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DEPARTMENT OF COMMERCE

U. S. COAST AND GEODETIC SURVEY

E. LESTER JONES, Director

RESULTS OF OBSERVATIONS MADE AT THE
UNITED STATES COAST AND GEODETIC SURVEY
MAGNETIC OBSERVATORY AT SITKA,
ALASKA, IN 1921 AND 1922

BY

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INTRODUCTION

[Latitude 57° 03'.0; longitude 135° 20'.1 west; elevation 50 feet (15 meters)]

The magnetic observatory at Sitka was built in 1901 and its operation began in January, 1902. A description of the buildings will be found in the first volume of the observatory results (1902-1904). The methods of observing are explained in *Directions for Magnetic Measurements*, published in 1911 (second edition in 1921).

The division of terrestrial magnetism of the United States Coast and Geodetic Survey, of which N. H. Heck, hydrographic and geodetic engineer, is chief, includes both the office and field work. The office computations and preparation of results for publication were in charge of the writer, assisted by Frank Neumann, O. S. Hill, J. B. Goldsmith, and I. I. Kaplan, computers. The work of the observatory was in charge of F. P. Ulrich, magnetic observer, except for the period from September, 1921, to May, 1922, when A. K. Ludy, magnetic observer, was in charge.

Up to the end of 1914 each hourly value of declination, horizontal intensity, or vertical intensity in the monthly tabulations represented the momentary value of the quantity for the specified hour, local mean time. Beginning with 1915 the published hourly values are average values for successive periods of an hour, beginning at midnight of the specified standard meridian (one hundred and thirty-fifth in the case of Sitka). Thus, a value in the column headed 2 represents the average value for the hour beginning at 1^h and ending at 2^h, one hundred and thirty-fifth meridian mean time.

EARTHQUAKES

A Bosch-Omori seismograph has been in continuous operation since April, 1904. It consists of two horizontal pendulums, one recording north-south motion (N) and the other recording east-west motion (E). In the following table the times are Greenwich mean time counted from midnight. The quantities given in the last column denote the actual movement of the stylus (one-half of the maximum range) as measured on the seismogram.

Period of pendulums, E. 22 sec., N. 18 sec.
 Steady mass, 10 to 12 kg.
 Multiplication, 10.

Register of earthquakes

No.	Date	Compo- nent	P			S			L			M		C		F		A	
			h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	h.	m.	h.	m.		mm.
	1921																		
1	Feb. 21	N	15	59	50	--	--	--	--	--	--	16	02	32	--	--	16	09	0.2
2	Apr. 10	N	13	41	47	--	--	--	--	--	--	--	--	--	--	--	13	48	
		E	13	41	12	--	--	--	13	42	17	13	42	57	13	48	14	01	10.8
3	Apr. 12	N	--	--	--	--	--	--	7	30	50	7	31	37	--	--	7	36	.2
		E	--	--	--	--	--	--	7	31	00	7	31	52	--	--	7	47	1.8
4	May 1	N	6	04	39	--	--	--	--	--	--	--	--	--	--	--	6	11	.3
5	May 28	N	20	55	53	--	--	--	--	--	--	20	59	17	--	--	21	02	.1
6	Aug. 23	N	4	30	45	--	--	--	20	42	32	20	43	32	20	45	20	54	.1
7	Sept. 5	E	20	24	20	20	28	16	--	--	--	20	28	44	--	--	20	35	.1
8	Sept. 11	E	4	20	58	4	24	37	4	53	28	4	56	18	--	--	5	25	.1
9	Sept. 19	E	15	59	47	--	--	--	19	18	33	19	20	40	19	24	19	32	.1
10	Nov. 11	N	19	00	13	--	--	--	--	--	--	--	--	--	--	--	--	--	
		E	15	40	43	15	49	47	--	--	--	15	49	58	--	--	15	58	.5
11	Dec. 18	N	15	40	40	15	49	47	--	--	--	15	50	11	--	--	15	59	.6
	1922																		
12	Jan. 5	E	--	--	--	--	--	--	9	08	27	9	09	06	9	09	9	13	.1
13	Jan. 17	E	4	03	47	4	10	51	--	--	--	4	10	55	4	15	4	42	1.5
		N	4	01	56	4	10	51	--	--	--	4	10	55	4	12	4	22	2.0
14	Jan. 22	E	--	--	--	--	--	--	4	00	46	4	10	00	4	16	4	21	.2
15	Jan. 26	E	--	--	--	--	--	--	9	38	07	9	38	44	--	--	9	46	.3
16	Jan. 31	E	13	21	30	--	--	--	13	24	52	13	26	02	13	27	14	40	30.4
		N	13	21	30	--	--	--	13	24	58	13	26	41	13	33	14	24	4.4
17	Apr. 2	E	19	17	25	--	--	--	10	20	43	19	24	04	--	--	19	44	.1
		N	19	19	39	--	--	--	--	--	--	19	19	58	--	--	19	23	.3
18	Apr. 8	E	21	02	11	--	--	--	21	10	46	21	07	04	--	--	21	19	.2
		N	--	--	--	--	--	--	--	--	--	--	--	--	--	--	21	14	
19	Apr. 13	E	15	08	03	--	--	--	15	08	29	15	08	31	--	--	15	14	1.0
		N	15	08	11	--	--	--	--	--	--	--	--	--	--	--	15	12	
20	July 2	E	13	39	22	13	43	23	13	45	13	13	47	44	--	--	14	09	.1
21	Aug. 11	E	--	--	--	--	--	--	13	55	27	13	57	33	--	--	14	07	.1
		N	--	--	--	--	--	--	13	56	12	13	57	28	--	--	14	11	.1
22	Aug. 13	E	--	--	--	--	--	--	0	52	00	0	55	07	--	--	1	07	.1
		N	--	--	--	--	--	--	0	52	50	1	03	17	--	--	1	14	.2
23	Sept. 1	E	19	33	27	19	37	38	19	58	21	20	05	14	20	13	20	43	.8
		N	19	31	03	19	37	43	20	02	35	20	16	06	20	19	20	48	.2
24	Sept. 3	E	3	32	25	--	--	--	--	--	--	3	32	37	--	--	3	36	.1
		N	3	32	29	--	--	--	--	--	--	3	32	41	--	--	3	34	.1
25	Sept. 14	E	--	--	--	--	--	--	20	14	54	20	13	21	--	--	20	33	.1
		N	--	--	--	--	--	--	20	14	54	20	18	48	--	--	20	29	.1
26	Oct. 6	E	5	33	37	--	--	--	5	35	44	--	--	--	--	--	5	39	.1
		N	5	32	25	--	--	--	5	34	51	5	35	07	--	--	5	39	.1
27	Oct. 24	E	21	29	05	21	35	34	21	41	54	21	44	52	--	--	22	08	.8
		N	--	--	--	21	35	34	--	--	--	21	39	39	--	--	22	00	.5
28	Nov. 11	E	--	--	--	4	57	45	5	20	20	5	26	53	0	11	8	12	13.1
		N	--	--	--	4	58	38	5	22	20	5	29	41	5	31	8	44	11.0
29	Nov 17	E	11	54	08	11	56	58	11	58	59	12	01	00	--	--	12	16	.2
		N	11	54	08	--	--	--	11	58	56	12	02	50	--	--	12	85	.1
30	Dec. 31	E	7	28	12	7	34	58	7	42	20	7	43	34	--	--	8	08	.5
		N	--	--	--	7	35	05	--	--	--	7	39	21	--	--	8	16	.2

REMARKS

1. No definite phases. E not in operation.
2. E not working well.
- 4, 5. No definite phases. E not in operation.
- 7, 8, 9, 12, 14, 15. No definite phases. Nothing on N.
16. Distance 1,500 km; O at 13:17:10.
- 17, 18. Phases ill-defined.
20. Phases ill-defined; first two are very faint. The one tabulated as L may be S, and L may come at 13:47:21.
23. SR₁ on E at 19:43:02; SR₂ on N at 19:46:57. Emergence on N at 19:49:07 and on E at 19:52:59. From SR₂ and S_w distance=8,700 km. and O=19:15:51.
24. Probably local. Recorded on D and H variometers from 3:33 to 3:34.
25. Record obscured by wind tremors.
27. SR₁ on N at 21:38:59. O at 21:20:54, distance 4,750 km.
28. PR₁ at 4:50:18 on N and at 4:50:43 on E. PR₂ on E at 4:53:02. SR₁ at 5:05:05 on E and 5:05:17 on N. SR₂ at 5:09:18 on E and 5:09:14 on N. L₂ at 5:23:45 on E and at 5:25:49 on N. O at 4:32:38, distance about 11,000 km.
29. Preliminary phases ill-defined.
30. A phase resembling L at 7:49:02 on E and 7:49:34 on N. Distance 5,070 km.; O at 7:19:40. SR₁ at 7:38:16 on E and at 7:38:24 on N.

MAGNETIC STORMS

Magnetic disturbances of considerable magnitude were recorded on the days tabulated below. When a storm began abruptly, the time of beginning is given to the nearest minute.

On the succeeding sheets will be found reproductions of the magnetograms showing the principal storms, reduced to one-half the original size. Upward motion of the curves corresponds to decreasing east declination, increasing H and decreasing Z .

Serial No. 481

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R. P. LAMONT, Secretary
COAST AND GEODETIC SURVEY
R. S. PATTON, Director

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INTRODUCTION

[Latitude 57° 03'.0; longitude 135° 20'.1 west; elevation 50 feet (15 meters)]

The magnetic observatory at Sitka was built in 1901 and its operations began in January, 1902. A description of the buildings will be found in the first volume of the observatory results (1902-1904). The methods of observing are explained in *Directions for Magnetic Measurements*, published in 1911 (third edition in 1930).

The division of terrestrial magnetism and seismology of the United States Coast and Geodetic Survey, of which N. H. Heck, hydrographic and geodetic engineer, is chief, includes both the office and field and observatory work in terrestrial magnetism. The office computations and preparation of results for publication were in charge of the writer and the assistant chief of the division, D. L. Hazard, assisted by O. S. Hill, Augustine McCarthy, and I. I. Kaplan, mathematicians, and R. R. Bodle, L. P. Sissman, W. M. Hill, and John Hershberger, magnetic observers. The work of the observatory was in charge of F. P. Ulrich, magnetic observer, for the entire period of two years covered by this volume.

Up to the end of 1914 each hourly value of declination, horizontal intensity, or vertical intensity in the monthly tabulations represented the momentary value of the quantity for the specified hour, local mean time. Beginning with 1915 the published hourly values are average values for successive periods of an hour, beginning at midnight according to the mean time of the one hundred and thirty-fifth meridian. Thus, a value in the column headed 2 represents the average value for the hour beginning at 1^h and ending at 2^h, one hundred and thirty-fifth meridian mean time.

INSTRUMENTS

VARIATION INSTRUMENTS

The magnetograph is of the Eschenhagen pattern and consists of a recording apparatus and declination (*D*), horizontal intensity (*H*), and vertical intensity (*Z*) variometers. The variometers are mounted to the west of the recording apparatus. Upward motion of the curves corresponds to decreasing east declination, increasing horizontal intensity and decreasing vertical intensity.

The variations in temperature were recorded by the thermograph attached to the *Z* variometer. From the following tables of daily means it will be seen that the inside temperature is affected materially by outside changes. The seasonal range is reduced to some extent by the use of oil lamps in the corridors during cold weather.

EARTHQUAKES

A Bosch-Omori seismograph has been in continuous operation since April, 1904. It consists of two horizontal pendulums, one recording north-south motion (*N*) and the other recording east-west motion (*E*). The seismographs were adjusted several times with resulting changes in the periods of the pendulums. The constants of the instrument are as follows:

	<i>E</i>	<i>N</i>
Steady mass..... kilograms.....	10	10
Multiplication.....	10	10
Period:		
From Jan. 1, 1923..... seconds.....	22.1	18.2
Mar. 15, 1923.....do.....	18.6	17.4
Dec. 1, 1923.....do.....	13.9	18.1
May 29, 1924.....do.....	19.0	17.6
Nov. 15, 1924.....do.....	18.8	17.1

The following table is a register of the earthquakes recorded by the seismograph. The times are Greenwich mean time counted from midnight. In order to find a place in the table for impulses and emergences which have not been identified with any phase of the seismogram, the times of their appearances have often been included in the column headed *P* and sometimes in the columns headed *S* and *L*. The quantities given in the last column are the actual movement of the stylus (one-half of the maximum range) as measured on the seismogram.

On January 31, 1925, the President approved an act of Congress which authorized the Coast and Geodetic Survey to make investigations and reports in seismology, and in accordance with the provisions of this act the scope of the work of this bureau in seismology has been enlarged, and its importance has been felt to warrant the issuance of separate publications for the seismological reports. Accordingly the records of the operation of the Bosch-Omori seismograph at the Sitka magnetic observatory will be published hereafter in the seismological reports, which are being issued quarterly, beginning with the first quarter of 1925.

Register of earthquakes

No.	Date	Component	P			S			L			M			C	F		A
			<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>mm.</i>	
	1923																	
1	Jan. 22.....	E	9 08 27		1 9 12 02			9 12 35		9 17 03		9 25			10 48		5.0	
		N	9 08 27					9 14 30		9 17 25					10 54		2.7	
2	Feb. 2.....	E	5 14 39		5 20 07			5 28 29		5 28 57					7 46		2.8	
		N	5 14 39		5 20 07			5 28 29		5 28 57					7 39		4.2	
3	Feb. 3.....	E	e 5 15 15		1 18 14 18			1 18 14 18							20 50		80.0	
		N	16 08 44		1 18 14 18			16 19 07							20 50		80.0	
4	Feb. 24.....	E	10 08 44		7 46 42			7 50 35		7 54 20					9 49		9.3	
		N	7 41 19		7 46 42			7 51 23		7 54 58					9 45		5.5	
5	Mar. 2.....	E	e 17 12 20					17 31 07		17 34 45		17 36			18 15		0.5	
		N	e 17 12 43					17 31 07		17 34 45		17 36			18 02			
6	Mar. 24.....	E	e 13 16 32					13 19 40		13 27 41		13 32			14 06		2.3	
		N	e 13 18 32					13 19 52		13 24 06		13 25			14 06		2.0	
7	Apr. 10.....	E	10 31 32					10 31 50		10 31 56		10 32			10 35		0.4	
		N	e 10 31 41					10 31 50		10 31 56		10 32			10 35			
8	Apr. 13.....	E	15 38 50					15 47 03		15 51 44					16 20		0.3	
		N	15 38 50		15 45 10			15 49 01		15 49 41					16 30		0.3	
9	Apr. 24.....	E	22 45 08					22 45 48		22 45 56		22 46			23 00		1.5	
		N	22 45 06					22 45 48		22 45 51		22 46			22 55		1.9	
10	Apr. 25.....	E	19 32 28					19 32 58		1 19 33 16		19 34			19 47		7.5	
		N	19 32 28					19 32 55		1 19 33 09		19 34			19 47		6.6	
11	do.....	E	19 48 36					19 49 02		19 49 25					19 55		0.6	
		N	19 48 36					19 49 02		19 49 25					20 00			
12	May 2.....	E	e 16 28 08					16 28 42		16 28 42					16 43		0.2	
		N	e 16 28 08					16 29 06		16 29 06					16 43		0.2	
13	May 4.....	E	16 29 24					16 32 02		16 39 14		16 43			18 14		12.0	
		N	e 16 30 09		16 31 33			e 16 32 50		16 35 24		16 40			18 27		9.5	
14	May 23.....	E	e 22 49 34					22 55 57		22 57 40		22 59			23 56		0.3	
		N	e 22 49 34					22 56 04		22 57 44		22 59			24 07		0.2	
15	June 1.....	E	e 17 35 13		17 42 29			17 56 10		18 07 37					18 31		0.1	
		N	e 17 34 07		17 42 44			18 00 14		18 03 56					18 36		0.1	
16	June 18.....	E	8 28 21		8 38 19			8 50 39							9 16			
		N	8 28 21		8 38 12			8 50 20							9 16			
17	June 19.....	E	22 46 15		22 48 21			22 49 02		22 51 12					23 24		0.6	
		N	22 46 23		22 48 12			22 48 47		22 49 59		22 56			23 24		1.0	
18	June 20.....	E	e 6 08 06					6 08 43		6 08 47					6 12		0.1	
		N	i 6 08 18					6 08 43		6 08 43					6 12		0.1	

Register of earthquakes—Continued

No.	Date	Component	P			S			L			M			C		F		A	
			h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	h.	m.		mm.
1924																				
64	Aug. 27	N	e	8	34	21														
65	Aug. 30	E					3	28	17	3	45	25	3	48	37			8	38	
		N					3	28	21	3	43	48	3	46	43			4	38	
66	Sept. 13	E					14	56	47	15	15	12	15	26	02			16	00	
		N					14	57	04	15	14	20	15	36	00			16	00	
67	Sept. 14	E	e	13	26	23				e	13	32	13	13	32	45		14	00	
		N	e	13	23	37				e	13	31	43	13	32	42	13	43	13	53
68	Oct. 17	E		4	22	20		4	24	31		4	24	52	4	25	17	4	26	
		N						4	24	52		4	24	52	4	25	18	4	27	
69	Oct. 20	E		19	59	14		20	04	22		20	08	53	20	12	28	20	19	
		N						20	04	22		20	09	52	20	11	33	20	22	
70	Dec. 23	E	e	23	03	49		e	23	11	04		23	18	19		23	25	47	
		N						e	23	11	15		23	20	04		23	25	47	
																	23	33		
																	23	33		
																	24	01		
																	24	01		

REMARKS

- O at 9:03:59, distance 2,140 km.; L₂ on E at 9:16:08.
- O at 5:07:45, distance 3,680 km.; e on E at 5:16:12 and on N at 5:18:47; SR on E at 5:22:25 and on N at 5:22:19; e on E at 5:24:27 and on N at 5:24:52; L₂ on E at 5:27:27.
- O at 16:01:42, distance 3,780 km.; e on E at 16:11:19 and on N at 16:11:28; e on N at 16:13:19; SR on N at 16:16:55; L₂ on N at 16:21; L(?) on N at 17:01. L₂ masked by activity in S. Off paper at 16:20:35. L_w off at 16:21:35. L_w on after 16:32:17. L_w stylus replaced, began 17:11; recorded on the magnetograph.
- O at 7:34:32, distance 3,590 km.; PR on E at 7:42:25; SR on N at 7:48:46; L₂ on E at 7:52:45 and on N at 7:52:58.
- L₂ on E at 17:33:01.
- L₂ on E at 13:22:05.
- Recorded on the magnetograph.
- e on E at 15:42:59.
- Not very distant; tremors of 1-second period superimposed on the long period waves; felt in Sitka; recorded on the magnetograph.
- e on N at 19:40:46. Tremors of less than 1-second period superimposed on the long waves. e_w phase is smooth. Felt in Sitka; recorded on the magnetograph.
- Same character as preceding earthquake; recorded on the magnetograph.
- O at 16:26:46, distance 1,210 km.; L on N at 16:34:14; M₁ on E at 16:33:46; P₂ has characteristics of a smooth long-wave phase; e_w very weak recorded on the magnetograph.
- Wind tremors strong.
- O at 17:23:47, distance 6,860 km.; SR₁ on N at 17:47:57; e on E at 17:51:20 and on N at 17:51:13; L₂ on E at 18:01:58; L₃ on E at 18:06:48.
- O at 8:16:28, distance 8,620 km.; PS on E at 8:39:25; L₂ on E at 8:53:29; L₃ on E at 8:59:07. No definite maxima.
- O at 22:48:53, distance 1,090 km. Motion very irregular.
- e on E at 6:08:29. Local tremors.
- Tremors of 2 seconds period are superimposed on the long waves; local.
- O at 7:00:31, distance 4,280 km.; L₂ on E at 7:22:41; L₃ on E at 7:30:54; L₂ on N at 7:34:24; M₁ on E at 7:34:53.
- Wind tremors strong.
- O at 11:13:38, distance 7,250 km.; PS on N at 11:33:29; L₂ on E at 11:50:47.
- O at 14:18:19, distance 3,030 km.; PR on E at 14:24:50; e on E at 14:30:42 and on N at 14:30:50. Wind tremors troublesome on N. F₂ occurred while changing paper.
- eL on E at 7:45:14.
- e on E at 15:27:23. Interpretation based on Honolulu record.
- O at 23:14:34, distance 4,280 km.; SR₂ on both at 23:31:16; e on E at 23:36:08 and on N at 23:36:00.
- O at 2:57:58, distance 6,980 km. P is very faint and uncertain. The distance is too great for the probable location of the epicenter.
- O at 2:46:45, distance 6,460 km.; e on N at 3:11:30 and on E at 3:13:52.
- Very faint long waves.
- Phases very poorly defined.
- e on N at 17:22:45. Phases not well defined.
- e on E at 8:34:35. Very faint; eP₂ may be microseismic.
- O at 1:20:28, distance 6,280 km.; e on E at 1:54:25 and on N at 1:55:53; M₂ on N at 1:56:16. P obscured by microseisms. Distance from L_w-S.
- O at 3:29:19, distance 9,890 km.; SR₁ on both at 3:59:57; SR₂ on N at 4:04:09; e on N at 4:09:04; L₂ on N at 4:13:55. Origin based on S_w and L_w.
- O at 7:10:53, distance 5,250 km.; ePR on N at 7:21:38; SR₁ on both at 7:30:05. Origin based on S_w and SR_{1w}.
- Preliminary phases obscured by wind tremors.
- O at 21:08:49, distance 9,230 km.; e on E at 21:30:44; PS on E at 21:32:40, SR₁ on E at 21:37:31.
- Recorded on the magnetograph. Severe wind tremors.
- Strong wind tremors prevailing.
- All weak phases obscured by wind tremors.
- No definite maxima.
- L₂ on E at 10:46:02. Weak phases obscured by wind tremors.
- Very slight.
- O at 10:30:48, distance 5,600 km.; SR on E at 10:50:49; L₂ on E at 10:58:58. Wind tremors severe.
- Tremors are superimposed on the long waves; recorded on the magnetograph.
- O at 16:20:07, distance 10,000 km.; PR₁ on E at 16:37:03; PS on E at 16:44:31; PS on N at 16:44:26; SR₁ on E at 16:49:25; eSR on N at 16:50:36; e on N at 16:57:51.
- Wind tremors troublesome.
- ePR₂ on E at 20:07:53; eSR₂ on N at 20:19:52; eL₂ on E at 20:26:35. Phases ill-defined. The first two on E may be microseisms. The tabulated P₂ and S₂ give the distance 6,440 km. and O, 19:54:17.
- Maxima uncertain; paper was changed between 17:11 and 17:15 on N and between 17:15 and 17:19 on E.
- e on E at 2:03:08 and on N at 2:03:34; e on E at 2:05:24 and on N at 2:08:14; SR₁ at 2:15:38 and on N at 2:15:32; e on both at 2:29:47. First phase probably PR₁.
- O at 15:44:17, distance 5,030 km.; SR on N at 16:03:55. Changing paper on E from 15:43 to 16:21.
- O at 4:50:55, distance 8,160 km.; e on E at 5:19:00; L₂ on N at 5:25:12.
- O at 19:55:08, distance 8,790 km.; SR₁ on E at 20:21:44; SR₂ on N at 20:24:09.
- e on E at 5:32:17 and on N at 5:32:28; L₂ on E at 5:52:59 and on N at 5:53:15. First phase possibly PS.
- SR on E at 18:28:56 and on N at 18:26:34; L₂ on N at 18:37:28.
- Recorded on the magnetograph.
- SR on N at 3:33:10; e on N at 3:40:23; L₂ on N at 3:46:01. L_w well defined.
- e on E at 15:02:39; SR₂ on E at 15:07:49; L₂ on E at 15:19:39 and on N at 15:17:51. Interpretation uncertain.
- O at 4:19:40, distance 1,230 km. P and S barely perceptible. Tremors of 3 seconds period are superimposed on the long waves.
- O at 19:52:48, distance 3,390 km.; PR on E at 20:00:23; ePR on N at 20:00:29; SR on N at 20:06:20.
- O at 22:54:43, distance 5,600 km.; PR₁ on E at 23:05:49. Marking clock not operating; absolute time doubtful.