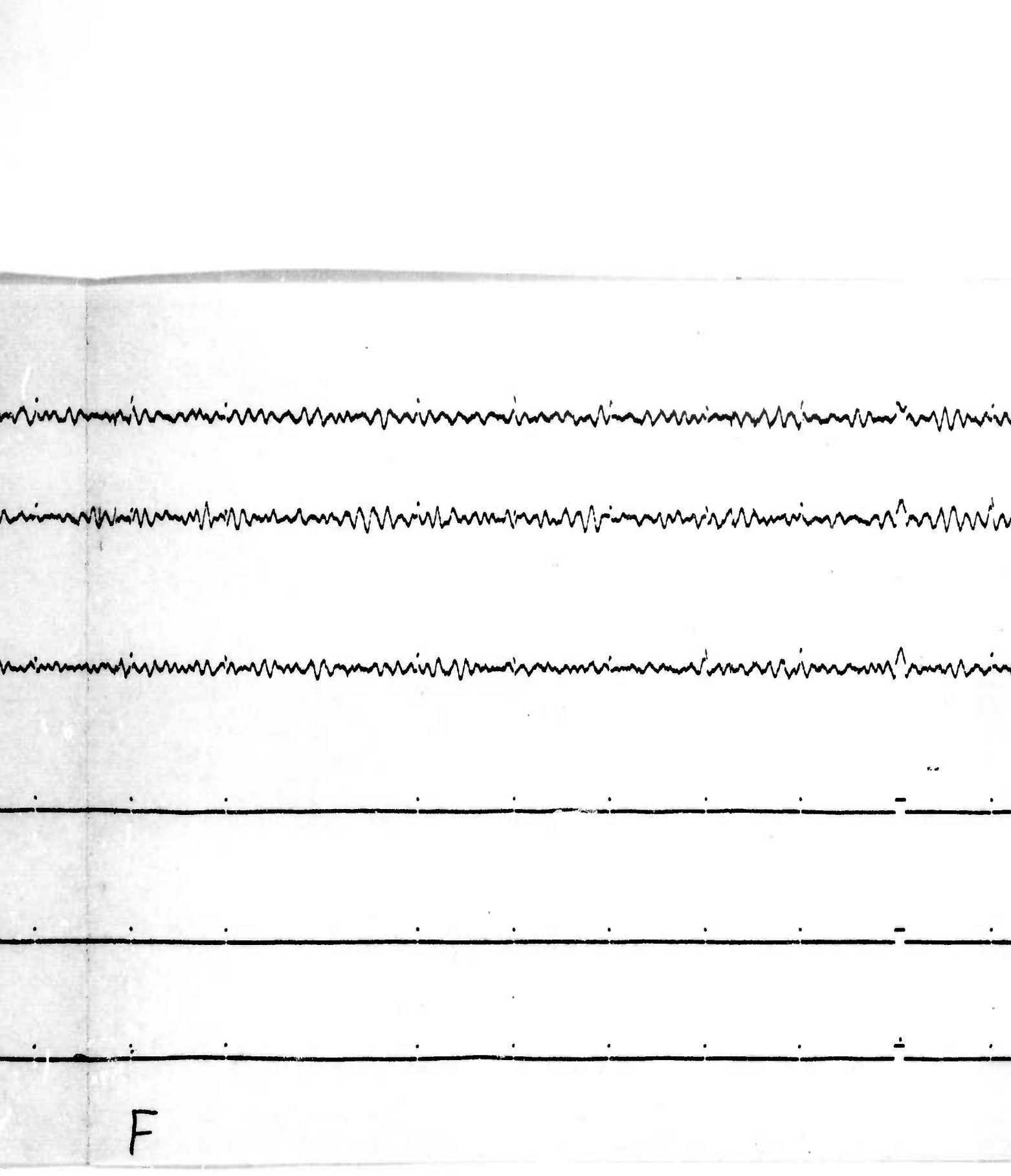
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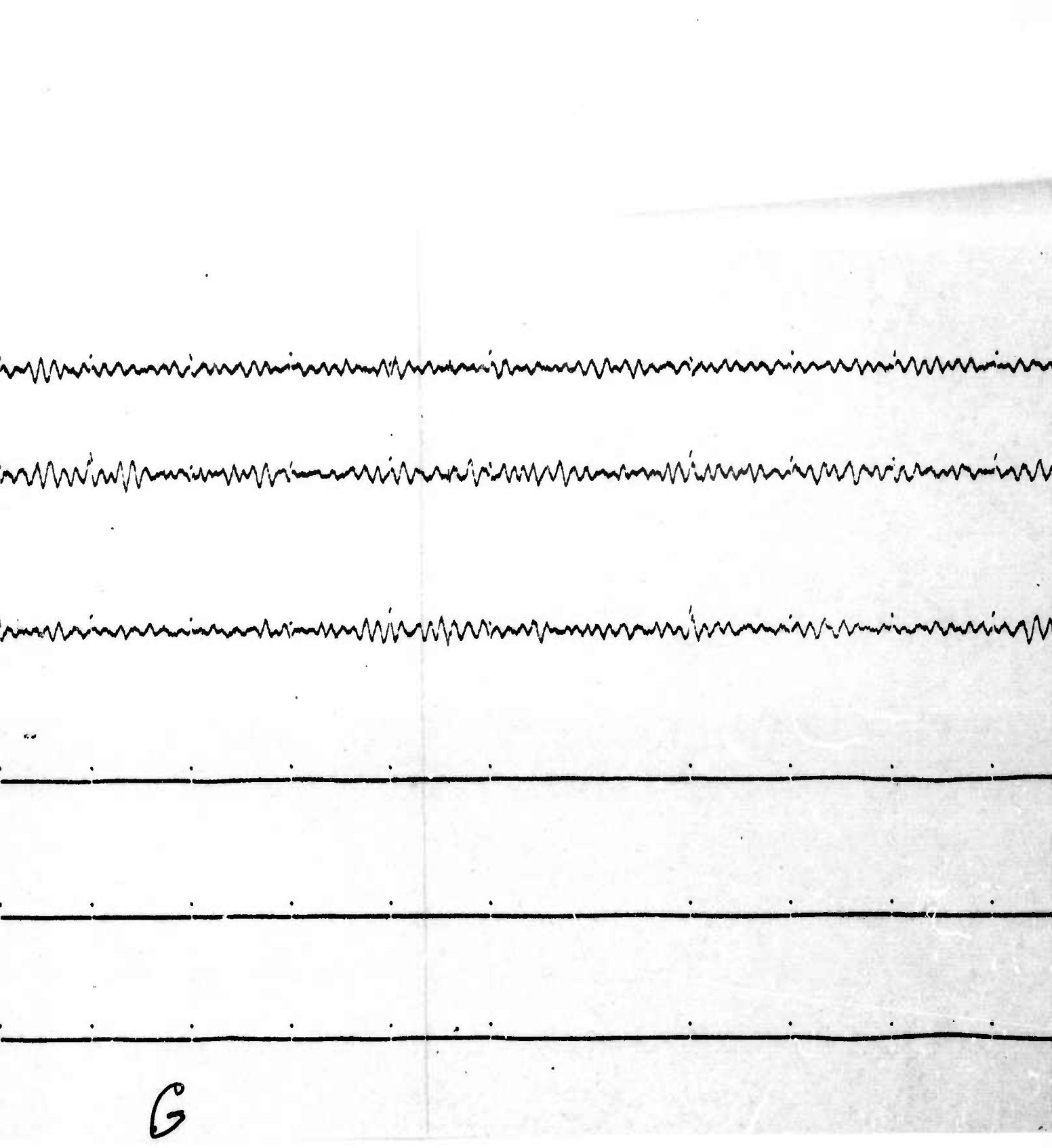
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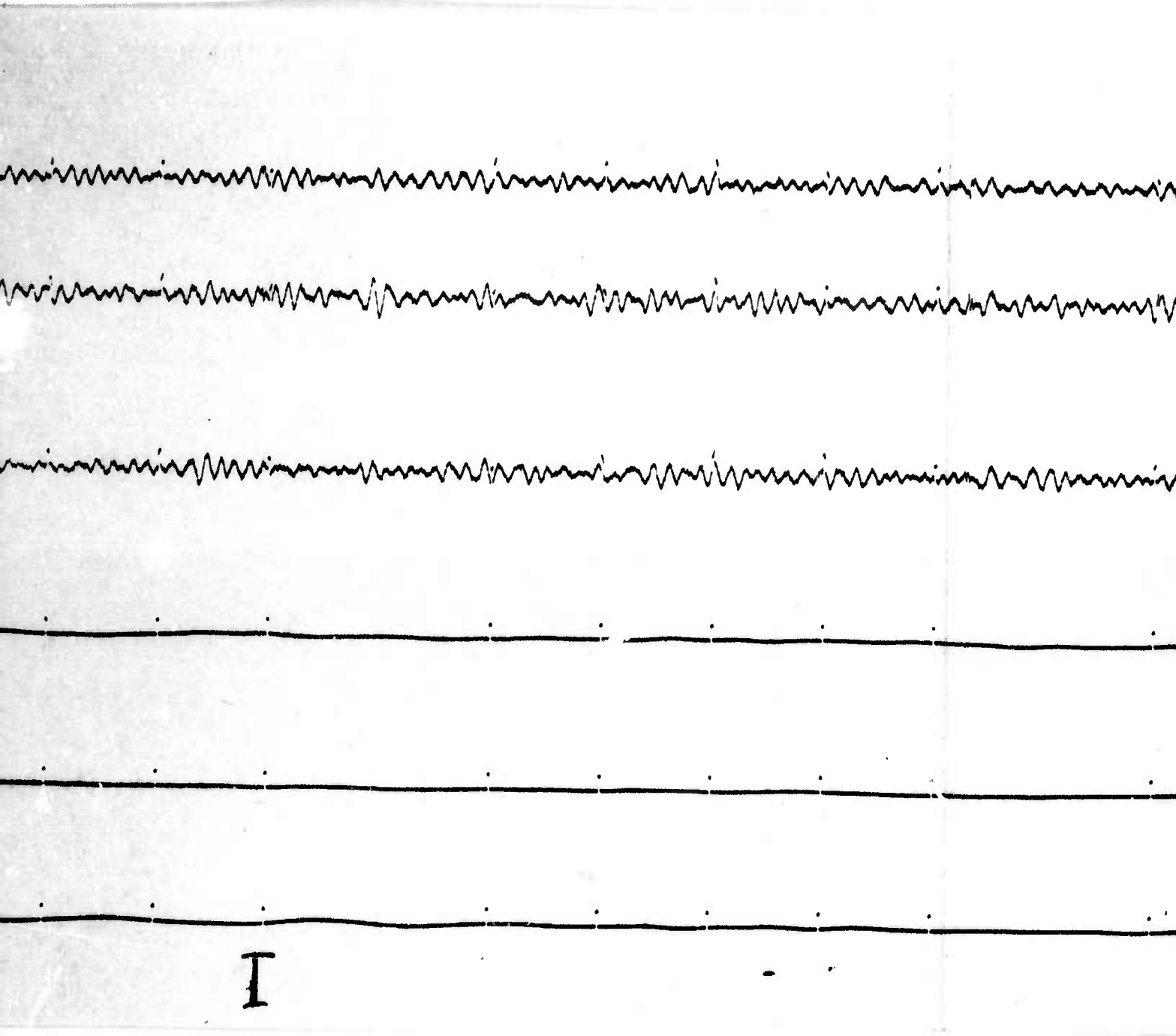
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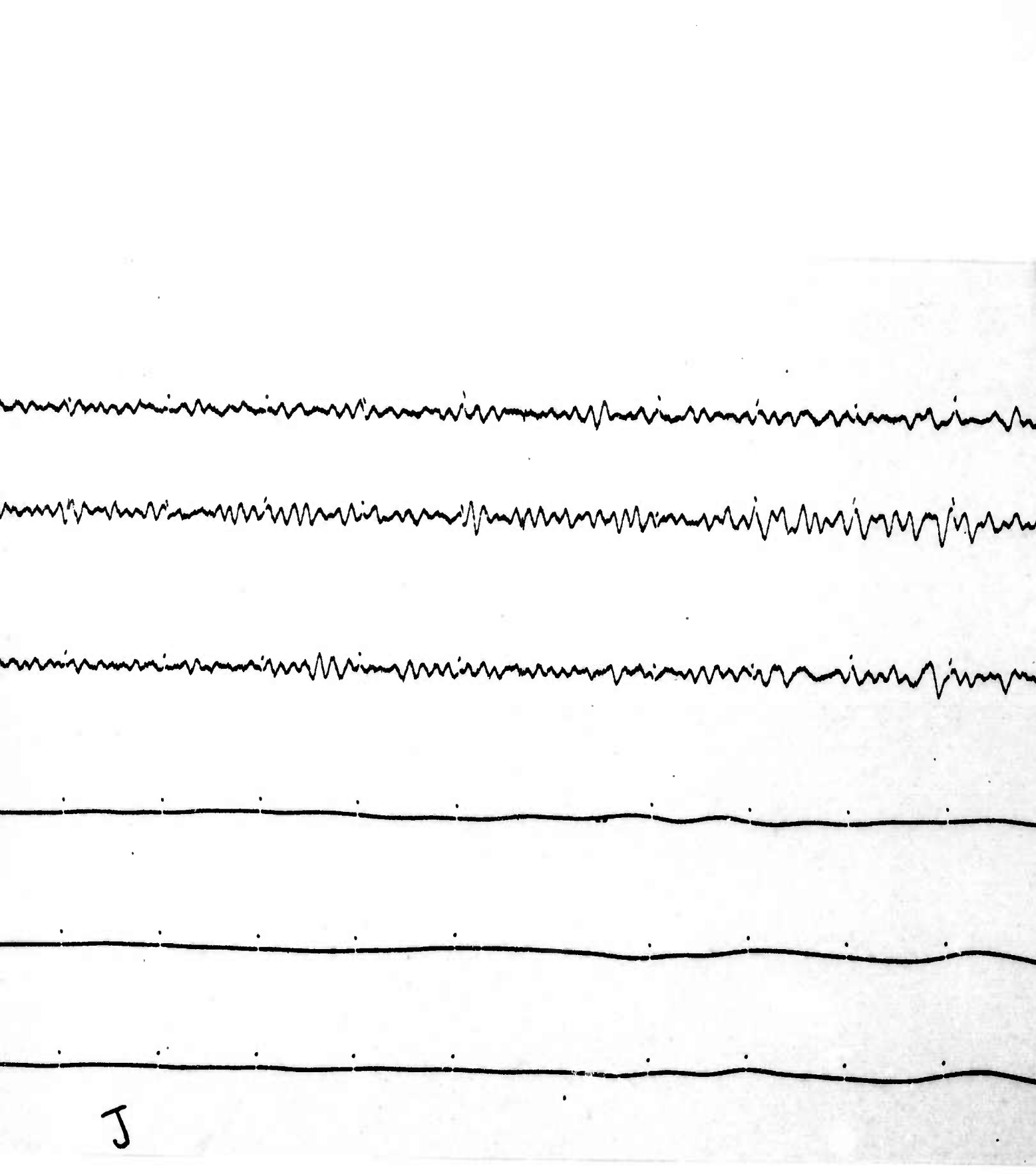
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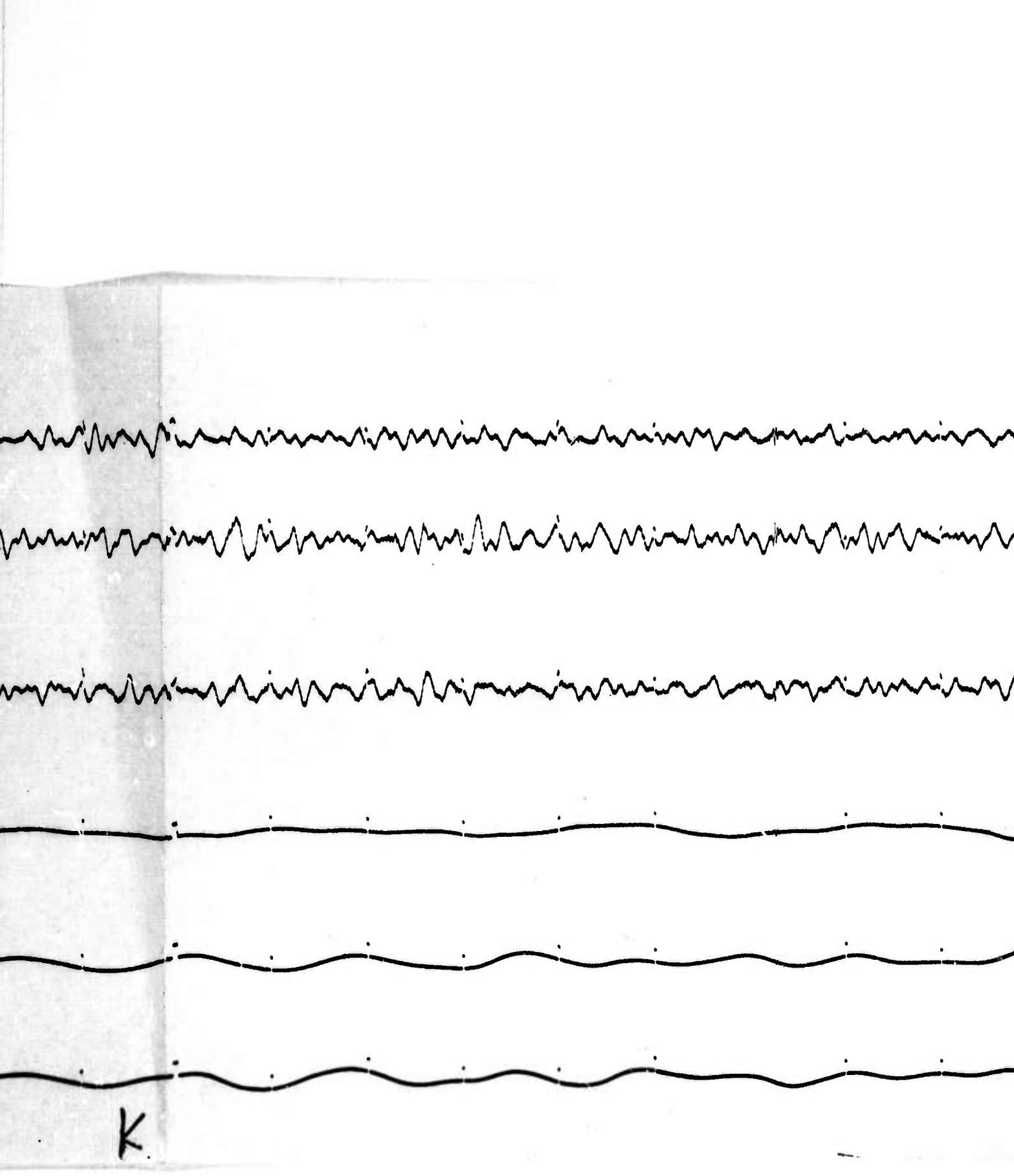
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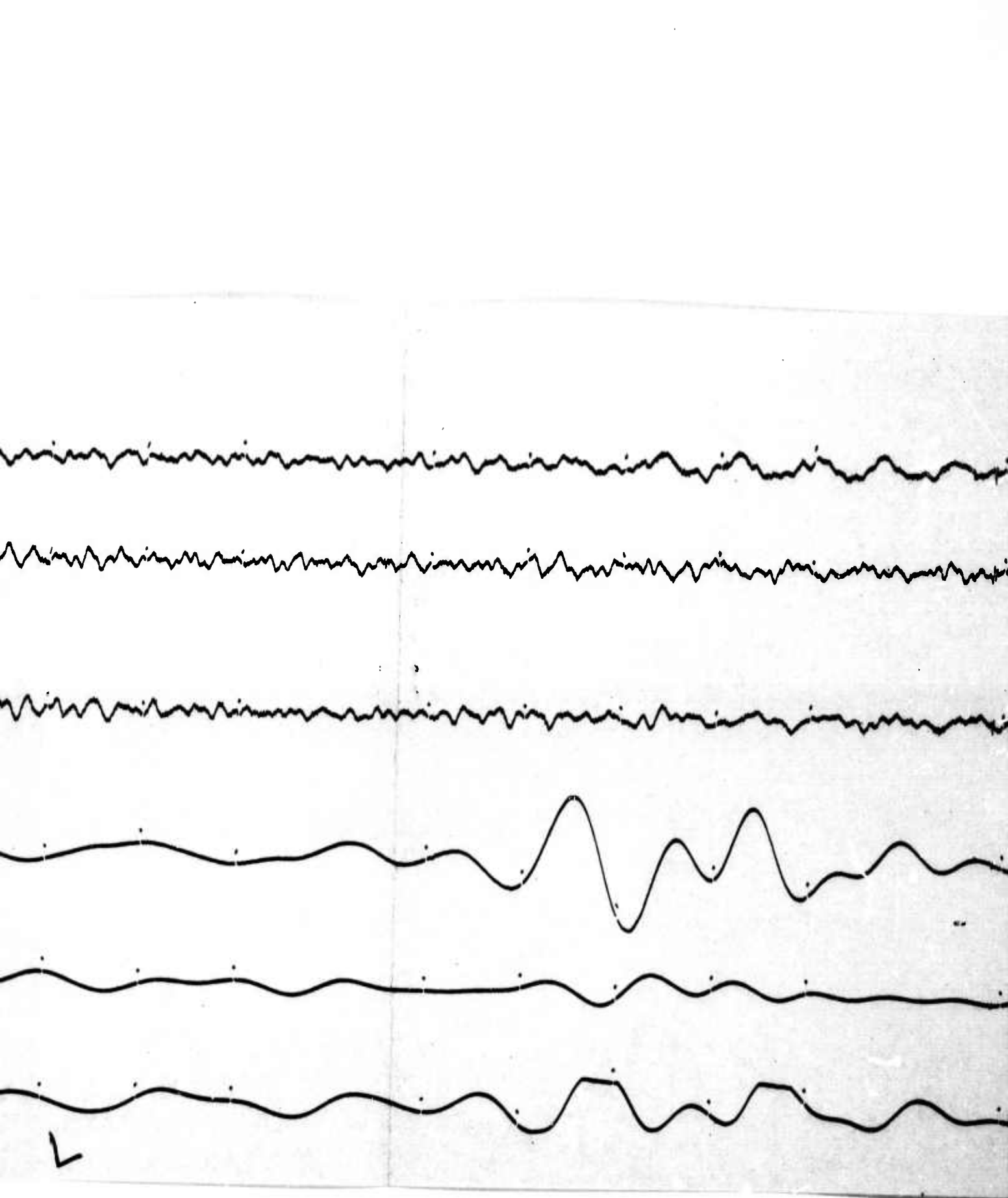

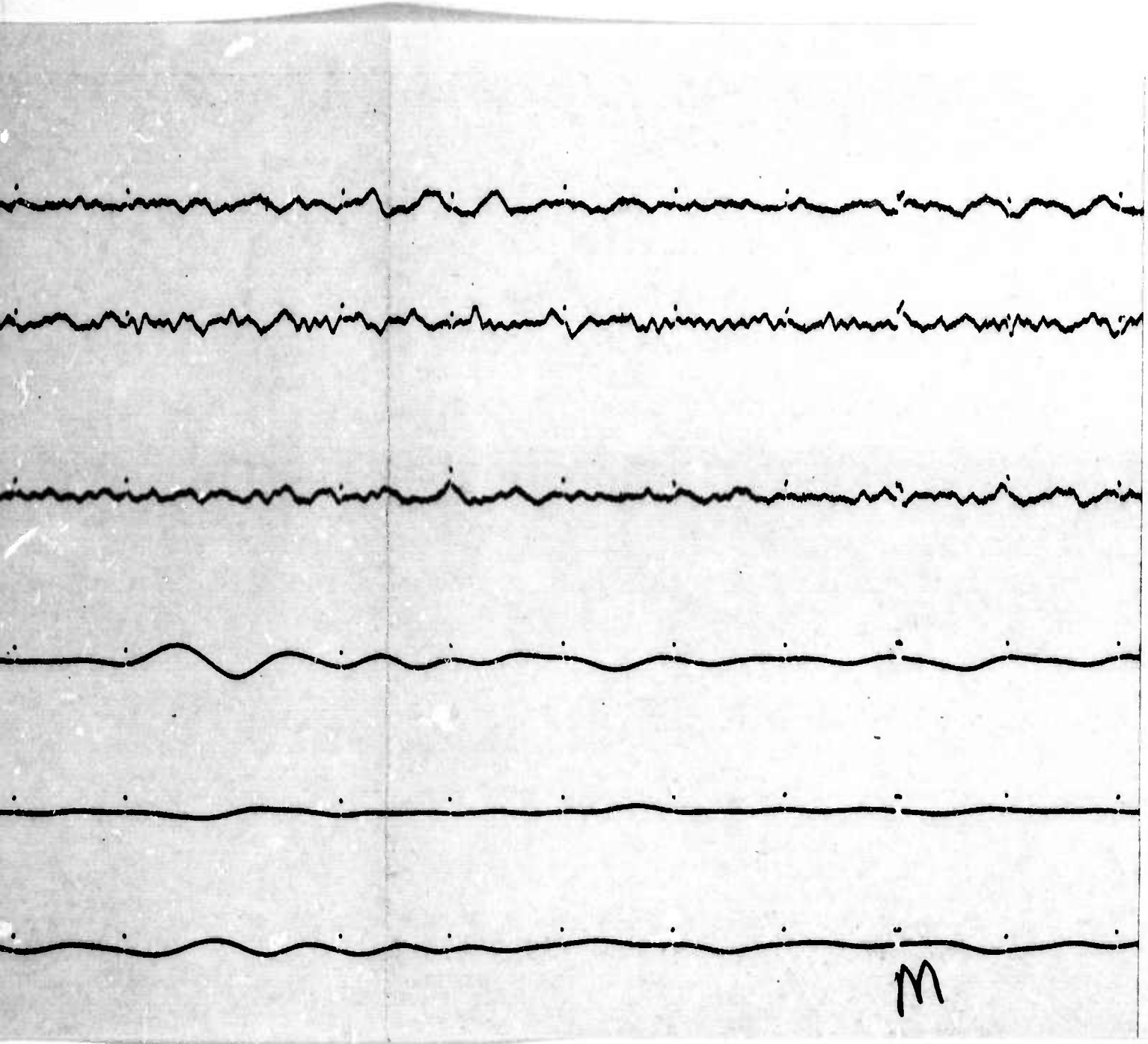
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