No. 9. 1929.

Geodætisk Institut

Proviantgaarden, Copenhagen, Denmark.

Bulletin

of the seismological station

KØBENHAVN

$\varphi = 55°41'$ N. $\lambda = 12°27'$ E. $h = 13$ m.

Lithologic foundation: chalk.

No. 9. Jan.—March 1929.

Instruments:

Galitzin pendulums with galvanometric registration.

Constants:

Component	l	T_1	A_1		μ^2	T	k
	cm	sec	cm			sec	
N	12.5	12.63	100		0.16	12.6	106
E	12.5	12.69	100	$^{21}/_{2}$—$^{26}/_{3}$	0.12	11.8	103
Z	14.4	11.55	100	$^{1}/_{1}$—$^{4}/_{3}$	0.2	9	90

Work was done on E and Z beyond the dates mentioned; records were nearly always obtained but the constants were undetermined.

Wiechert 1000 kg. horizontal seismograph.

Wiechert 1300 kg. vertical seismograph.

Constants:

Component	T	v	ϱ	V
	sec		mm	
N	9.0	3.9	0.8	221
E	9.1	3.7	0.5	199
Z	5.5	4	0.3	165

Milne-Shaw seismographs, N and E components, with the approximate constants $T = 12^s$ $v = 20$ $V = 300$.

Beginning with 1929 the bulletin of the seismological station København is worked out on new principles and published in a different form.

It is essential that the bulletin should contain the data which may contribute towards the determination of epicentres; therefore special care is given to the accurate measurement of the forerunners *P* and *S* in all cases where these phases can be identified, and special columns are reserved for them.

All recorded earthquakes are included in the bulletin, but the diagrams are not read in great detail. The beginning of a record is always read, unless it is impossible to fix the beginning owing to disturbance or microseismic movement. Forerunners are identified as such if possible; the movement is registered as "Undefined" when it cannot be decided whether it is due to a forerunner or to the main phase. Several forerunners may be included, but distinct and clearly marked phases only are read. The beginning of the main phase is read if it is not masked by movement due to the preceding phases; periods and amplitudes are not measured.

Well recorded earthquakes which may be of interest for further investigation receive special attention. Comments are made on the readings and additional readings are added under Notes.

Seismometric readings: Notation

P — normal first preliminary tremors, longitudinal waves.
PP... — longitudinal waves reflected at the earth's surface.
S — normal second preliminary tremors, transverse waves.
SS... — transverse waves reflected at the earth's surface.
PS; *PPS*;... — waves reflected at the earth's surface which travel partly as longitudinal, partly as transverse waves.
$\overline{S_cP_cS}$ — waves which traverse the mantle as transverse waves but are refracted through the core with longitudinal oscillation.
$\overline{P_cP_cS}$ — waves which pass the mantle on one side of the core as longitudinal waves, on the other side as transverse waves and are refracted through the core with longitudinal oscillation.
$\overline{S_cP_c}$ $\overline{P_cS}$ — waves which traverse the mantle as transverse waves, are refracted through the core with longitudinal vibration and are reflected on its inner boundary.
L — long, or surface, waves; main phase.
M — waves of greatest amplitude in the surface waves.
i — sharply defined beginning of a phase.
Δ — arcual distance from the station to the epicentre.
*) affixed to time of phase indicates that the beginning is in a time-mark.
*) affixed to number and date refers to Notes.

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No.	Date	Hour	Forerunners P	Forerunners S	Forerunners	Forerunners	L	Undefined	Distance	Remarks
	1929 Jan.		*m s*	*m s*	*h m s*	*m s*	*h m*	*h m*	°	
1	1	13			.9					
2	1	17						.3		
3	2	3					.1			
4	6	0					9			
5	8	7			.7					
6	8	9					.7			
7	11	2						4		
8	11	14					37			
9*	13*	0	*i* 14 9	*i* 23 9	*i* 17 17	28.3			67	Kurile Islands.
10	13	19						.2		
11	14	3						.1		
12	14	5						.6		
13	14	10					.2			
14	14	18					.3			
15	14	19					.8			
16	16	8	18.8	29 21	*i* 30 34		48			Philippine Islands.
17	16	14					.8			
18	17	0						14		
19*	17*	11	57 18	66 49					72	Venezuela.
20	17	22			56					
21	18	21			45.3					
22	19	3			40					
23	20	15			12.4	19 43				Moluccas.
24	21	5			.6		1.0			
25	21	10	39 37	48.2					63	Alaska.
26	21	16					.2			
27	22	14		58.7						Abessinia.
28*	23*	11	19 22	*i* 23 22			27		23	Greece.
29	24	7						.4		
30*	24*	20	49 25		59 53		76	.		Central America.
31	25	1			52.1		1.2			
32	26	3					.2			
33	26	15					.1			
34	27	16		26 0			.5			
35	28	22					.7			
36	30	17			18 37		.7			
37	31	18			.5		.8			
	Febr.									
38*	1*	17	*i* 22 9	*i* 28 20	*i* 29 40	*i* 31 39			41	
39*	2*	0	*i* 10 53	19 27					63	Atlantic Ocean.
40	2	15					.7			
41	3	3			6.6		27			
42	3	7					48			
43	3	17					18			
44	3	18					49			
45	4	11					3			
46	5	2					.3			
47	5	4					28			

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No.	Date	Hour	Forerunners P	Forerunners S			L	Undefined	Distance	Remarks
	1929 Febr.		m s	m s	h m s	m s	h m	h m	°	
48	6	3					45			
49*	6*	7	*i* 0 16	9 16	4.7	10 5	.3		67	
50	8	2			29		47			
51	8	8						.5		
52	9	2						33		
53*	10*	15	51 47		62 32	63 58	1.3			
54	10	17			29 57			33		Caucase.
55	14	15					21			
56	15	6			5.3		.5			
57	15	8			27.9		42			
58	16	19			43		102			
59	17	21			11 10					
60	18	19			8.4					
61	20	21			22 47					
62*	22*	20	52 4	60 32	61 30	62 5	70		62	
63	26	4					.5			
64*	26*	9	*i* 12 1	*i* 21 11	21 57	22 14	32		69	Alaska.
65	27	20					4			
66	28	1					.3			
	March									
67	1	7	42 18	51.5			64		69	Alaska.
68	1	9					31			
69	1	16					.4			
70	1	19					.5			
71	3	3	18 43							Afghanistan.
72	3	16			57 41		64			
73	3	18					.8			
74	5	16			24.5		39			
75*	7*	1	*i* 46 14	55 44			70		72	Aleutic Islands.
76	7	5	56.8							In preceding movement.
77	7	12								Disturbed.
78*	9*	2	24 43		35 27	35 47	59			
79*	9*	11			11		1.0			
80	10	1					1			
81	10	14			51.6	58 9	23			Marianne Islands.
82	10	23		7 46			30			Aleutic Islands.
83	11	13			49.4		1.1			
84	12	3					.2			
85	13	11	9.5	15 53			25		43	Turkestan. Strong micros.
86	14	14					54			
87	14	19					.4			
88	14	23					.3			
89	15	2					.6			
90	15	14					0			
91	15	18			12 44					
92	16	3			38.9					
93	16	6			22					

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No.	Date	Hour	Forerunners P	Forerunners S			L	Undefined	Distance	Remarks
	1929 March		m s	m s	h m s	m s	h m	h m	°	
94	16	12			47 31					
95	18	2			.2		40			
96	18	15					.9			
97	18	23	32 59	42 52			58		76	Japan.
98*	19*	21	6 33		17.0	22.7	.5			
99	20	21		33.4			53			
100*	21*	2	49 44		60.4	66.3				
101	22	3					40			
102	23	20			33		52			
103	25	4					.3			
104	26	5					34			
105	27	0					20			
106	27	5					.7			
107	27	7	46 23	50 10					21	Asia Minor.
108	27	10					7			
109	27	21						.3		
110	27	22					30			
111	28	3					53			
112	28	20			47.6		68			Strong micros.
113	30	17					.0			
114	31	3					.6			
115	31	5			54.1		20			
116	31	20		39.3			57			

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NOTES

No. 9. Jan. 13. 0^h. Kurile Islands. 155 E 47 N. Very strong. *iP* on *N* and *Z*; about ½ min. later there seems to be another phase (P_cP?). *PP* and *PPP*, $18^m\ 32^s$, sharp on *Z*; first forerunners not very strong on *E*; on *N* very strong with many phases. iS_E; *S* not very large on *N*; on both followed by very large movement, possibly due to more than one phase. *SS* and *SSS*, $31^m.3$, large. On *N* the beginning of *L*, $36^m.5$, has very long periods and large amplitudes; on *E* the beginning not so well defined, but earlier. Large *M* groups.

No. 19. Jan. 17. 11^h. Destructive in Venezuela. Faint first forerunners, no reflections. *S* not sharp; after *S* the movement continues strong until *L*, the beginning of which is not clearly marked; earliest on *N*.

No. 28. Jan. 23. 11^h. Greece. The movement small, but *P* and *S* well defined.

No. 30. Jan. 24. 20^h. Central America. The beginning of *P* faint, but on *WZ* clearly marked (no *GZ*). *PP* $52^m.5$ about as big as *P*. The *S* phase, largest on *E*, begins 59^m53^s but increases shortly afterwards ($\overline{S_cP_cS}$ and S_n?). *PS* $61^m\ 13^s$. *SS* $66^m.0$, *SSS* $69^m.5$, both distinct on *E*. *L* begins rather clearly on *E*; *M* shortly after *L*; several, not very large, groups.

No. 38. Feb. 1. 17^h. 39°.2 N 69°.0 E, Zèravchan, according to Pulkovo. The forerunners very strong with a continued, strong movement. The first forerunners strongest on *Z* and *E*, *S* strongest on *N*. Both *P* and *S* followed by several, clearly marked unidentified phases (due to succeeding shocks or to reflections?). *SS* large, continues into *L*, which is smaller (deep focus?). *L* very irregular.

No. 39. Feb. 2. 0^h. Atlantic Ocean. iP_Z. The movement increases about $11^m.7$ (P_cP?); continues strong; varying, but without clearly marked phases. The beginning of *S* read on *N*; on *E* uncertain, perhaps earlier. After *S* strong movement continued in *L*, not very different in appearance.

No. 49. Feb. 6. 7^h. Sea of Okhotsk. Faint, but forerunners clearly marked. *L* irregular.

No. 53. Feb. 10. 15^h. Central America. The phases clearly marked on *Z* and *E*, but strong microseismic movement makes the reading somewhat uncertain. Additional phases: *PP* 55^m13^s, about as big as *P*; *SS* $7^m.9$. *L* regular, not large.

No 62. Feb. 22. 20^h. (Atlantic Ocean?). *P* and *S* very clearly marked, each by an oscillation of large amplitude; *P* begins faintly. The movement continues strong after *P* and stronger after *S*; no marked *PR* or *SR*. 62^m5^s a phase very clearly marked on *E*. *L* begins distinctly, with large amplitudes; shortly afterwards *M*.

No. 64. Feb. 26. 9^h. Alaska. *iP* on *Z* and *N*, large amplitudes. *S* small, following phases ($\overline{S_cP_cS}$?) larger. *L* regular, begins earliest on *E* with waves of long period.

No. 75. March 7. 1^h. Aleutic Islands. Very strong record. *P* has very large amplitudes on *Z* and *N*; the following movement strong. *S* has very large amplitudes and the movement continues strong. The beginning of *L* distinctly marked on *N* and *Z*; the first waves have long period and large amplitudes. *M* very large.

No. 78. March 9. 2^h. Bonin Islands region; $\triangle$ = c. 90°. *P* and *PP* faint. Some increase of movement before 35^m27^s.

No. 79. March 9. 11^h. New Zealand region; $\triangle$ = c. 160°. No Galitzin records; other records disturbed by change of sheets. Increasing movement without clearly marked phases. The first part of *L* has long periods and rather large amplitudes; regular *M* groups about 20 minutes later.

No. 98. March 19. 21^h. Central America; $\triangle$ = c. 90°. Forerunners more clearly marked on *E* than on *N*. *L* regular.

No. 100. March 21. 2^h. Central America; $\triangle$ = c. 88°. *P* and *PP*, 53^m4^s, very clearly marked on *Z*, about equally big. *S* phases not clearly separated. *PS* c. $61^m.5$. *L* not very regular, the beginning uncertain.

No. 10. **1929.**

Geodætisk Institut

Proviantgaarden, Copenhagen, Denmark.

Bulletin

of the seismological station

KØBENHAVN

φ = 55°41′ N. λ = 12°27′ E. h = 13 m.

Lithologic foundation: chalk.

No. 10. April—June 1929.

Instruments:

Galitzin pendulums with galvanometric registration.

Constants:

Component	l	T_1	A_1	μ^2	T	k
	cm	sec	cm		sec	
N	12.5	12.63	100	0.16	12.6	105
E	12.5	12.69	100	— 0.06	12.3	100
Z	14.4	11.55	100	0.1	10	100

During the greater part of May *E* was not recording.

Wiechert 1000 kg. horizontal seismograph.

Wiechert 1300 kg. vertical seismograph.

Constants:

Component		T	v	ϱ	V
		sec		mm	
N	¼—¼	9.0	3.9	0.8	221
	¼—⅒	9.1	3.9	0.3	221
E	¼—⅒	9.1	3.8	0.5	199
Z		5.5	4	0.3	165

On May 16. recording of the Wiechert horizontal seismograph was suspended.

Milne-Shaw seismographs, *N* and *E* components, with the approximate constants $T = 12^s$ $v = 20$ $V = 300$.

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No.	Date	Hour	Forerunners P	Forerunners S			L	Un-defined	△	Remarks
	1929 April		m s	m s	h m s	m s	h m	h m	°	
1	2	3					58			
2	5	9					11			
3	5	23			46.3		.8			
4	6	4					.6			
5	7	19	45 5		55.6					
6	8	1					.4			
7	8	10			38 58					Earlier forerunners disturbed.
8	9	3					.4			
9	9	4			14.4	17 11				
10	9	7						.9		
11	10	5						49		
12	10	6					.8			
13	10	18					.7			
14	11	0					17			
15	11	1						4		
16	11	1						46		
17	12	0					39			
18	12	5					28			
19	13	0					.7			
20	13	7			13.9		42			
21	13	21			31.2		1.1			
22	13	23						52		
23	16	1	4 55	15 10			33		81	Japan.
24	16	5					.8			
25	16	14			31.9		1.0			
26	17	3		24 7			28			Crete.
27	17	11						57		
28	17	19					16			
29	18	4					.5			
30	19	4						21		
31	19	21						.3		
32	20	1			15		16			Not very distant.
33	21	12	45 38	51 51			58		42	
34	21	20						32		
35	22	8						32		
36	27	12					27			Forerunners disturbed.
37	27	21			.4		59			
38	28	5	7 56	15 20					53	
39	28	19						46		
40	29	18						41		
41	30	19			11		.5			
	May									
42	1	6					.6			
43	1	8			3.1		.5			
44*	1*	15	44 26	50 1	45.9				36	Persia.
45	1	21						.2		
46	1	22						.8		

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No.	Date	Hour	Forerunners P	Forerunners S			L	Un-defined	△	Remarks
	1929 May		m s	m s	h m s	m s	h m	h m	°	
47	2	14	37 30	46 58			61		71	Kurile Islands.
48	3	8					.9			Faint forerunners.
49	3	16		32 30			38			Persia.
50	4	4					.3			
51	4	6			47.7		54			
52	5	5					.8			
53	5	17		19.4			.5			Indian Ocean.
54	6	5			28 11	37.6	.9			New Guinea.
55	7	9					.6			
56*	7*	16			54 42		86			New Guinea.
57	8	12					.7			
58	8	14					.4			
59	10	11					46			
60	11	19						28		Italy.
61	12	10					.3			
62	12	17					.2			
63	13	6						52		
64*	13*	13	34 9	39 33					34	Persia.
65	15	9					.4			
66	16	1			32.5		37			
67	16	10						.2		
68	16	21					.4			Faint.
69	17	0					.8			Faint.
70	18	1	11 7*	18 14			.4		50	Abessinia.
71*	18*	6	42 59	*i* 47 6			49		24	Asia Minor.
72	19	5			28		1.0			
73*	20*	5	4 25	13 51	14 38	18 58	28		71	Aleutic Islands.
74	20	12	20 55	23 39			26			Faint.
75	20	18					.8			
76	21	2					.9			
77	21	5					.5			
78*	21*	16	47 30	57.4	50.4	62.4	73		77	Japan.
79	22	0			45 37	48 58				Very distant. *L* faint.
80	22	20			26.6		1.4			
81	22	23					.5			
82*	23*	18	37 18							Felt in Norway and Denmark.
83	24	19					12			
84	25	12	12 50		23 13	23 52	.7			Peru.
85	26	9					38			The beginning disturbed.
86	26	19			57.2		1.4			
87*	26*	22	51 2	60 23			67		71	Pacific Ocean near Alaska.
88	27	5			47 24		.9			
89	28	0			19 31		.6			
90	28	5					.9			
91	28	7						19		
92	28	18						.3		
93*	29*	23								Felt in Norway and Denmark.
94*	30*	10			1 54	2 45	34			Argentine.
95	30	13					.1			In preceding movement.
96	31	0	21 44	31.4			46		74	Japan.

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No.	Date	Hour	Forerunners P	Forerunners S			L	Un-defined	△	Remarks
	1929 June		m s	m s	h m s	m s	h m	h m	°	
97	1	18	10 54	21.1			.6		80	Riou-Kiou Islands.
98*	2*	21	*i* 50 1	*i* 59 28	64.7				72	
99*	2*	21	*i* 51 19*							
100*	3*	20	36 57	42 43	38.3	43 2			38	Turkestan.
101	4	7			17 59					Turkestan.
102	4	15	28 50		*i* 32 55	38 45				Philippine Islands.
103	5	9					25			Disturbed.
104	6	11	0.4*	8 41					62	Atlantic Ocean.
105	6	14			43.0					
106	6	16					.6			
107	7	1					.2			
108	9	8			27.7		.6			
109*	9*	9	19 24*	28 51	33.8		.7		72	Kurile Islands.
110	9	19						56		
111	9	23					50			
112	10	0					.9			
113*	10*	23	*i* 6 28	9 56	7.4		11		19	
114	12	11	57.8		62 31	72 12				Pacific Ocean.
115	12	15					.1			
116*	13*	0	*i* 23 46	33 12	34 8		.8		72	Kurile Islands.
117*	13*	9	38 4		49 9	49 50	1.1			Mindanao region.
118	13	20			.1		.6			
119	13	22					.6			
120	13	23	14.0		24.7		.8			
121	14	6					.8			
122	14	23			46.5		65			
123	15	2					.8			Faint preceding movement.
124	15	9					.7			
125	15	16					.9			
126	15	20			0.0		.4			Mindanao region.
127	15	21			31.9		.9			Mindanao region.
128	16	15					.7			
129*	16*	23			7 19	8 17				New Zealand.
130	17	10	29.9		41 11		1.1			Mindanao region.
131	18	1					.9			
132	18	14			24.8					Persia.
133	18	18					.9			
134	19	4					.9			
135	19	7	44 19		54 53	55.6	80			Pacific Ocean.
136	19	10					.7			
137	19	13					.3			
138	19	19					58			
139	20	18			47 6		1.2			
140	20	20			35 3		.9			
141	21	5					.5			
142*	22*	15			50 8	50 51				New Zealand.
143*	22*	18			59 6	59 50				New Zealand.
144	23	4					.1			
145	23	22			.2		.6			
146	24	2					.8			

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No.	Date	Hour	Forerunners P	Forerunners S			L	Un-defined	△	Remarks
	1929 June		m s	m s	h m s	m s	h m	h m	°	
147	25	7					.4			
148	25	10					.4			
149	26	6	40 52	50 19			68		72	Aleutic Islands.
150	26	17	1 16				31			Japan.
151*	27*	13	2 8		12 52	14 3	34			
152	27	22	43 9	46 30			48		18	
153	28	1					.6			
154	28	2					.5			
155	28	22						33		
156	29	2					.4			
157	30	2	58 17		68.9	69 40	.6			Mindanao region.
158	30	5			33.2		1.1			

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NOTES

No. 44. May 1. 15^h. Persia. Very strong record. A faint movement precedes *iP* 44^m 28^s; dilatation; the movement continues strong after *P*. *PP* most clearly marked on *E*. *S* and following movement large; the beginning of *L* not certain. *M* very large, largest on *N*.

No. 56. May 7. 16^h. New Guinea. *PP* 54^m42^s. Other forerunners, not clearly marked. *L* has long periods. *L'* $18^h.7$.

No. 64. May 13. 13^h. Persia. *P* faint. In the first part of *L* somewhat irregular waves of long period and large amplitude; later regular *M* groups.

No. 71. May 18. 6^h. Asia Minor. *P* not strong, *S* very large. *M* not very regular.

No. 73. May 20. 5^h. Aleutic Islands. Not very strong record but all phases clearly marked. *S* strongest on *E*, following phase ($\overline{S_cP_cS}$?) on *N*. Very regular *M* in first part of *L*.

No. 78. May 21. 16^h. Japan. *S* rather small, unsharp, followed by larger movement, but no clearly marked phase. *L* begins distinctly; shortly afterwards *M* waves of long period; largest *M* group about 8 min. later.

No. 82. May 23. 18^h. Skagerak; felt in Norway and Denmark. $\triangle$ = c. 4°. *P* on *WZ* only, very faint. $\overline{P}$ 37^m34^s more clearly marked, also visible on *GZ*. There seem to be two shocks; P_2 38^m8^s on *WZ*. Strongest phases, clearly marked on *N* and *E*, 38^m20^s and 39^m10^s.

No. 87. May 26. 22^h. Very strong record. *P* begins faintly on *Z*; increases on *Z* and begins on *N* and *E* about 11 sec. later. *P* not very large; the movement continues about equally strong until *S*. *S* very large; well recorded on *M-S E* only, the light being too faint on *GN* and *M-S N* (no *GE* record). *L* begins distinctly, very early, with waves of long period and large amplitude; later, very large *M* groups.

No. 93. May 29. 23^h. Skagerak, felt in Norway and Denmark. $\triangle$ = c. 4°. *P* very faint, perhaps 31^m56^s; $\overline{P}$ stronger, but in time-mark, 32^m15^s. Strongest phase on *N* and *E*: *i* 33^m10^s.

No. 94. May 30. 10^h. Argentine. $\triangle$ = c. 110°. *P'* 1^m54^s, faint; *PP* 2^m45^s, clearly marked. Before (S_n) 18^m36^s some increase of movement, but no clearly marked phase. *SS* 18^m36^s; *SSS* $22^m.5$. Very regular, not large *M*.

Nos. 98—99. June 2. 21^h. Japan Sea and Pacific Ocean respectively, according to the Russian stations. P_1 very clearly marked on *Z*, but not large; P_2 much larger. S_1 large; in following movement phases not very clearly marked. *L* small, irregular, the beginning uncertain.

No. 100. June 3. 20^h. Turkestan. *P* and *PP* clearly marked on *Z* and *E*. The first *S* movement quite large on *E*; on *N* small, followed by larger movement (another phase?). The beginning of *L* uncertain. On *N* large *M* begin sharply $49^m.6$; *M* smaller on *E*.

No. 109. June 9. 9^h. Kurile Islands. Record disturbed by change of sheets; no *GE*. In the beginning of *L*, on *E*, a group of oscillations of long period and large amplitude.

No. 113. June 10. 23^h. Arctic Sea *W* of Norway according to Pulkovo. iP_N; the movement continues strong; *S* not very well defined. Large, quite regular *M*.

No. 116. June 13. 0^h. Kurile Islands. Strong record. iP_Z. *S* small. i_Z 25^m44^s may be *P* of a succeeding shock, $35^m.2$ and $36^m.2$ the corresponding *S* and *PS*. e_Z 37^m18^s possibly *P* of a third, stronger shock; *S* 46^m44^s and *PS* 47^m46^s not quite certain phases since *L* of the first shock begins about this time. In the beginning of *L* a group of long period waves of large amplitude; followed by *M* of shorter period. About 14 min. after the beginning of *L* again a group of long-period waves of large amplitude, followed by *M* groups of shorter period, possibly *L* of the third shock.

No. 117. June 13. 9^h. Mindanao region. Strong record. *P* not very strong, but clearly marked; *PP* $42^m.0$, larger. Later phases quite large but not very well defined. Additional phases: $50^m.9$; $55^m.0$; $57^m.4$; $59^m.1$. *L* begins earliest on *N* with waves of long period; large *M* groups.

No. 129. June 16. 23^h. New Zealand. $\triangle$ = 161°. Very strong record. P'_1 7^m19^s; P'_2 8^m17^s; *PP* 12^m4^s. The movement continues strong; several later phases, not all very well defined. $\overline{S_cP_cSP}$ 22^m20^s and *PPS* 25^m20^s large; *SS* 33^m30^s and *SSS* $38^m.0$ very large. The beginning of *L* uncertain; in first part irregular waves of long period and very large amplitude; later very large, regular *M* groups.

No. 142. June 22. 15^h. New Zealand. P'_1, P'_2 and *PP* 54^m38^s distinct on *Z*, P'_2 and *PP* on *N* and *E*. Several later phases in forerunners, not clearly marked. The beginning of *L* faint, uncertain. *L* waves very regular, of long period.

No. 143. June 22. 18^h. New Zealand. Fainter than preceding record. P'_1 and P'_2 distinct on *Z*.

No. 151. June 27. 13^h. South Sandwich Islands; $\triangle$ = c. 115°. Very strong record; the first part slightly disturbed. *P* and *P'*, 5^m56^s, small but clearly marked on *Z*. *PP* 6^m53^s, large; *PPP* $9^m.7$. Strong continued movement, but later phases quite clearly marked. S_cP_cS largest on *N*, following phase on *E*. Additional phases: $15^m.1$ on *E*; $15^m.7$ on *N*; (*PS*) 16^m52^s, large; *SS* $22^m.7$ very large; *SSS* $27^m.2$ large. *L* begins early; in first part groups of waves of long period and very large amplitude; later very large *M* of shorter period; several large groups.

Bianco Lunos

No. 11. **1929.**

Geodætisk Institut

Provlantgaarden, Copenhagen, Denmark.

Bulletin

of the seismological station

KØBENHAVN

φ = 55°41′ N. λ = 12°27′ E. h = 13 m.

Lithologic foundation: chalk.

No. 11. July—September 1929.

No. 11. July—September 1929.

Instruments:

Galitzin pendulums with galvanometric registration.

Constants:

Component	l	T_1	A_1	μ^2	T	k
	cm	sec	cm		sec	
N	12.5	12.63	100	0.16	12.6	105
E	12.5	12.69	100	0.1	13	100
Z	14.4	11.55	100	0.3	9	100

Wiechert 1000 kg. horizontal seismograph.

Wiechert 1300 kg. vertical seismograph.

Constants:

Component		T	ν	ϱ	V
		sec		mm	
N	$^{10}/_{7}$—$^{24}/_{7}$	13.0	8.8	1.4	239
	$^{24}/_{7}$—$^{30}/_{9}$	13.2	9.3	0.8	230
E	$^{10}/_{7}$—$^{24}/_{7}$	12.7	11.3	0.5	204
	$^{24}/_{7}$—$^{30}/_{9}$	13.2	8.7	1.0	207
Z		5.7	4	0.2	165

Milne-Shaw seismographs, *N* and *E* components, with the approximate constants T = 12^s ν = 20 V = 300.

København.

No.	Date	Hour	Forerunners P	Forerunners S	Forerunners	Forerunners	L	Undefined	△	Remarks
	1929 July		m s	m s	h m s	m s	h m	h m	°	
1	2	1			2.0		29			
2	2	2					.8			
3	2	16					.2			
4	3	1	3 18	11 37	13 3				61	*L* faint.
5	3	7						.5		Seismic?
6	3	8			32.8					
7	3	18					.8			
8	4	4	38 40							Other phases unsharp.
9	4	7	20.1	24 42					27	
10	4	7	37 1	41.5					27	
11	4	8	2 22	6.9					27	
12	4	9			52					Disturbed.
13	4	12					.6			
14*	5*	14	*i* 30 33	40 0	33 17	45 11	.8		72	
15	5	19					.5			
16*	5*	22	47 46*	57 15	57 40				72	
17	5	23	21 17							In preceding movement.
18*	6*	2	15 21							
19*	6*	9	*i* 56 30	*i* 64 50	66.4		71		61	
20	7	6					.8			
21	7	10					6			Forerunners disturbed.
22*	7*	21	*i* 34 42	*i* 44 7	37 28	*i* 45 0			71	
23	8	2	16.4	26.0			40			*P* and *S* faint.
24	8	19			29.8		.8			
25	9	6					.5			
26	9	9					.4			
27	9	18					.3			
28	10	15					.1			
29	11	14					15			
30	11	21	8 33	17 58			32		71	S. of Aleutian Islands.
31	12	16		13.0			26			Alaska.
32	12	18	11 31	21.9			42			
33	12	22					29			
34	12	23					.5			
35	13	5					.5			Faint forerunners.
36	13	7		49 18						Disturbed.
37	13	12					58			
38	13	15					.8			Forerunners disturbed.
39	14	6					.9			
40*	14*	9	48 7	57 19	52.6	65.6	71		69	
41*	15*	7	*i* 51 5	*i* 56 35					35	
42	15	10					.5			
43	15	15					.4			
44	16	2					.2			
45	16	20					1			
46	16	23					32			
47	17	8	*i* 49 35							
48	17	21					.3			Disturbed.
49	18	7					30			
50	18	21						8		

København.

No.	Date	Hour	Forerunners P	Forerunners S	Forerunners	Forerunners	L	Undefined	△	Remarks
	1929 July		m s	m s	h m s	m s	h m	h m	°	
51	19	8						39		
52	21	11					.5			
53	21	13			39.9		1.0			
54	23	15					.7			
55*	23*	18	47 28	*i* 51 11			52		21	
56	23	20	8.8	12.5			13		21	In foregoing; repetition.
57	24	3					.5			
58	25	0			30.0					
59	25	15					.7			
60	25	23	8.9	18 27			33		73	
61	26	17					50			
62	26	23	0 12	10 7	3.2	11.0	29		77	Japan.
63	27	13					.3			
64	28	17					43			
65	30	8					.4			Disturbed.
	Aug.									
66*	1*	5	13 37	23 16	23 46				74	
67	1	6					.7			
68	1	9					.5			
69	1	15					.0			
70	3	13					.9			Preceding movement disturbed.
71	3	15			17 12		.9			
72	3	19		6 34			.3			Aleutian Islands.
73	4	9			13 42		16			Faint preceding movement.
74	4	15					.5			
75	4	23			0		.6			
76	5	15					.4			
77*	6*	1	34 34	37 48			40		17	
78	6	13					.1			
79	7	20					.9			Some preceding movement.
80*	8*	13	8 31	17 44			33		69	
81	10	5					7			
82	11	10					.4			
83	11	18						.7		
84	11	19					.5			
85	14	2			33					} One or two earthquakes?
86	14	3					46			
87	14	6					50			
88	14	15					49			
89	14	19			15 40		.7			
90	15	15					44			
91*	15*	20	*i* 9 20	20 7*	19 47		35			
92	16	21			55.7					
93	16	23	34 27	38 48			42		25	
94	17	4						27		
95*	17*	23	53 37		57 3	64 14	1.4			
96	18	6					.9			
97	18	9					.6			Forerunners disturbed.

København.

No.	Date	Hour	Forerunners P	Forerunners S			L	Undefined	△	Remarks
	1929 Aug		*m s*	*m s*	*h m s*	*m s*	*h m*	*h m*	°	
98	18	15					.7			
99*	19*	2	*i* 55 18	65 22	58 7	66 7	82		78	
100	19	20	56 43	66 51			1.5		79	China Sea.
101	19	23			26.8		30			
102	20	16	50 31	60 38			1.3		79	Riou Kiou Islands.
103	20	17	49 52	60 19			1.3		83	In foregoing.
104	21	1			33.3		38			
105	21	10					.2			Faint forerunners.
106	22	7			54.2					Disturbed.
107	22	16			56		1.5			
108	22	19	51.6		61.9		1.3			
109	23	16						2		
110	24	3			13.4		1.6			
111*	28*	19	3 25	13 3	6 17	18 0	29		74	Japan.
112	29	1					.4			
113	29	10			28 52		1.5			
114	29	20					.5			
115	29	23					.7			
116	30	5					27			
117	31	19			37.0		.8			
	Sept.									
118	1	10					.3			
119	1	16			14 1	17 58	1.2			
120	2	5						56		
121	2	11			36.8	37 24	1.0			P faint, ca. 11h 26m.
122	3									No records from 8—17h.
123	3	21					.8			
124	4	22			36					
125	5	14					37			
126	5	17					.2			
127	6	12					.7			
128	8	17					55			
129	8	23					.1			
130	9	4					.4			
131	9	19					.5			
132	10	20			40.4	47.1	1.2			
133	10	22					.7			
134	11	22		41 1			1.0			Formosa.
135	12	5						.5		
136	13	1					.0			
137	13	3					.2			
138	14	1						.0		
139	14	3					.2			
140*	15*	13	15 17	19 35					25	
141	16	1					.3			
142	17	6					.3			
143*	17*	19	28 44	38 0					70	
144	20	4					.9			

København.

No.	Date	Hour	Forerunners P	Forerunners S			L	Undefined	△	Remarks
	1929 June		*m s*	*m s*	*h m s*	*m s*	*h m*	*h m*	°	
145	21	19						.8		
146	24	2					37			
147	24	14						6		
148	26	5					.8			
149	26	15			59.4		1.4			
150	27	23			39.5		.9			

København.

NOTES

No. 14. July 5. 14^h. Aleutian Islands. Strong record. *PP* and *SS* well defined phases on *N*, hardly visible on *E*. $PP < P$. The beginning of *L* not very certain, earliest on *E*, where irregular, long-period waves precede regular *M* groups. *C* of long duration. Short-period movement 46^m42^s, conspicuous on *Z*, possibly *P* of a second shock.

No. 16. July 5. 22^h. The pulse read as *S* distinct but small, visible on *E* only; 57^m40^s much stronger movement begins on *N* and *E*. *L* regular.

No. 18. July 6. 2^h. *S* not clearly marked, e_E $24^m.8$, e_N $25^m.2$. *L* regular, of long duration.

No. 19. July 6. 9^h. Atlantic Ocean. *L* begins earliest on *N* with waves of long period and rather large amplitude. Later *M* small.

No. 22. July 7. 21^h. Aleutian Islands. Very strong record. *iP* on *N* and *Z*. On *N* forerunners strongest with clearly marked reflections. $PP < P$. *S* followed by large movement. On *E*, *L* begins immediately after *SSS* with irregular waves of long period. *M* very large.

No. 40. July 14. 9^h. Sea of Okhotsk. First part of record disturbed by change of sheets. *PPP* and *SSS* clearly marked on *E*. *L* earliest on *E*, in first part long period waves of large amplitude; later *L* not large, not very regular.

No. 41. July 15. 7^h. Persia. *P* and *S* very clearly marked. *S* followed by irregular movement. *L* irregular, not large, the beginning uncertain.

No. 55. July 23. Iceland. *P* and *S* very clearly marked phases, but beginnings unsharp. *L* begins distinctly; a large, regular *M* group.

No. 66. Aug. 1. 5^h. Not strong record, but *S* and *PS* very clearly marked on *N*.

No. 77. Aug. 6. 1^h. Jan Mayen. *P* faint, the reading not quite certain. *L* has rather long periods.

No. 80. Aug. 8. 13^h. Burma. *S* not very well defined. *L* earliest on *N*; in first part some long period waves of large amplitude; later *L* irregular, not large.

No. 91. Aug. 15. 20^h. Central America. Faint record, but *P*, $\overline{S_cP_cS}$ and S_n very clearly marked, $\overline{S_cP_cS}$ on *E* only. *L* begins distinctly with waves of long period.

No. 95. Aug. 17. 23^h. Central America. *P* and *PP* clearly marked. *S* phases not very well defined. *L* very regular.

No. 99. Aug. 19. 2^h. Riou Kiou Islands region. Phases clearly marked. $PP < P$. In first part of *L*, on *N*, long period waves of rather large amplitude; later *M* group on all.

No. 111. Aug. 28. 19^h. Japan. Forerunners small but clearly marked. *L* begins earliest on *N* with waves of long period. *M* waves continue for some time about equally large.

No. 140. September 15. 13^h. Asia Minor. *P* and *S* very clearly marked. *L* irregular.

No. 143. September 17. 19^h. Pacific Ocean. *P* faint on *N* and *E*. *S* rather large, followed by much movement; *RS* have long periods. The beginning of *L* uncertain; one rather large *M* group; later *L* somewhat irregular. *C* of long duration.

Bianco Luno

No. 12. 1929.

Geodætisk Institut

Proviantgaarden, Copenhagen, Denmark.

Bulletin

of the seismological station

KØBENHAVN

$\varphi = 55°41'$ N. $\lambda = 12°27'$ E. $h = 13$ m.

Lithologic foundation: chalk.

No. 12. Oct.—Dec. 1929.

Instruments:

Galitzin pendulums with galvanometric registration.

Constants:

Component	l	T_1	A_1		μ^2	T	k
	cm	sec	cm			sec	
N	12.5	12.63	100		0.10	12.6	105
E	12.5	12.69	100		0.0	13.0	99
				from $^{10}/_{11}$	0.1	12.8	98
Z	14.4	11.55	100		0.3	9	100

E was dismounted on Dec. 15.

Wiechert 1000 kg. horizontal seismograph.

Wiechert 1300 kg. vertical seismograph.

Constants:

Component	T	v	ϱ	V
	sec		mm	
N	9.8	4.6	0.8	225
E	9.6	4.4	0.6	195
Z	5.8	4	0.2	160

Milne-Shaw seismographs, *N* and *E* components, with the approximate constants $T = 12^s$ $v = 20$ $V = 300$.

Wood-Anderson torsion seismometer, *N* component, $T =$ c. 11^s.

København.

No.	Date	Hour	Forerunners P	Forerunners S			L	Un-defined	△	Remarks
	1929 Oct.		*m s*	*m s*	*h m s*	*m s*	*h m*	*h m*	°	
1	2	10					.2			Strong microseisms.
2	5	3					.4			„ „
3*	5*	17	*i* 10 54	19 52	20 39	24.5	.5		67	Kamtchatka.
4	5	19	*i* 12 3	21.3			.6			*S* faint.
5	6	6					.7			
6*	6*	8	5 39		9 59	16 21				Pacific Ocean.
7*	6*	13			32 25*		1.5			
8*	7*	15			27 23		1.3			
9*	8*	17			35 44	39.3	1.4			Pacific Ocean.
10	9	3					.9			
11	10	23					12			
12	14	10	21.2	30.7			.7			Readings uncertain.
13	16	16						52		
14*	16*	20		47 19	48 26*	51 37	1.0			Burma.
15	18	0					.6			
16	18	11					18			
17*	19*	10	26 51		37 21	38 5	55			Chile.
18	19	20			45 3	53.6	1.2			
19	20	16			19 30		.7			
20	21	11			3.7		.4			Disturbed.
21	21	12					.7			
22	22	19					23			
23	23	20					.3			
24	24	6			56.9		1.2			Disturbed by microseisms.
25	26	13			47 57					Felt in Halland, Sweden.
26	27	3					.3			
27	27	16						.9		
28	27	20						.1		
29	28	10						.2		
30	29	6		7 40			.2			Persia.
31	29	12					.2			
	Nov.									
32*	1*	7	*i* 0 24	2.7						Rumania.
33	2	2						.2		Faint.
34	4	16					.7			
35	5	12			2.5		.4			
36	8	4					.1			
37	9	2						.3		
38	13	1					.5			
39*	15*	19	4.6		8 53	18 8	.6			Caroline Islands.
40*	17*	3	56.8		67 50	68 33	1.4			
41	18	6			.1		.5			
42*	18*	20	40 3	46 29*	41.8	49 42			44	New Foundland.
43*	23*	0			21.2	28.8	.9			New Guinea.
	Dec.									
44	3	8					.7			
45	6	12					.5			
46*	6*	17			16 14	22.4	.7			Sandwich Group.

København.

No.	Date	Hour	Forerunners P	Forerunners S			L	Un-defined	△	Remarks
	1929 Dec.		*m s*	*m s*	*h m s*	*m s*	*h m*	*h m*	°	
47*	6*	20			50 41	57.0	1 3			Sandwich Group.
48	9	7	2 16		12.5		.5			Sumatra.
49	13	4			53.5		55			
50	13	9					.5			
51	13	10					.4			
52	15	1					.7			
53	16	12					.4			
54*	17*	11	9 48	19 0	12.2	23.5			69	
55	17	18					.4			
56	17	22			.1		.5			
57	18	7			21.2		.6			
58	18	13					.7			
59	18	16					.9			
60	20	20						26		
61	24	5					.8			
62	31	1			28.6		.9			
63	31	5			.3		.6			
64	31	22			47		1.1			

København.

NOTES

No. 3. Oct. 5. 17^h. Kamtchatka. iP_Z. *P* faint on *E*. *PP*, $13^m.4$, weak; *PPP* just visible. *S* large; 20^m39^s another phase ($\overline{S_cP_cS}$?), on *E* clearly separated from *S*. SS_N has long periods. *L* not regular; the first part most regular on *E* with long periods and large amplitudes.

No. 6. Oct. 6. 8^h. Pacific Ocean; $\triangle$ = c. 110°. *P* faint, visible on *Z* only; *PP* much stronger. The following phases clearly marked on *N*, but hardly to be distinguished on *E*: $\overline{S_cP_cS}$ 16^m21^s; ($\overline{S_cP_cP_cS}$) 17^m2^s; *PS* 19^m7^s; *PPS* $20^m.1$; $21^m.4$; *SS* $24^m.7$. A movement of long period on *E* at 35^m possibly an early beginning of *L*, but followed by irregular, smaller movement. *M* about 45^m.

No. 7. Oct. 6. 13^h. On *Z* a clearly marked phase 32^m25^s; no other forerunners. *L* small. Strong microseismic movement.

No. 8. Oct. 7. 15^h. On *Z* a clearly marked phase 27^m33^s; no other forerunners. *L* small. Strong microseismic movement.

No. 9. Oct. 8. 17^h. Pacific Ocean; $\triangle$ = c. 155°. *P'*, 35^m44^s, and the following phase, $39^m.3$, quite strong on *Z*; the movement increases 40^m10^s. Later phases not clearly marked. On *N*: $42^m.4$; $49^m.7$; $54^m.7$. On *N* and *E*: *SS* $58^m.9$. Several *M* groups.

No. 14. Oct. 16. 20^h. Burma; $\triangle$ = c. 65°. Strong microseismic movement. Forerunners most clearly marked on *E*. *L* irregular, earliest on *N*; large *M* group of short duration.

No. 17. Oct. 19. 10^h. Pacific Ocean off Northern Chile; $\triangle$ = c. 100°. Strong record. No Galitzin records, the other records except Wood-Anderson disturbed by work at the station. *P* begins faintly; the movement increases at $27^m.4$. *PP*, 31^m3^s, stronger. $\overline{S_cP_cS}$ 37^m21^s and ($\overline{S_cP_cP_cS}$) 38^m5^s strong and clearly marked on *E*; S_n $38^m.5$, on *N*, stronger. *SS* $44^m.6$. *M* regular.

No. 32. Nov. 1. 7^h. Rumania. *P* followed by strong movement, *S* not well defined. After *S*, strong movement continues; the beginning of *L* uncertain. *M* irregular.

No. 39. Nov. 15. 19^h. Caroline Islands; $\triangle$ = c. 105°. In forerunners continued oscillatory movement; many phases, but not very clearly marked. Some of the best marked can be interpreted as follows: P'_Z 7^m51^s; *PP* 8^m53^s; $\overline{S_cP_cS}$ 15^m17^s; $\overline{S_cP_cP_cS}$ $16^m.0$; S_n 16^m35^s; *PS* 18^m8^s; *SS* 23^m46^s. *M* irregular.

No. 40. Nov. 17. 3^h. Mindanao region according to *URSS*; $\triangle$ = c. 95°. *PP*, c. $60^m.9$, stronger than *P*, but the beginning not clearly marked. 67^m50^s ($\overline{S_cP_cS}$?) very clearly marked, largest on *E*. c. 70^m a distinct phase, but beginning uncertain. *SS* $75^m.3$. *L* earliest on *N*; the first waves have periods of more than 1 min.

No. 42. Nov. 18. 20^h. New Foundland. The first impulse not strong, compression; sharp increase on *Z* 40^m7^s and 40^m22^s; followed by oscillatory movement. *S* large. One very large, regular *M* group.

No. 43. Nov. 23. 0^h. New Guinea; $\triangle$ = c. 110°. Forerunners not large and not clearly marked. *PP* $21^m.2$; *PS* $33^m.2$; *SS* $36^m.8$. The first *L* waves have long periods; *M* not large, but of long duration.

Nos. 46/47. Dec. 6. 17^h and 20^h. Sandwich Group; $\triangle$ = c. 110°. Disturbed by strong microseismic movement. Faint forerunners precede *PS*, the first phase read, which is very clearly marked.

No. 54. Dec. 17. 11^h. Between Kamtchatka and Aleutian Islands according to Strasbourg. Very strong record. *P* increases $10^m.1$. *S* large, followed by large oscillations. The beginning of *L* not certain; large *M* of long duration.