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No. 49. 1939.

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. 49. Jan.—Dec. 1939.

Instruments:

Galitzin-Wilip seismographs.

Constants:

Component	l	A_1	T_1	T	k
	cm	cm	sec	sec	
N	12.5	100	12.59	12.4	103
E	12.5	100	12.60	12	102
Z	14.5	100	11.52	11	91

Damping was approximately aperiodic.

Wiechert 1000 kg. horizontal seismograph.

Wiechert 1300 kg. vertical seismograph.

Constants:

Component		T	ν	ϱ	V
		sec		mm	
N	$^1/_1$—$^{16}/_3$	8.9	3.2	0.5	210
	$^{16}/_3$—$^{14}/_5$	9.4	4.7	0.2	135
	$^{14}/_5$—$^{31}/_{12}$	9.3	4.7	0.5	180
E	$^1/_1$—$^{16}/_3$	8.9	3.4	0.4	215
	$^{16}/_3$—$^{31}/_{12}$	9.2	5.2	0.5	215
Z		5.2	4	0.2	160

Milne-Shaw seismograph, E component, with the approximate constants $T = 12^s$ $\nu = 20$ $V = 300$.

Benioff vertical seismograph, $T_1 = {}^1/_4{}^s$ $T = 1^s$.

The Galitzin-Wilip and Benioff seismographs were not recording from $^{25}/_8$ to $^{17}/_{10}$, and the Milne-Shaw seismograph was not recording from $^{25}/_9$ to $^{17}/_{10}$.

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København.

No.	Date	Hour	Forerunners P or P′	Forerunners S	Forerunners	Forerunners	L	△	Remarks
	1939		*m s*	*m s*	*m s*	*m s*	*h m*	°	
	Jan.								
1	20	1	e 29 49	34 0*					Somewhat uncertain owing to microseismic movement. Tripoli.
2	20	14	e 27 56						Possibly earlier; microseisms. Tripoli.
3	20	20	i 53 6	63 50	*i* 53 7				
4	23	2	*e* 28 10	32 28	i 28 14	*i* 32 36		24	*eP* small, uncertain. Tripoli.
5	24	4	i 13 39						
6*	25*	3	47.4		e 50 56	52 25			Chile.
7	27	20	14 22				20		
8*	30*	2	i 37 23		38 42	46 4	69		Felt in New Guinea.
9	31	0	i 8 55		10 55	17.0			e_N $19^m.9$, 21^m16^s, $26^m.2$.
	Febr.								
10	2	13	i *i* 3 40		i 6 25	i 9 13			
11*	3*	5			47.4				
12	3	20	i *i* 33 1		*i* 33 46		1.5		
13	6	7	i 25 52						
14	7	15			e 1 15				
15	9	2	i 50 4						
16	14	17			i 32 6				
17	16	19	e *e* 3 3		i 3 4				
18	24	5			i 45 7				
	March								
19	8	22	i 17 13		*i* 18 54				
20	13	5	i *i* 29 51		*e* 30 17				
21	20	3	- *i* 34 23 +		44.2	44 37	60		*e* $45^m.4$. Japan. Masked by microseisms.
22*	21*	1	i 23 41	33 49	27 1	38.4		81	Indian Ocean.
23	23	16	*e* 40 21		44.1	44 41			i *e* 40^m27^s, i *i* 40^m45^s large on BZ.
	April								
24	4	20	e 31 31						First onset possibly 27^s; microseisms.
25*	5*	17	*e* 2 3 +		*i* 2 9	*i* 5 6	.7		Fiji Islands.
26	6	4	e 14 59	20 35	20 38				The time of *P* not quite certain; microseisms. Iran.
27	10	11	i 36 24						
28	12	12	i 34 13						
29*	18*	6	e *e* 37 3 +		41 16	47 34			Chile.
30*	21*	4	i *i* 39 13 —	*i* 47 29	*e* 40 58	*i* 41 53			Sea of Okhotsk.
31*	23*	16	e *i* 33 16 +	*i* 41 34	35 31	45 27	49	61	Atlantic Ocean.
32	28	0	i 38 58						
33	28	14	i 21 39						
34*	30*	3	11.9		14 37	16 34	48		Solomon Islands region.
	May								
35*	1*	6	i *e* 10 8	*i* 19 48				76	Japan.
36*	1*	6	i *i* 11 51 +	21 34				76	«
37*	1*	6	i 14 31						«
38	1	16	i *e* 17 29	27 6	17 32		43	75	«

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No.	Date	Hour	Forerunners				L	△	Remarks
			P or P′	S					
	1939 May		m s	m s	m s	m s	h m	°	
39*	2*	13	e e 27 24				49		California.
40	4	4			e 16 24				
	6	6							No Galitzin records.
41*	8*	1	e 53 9	i 58 14	54 4			30	Azores.
42	9	7	39 27 +	48 29				69	Pacific Ocean south of Alaska.
43	10	7	e 55 47	65 12	i 55 48			73	South of Aleutian Islands.
44	13	13			i 11 28	i 12 0			
45	13	20			i 5 57				
46	14	18	e 32 19		e 32 31				
47	16	7	i i 32 29 +	42 34			1.0	80	Riukiu Islands.
48*	17*	18	i e 43 36 +		47 17	54 7	76		Pacific Ocean. — ca 90° —
49	19	18			43.3	49 43			e 50^m34^s.
50	19	19			0 8	2 4			e $7^m.2$, $10^m.7$.
51	20	9	e e 39 3	42 7			44	17	Albania.
52	21	20	i i 40 32		e 42 48	i 43 16			e 40^m28^s. e 40^m31^s.
53	23	4	e e 28 48		i 28 50				
54	26	9	e e 49 42	57 0*	i 49 48	60 42		51	
55*	27*	3	i e 56 23	65 3	i 56 40	65 31	1.4	65	Birma. Depth ca. 60 km.
56	30	10	e e 14 51	21 6	i 16 32	i 16 38		41	*SS* $23^m.9$.
57	31	0	e e 28 33	31 47	32.0	32.1	34	18	Greece. *P* small.
	June								
58	2	3	e e 46 55	58 15	50 57	57.5			e_Z 59^m41^s. East of Mindanao.
59	4	12			17 7				
60	4	20	i 37 10						
61	5	23	e 10 52						
62*	8*	21	e 6 5		i 6 46	i 9 52			Pacific Ocean.
63	12	4	i e 16 4	24 55	17 18	18 37	37	67	i i 16^m12^s. e 20^m10^s. $26^m.1$.
64	13	20	e 53 40		57 55	66 52	91		*SKS* 64^m16^s.
65	18	4	i 4 8				34		
66	18	12	e 32 21						
67	18	16	i e 58 39	68 58	i 58 53		1.4	83	
68	19	0	e 50 37		i 50 42	i 51 2			
69	22	19	i i 28 33 —	36 2	30 32	39 28	44	53	*P* (—0.8, x, —1.0; +2.1, x, +2.0). Atlantic Ocean.
70	27	23	- e 17 55		21 54	22 29	.8		East of Mindanao.
	July								
71	2	19	e 54 23	63 48			1.3	73	Pacific Ocean.
72	4	18			40.7	44 45			49^m46^s; 50^m24^s; 50^m43^s; $52^m.7$; 54^m25^s.
73*	5*	22	i i 59 33 —		i 59 40	i 61 57			Deep focus. Fiji Basin.
74	6	1			i 24 25	i 27 8			
75	7	3			17 51		.4		
76	12	20	i i 19 58 +	29 25			.8	73	Pacific Ocean.
77	12	23			i 17 55	27 18	50		Some preceding movement. No G. *Z* record.
78	13	17	e 18 17 —		28.5		50		Pacific Ocean.
79	14	8	i e 42 46 +	51 52			1.1	69	Pacific Ocean.
80	17	3			i 48 47				

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No.	Date	Hour	Forerunners P or P′	Forerunners S	Forerunners	Forerunners	L	△	Remarks
	1939 July		m s	m s	m s	m s	h m	°	
81	18	3	e 38 1*	47 15	47 19	48 34	57	71	No G. Z record. e 55m34s. Pacific Ocean.
82*	20*	2	i i 41 33 —		44.0	48 11			Fiji Basin.
83	24	22	i 9 53	13.9			17		Iran.
84	25	3	i i 44 51	48 28	48 32		51	20	Asia Minor.
85	27	23	i 38 45				1.1		Pacific Ocean.
86	31	13	e 37 16				44		Asia Minor.
	Aug.								
87	1	16	e 6 54		i 6 57		27		Pacific Ocean.
88	2	1			10 31	10 57	26		11m9s; 17m.2. Some preceding movement.
89	2	13	e 10 42	14 17	i 10 44	14 20	17	20	e_Z 14m25s. Asia Minor.
90	3	2			48 3		1.8		
91	3	12	e 37 17	41 0*	i 37 19	i 37 22		21	i 37m35s. P(—1.0, +1.0, —1.1; +4.6, —4.7, +4.6). Asia Minor.
92	9	23	e e 48 14	51 56			54	21	Asia Minor.
93	12	2	i i 26 31		27 15	i 29 10			i i 29m46s. e 29m.9; 31m10s. New Hebrides. Deep focus.
94	12	10	e 1 27	10.9	i 1 28	i 1 46	27		
95	16	17	- e 19 51		30.4	36.0			Mexico.
96	17	15			i 57 27		1.4		
97	18	22	e 35 17		i 35 30	i 38 22	1.3		$i_{N,E}$ 39m5s.
98	18	23			e 0 21	i 0 31			i e 0m25s.
99	19	1	e 7.0		9 52	10 35	50		
100	21	15	i e 30 32	39 55			.9	72	South of Aleutian Islands.
101	22	0	i e 18 16	28 3	21 10		44	77	Japan.
102	23	4			55.7	59.7	1.7		
103	25	4			8 24	14.0	.7		15m23s; 18m.1.
	Sept.								
104*	8*	12	16 10	25 38	18 54	29 32	35		Aleutian Islands.
105	15	23	20 57	24 38	21 34		27	20	Asia Minor.
106	18	0			17 31				Near Wien.
107	19	3	i 30 52	36 22				34	
108	20	0							No time-marks.
109	21	12	49 28		49 37		57		
110	22	0	40 59 —		41 37	44.4	45		e_E 44m39s, e_N 44m43s. Asia Minor.
	Oct.								
111	10	18	43 51 +	53 37			1.1	77	Japan.
112	15	14							e 11m; small preceding movement. Italy.
113	17	6	41 19 +		42 29	43.9	1.4		e_Z 44m.0; 44m38s; $e_{N,E}$ 44m49s. New Hebrides. Deep focus.
114	19	21	37 14 +	40 53			44	20	
115	22	14			51 11		1.3		Preceded by small movement, 51m5s?
116	24	14	i 54 1						
117	26	1			16 6		.4		
118	30	13			34 48	i 35 18			e_N 35m.5; e_Z 36m29s. L small.

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No.	Date	Hour	Forerunners P or P′		Forerunners S		Forerunners		Forerunners		L		△	Remarks
	1939 Nov.		*m*	*s*	*m*	*s*	*m*	*s*	*m*	*s*	*h*	*m*	°	
119	4	10	i *e*	22 10 +	27	38	i 22	16					34	
120	17	18	i *i*	58 8 —										Large *Z* record; no succeeding movement.
121	18	1	*e*	43 56	53	2	53	53	58.0		1.1		69	
122	21	8	i *e*	54 10	*i* 58	32							25	
123*	21*	11	i *i*	9 31 +	*i* 15	44	*i* 10	18	10	40			44	Hindu Kush.
	Dec.													
124	5	8	e *i*	42 51 +	53	28	46	10	53	10		67		*SS* 59^m.0. *SSS* 63^m.1.
125	7	11	i *e*	27 53	*i* 37	16						51	73	
126	16	10	i *i*	58 3	*i* 67	28	i 58	4	*i* 68	40		80		*P* (— 3.5, — 2.1, + 9.5; + 5.0, + 4.0, — 11,8). Deeper than normal. Kurile Islands.
127	21	21	*e*	7 24										
128	21	21	e *e*	14 19			17.7		18	35				Large earthquake. Later phases not clearly marked. Celebes.
129	25	12	e	58 24								65		
130*	27*	0	i *i*	2 33	7.0		i 2	35	3	0*				Destructive in Anatolia.
131	27	0	e	55 52										
132	27	2	i	53 .34										
133	27	22	e *e*	39 5	43	15							24	
134	28	2	e	28 16										
135	28	3	i	30 20	34.4		*i* 34	33						
136	28	10	i	39 6										
137	29	11	e	38 48	43.2									

udtaget Kuwet
Tek Lehmanns Kontor

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NOTES

No. 6. Jan. 25. 3^h. Destructive in Chile; $\triangle$ = ca. 120°. Deeper than normal. No Galitzin *Z* record. *P* $47^m.4$ read on Wiechert *Z*, quite small, uncertain. e*P'* 50^m56^s. *e* $52^m.0$. *PP* 52^m25^s. *e* 54^m39^s. *SKS* 57^m34^s and *e* 59^m3^s large on *N* and *E*. e 61^m34^s; *e* 61^m40^s large. ee 65^m15^s. *L* about 80^m; periods of more than 1 min.

No. 8. Jan. 30. 2^h. Felt in New Guinea; $\triangle$ = ca. 125°. i*P'* 37^m23^s, ii *P'* 37^m26^s. *PP* 38^m42^s; 39^m0^s. e_Z 40^m0^s. e_E 40^m36^s. *SKKS* 46^m4^s, *e* 48^m37^s. e_Z $48^m.9$. $e_{N,E}$ 49^m0^s. $e_{N,E,Z}$ 50^m23^s. e_E 51^m17^s; $52^m.5$. e_Z 54^m43^s. e_N $55^m.6$; e_E $55^m.9$. *e* $57^m.3$, $59^m.7$.

No. 11. Febr. 3. 5^h. No Galitzin *Z* record. *PP* $47^m.4$. *e* $48^m.8$; $52^m.8$; e_N $57^m.7$. *e* $59^m.0$; $63^m.9$. e_N 64^m40^s.

No. 22. March 21. 1^h. Indian Ocean. i*P* 23^m41^s, *iP* 23^m45^s; *i* 23^m54^s. *PP* 27^m1^s; *PPP* 29^m2^s. iS_N 33^m49^s; i_E 34^m6^s; $i_{N,E}$ 34^m27^s. *SS* $38^m.4$. The oscillations following *S* have periods of about 1 min.

No. 25. April 5. 17^h. Fiji Islands; $\triangle$ = ca. 140°. e_ZP' 2^m3^s; i 2^m8^s; i_Z 2^m9^s. *iPP* 5^m6^s; i 5^m44^s. $iPKS_{N,E}$ 5^m50^s. e_N $7^m.0$. *PPP* $8^m.6$. *SKKS* $12^m.1$. $e_{N,E}$ $13^m.7$. $SKSP_N$ $15^m.2$. *PPS* 17^m22^s. *SS* $23^m.5$. e_N $27^m.9$.

No. 29. April 18. 6^h. Chile; $\triangle$ = ca. 110°. ee*P* 37^m3^s small. e_E 37^m31^s. PP_Z 41^m16^s; *e* 41^m30^s. *PPP* $43^m.9$. SKS_E 47^m34^s; *e* $48^m.0$; $SKKS_E$ 48^m34^s. e_N $49^m.2$, $49^m.6$. *PS* 50^m52^s; $i_{N,E}$ 51^m15^s.

No. 30. April 21. 4^h. Sea of Okhotsk. ii$_Z$*P* 39^m13^s. i 39^m52^s. *epP* 40^m58^s. ee$_Z$ 41^m44^s; ii*sP* 41^m53^s. ee*PP* 43^m34^s. e_Z $47^m.4$. *iS* 47^m29^s and *i* 48^m18^s large on *N* and *E*. *e* $50^m.6$; e_E 51^m18^s; *e* $52^m.0$. *L* small.

No. 31. April 23. 16^h. Atlantic Ocean. ei$_Z$*P* 33^m16^s; i 33^m21^s. e_N 33^m45^s. PP_Z 35^m31^s. PPP_N $37^m.0$. $iS_{N,E}$ 41^m34^s large. e_N 42^m33^s. $e_{N,E}$ 43^m20^s, clearly marked on *E*. *SS* 45^m27^s.

No. 34. April 30. 3^h. Solomon Islands region; $\triangle$ = ca. 130°. Very large earthquake. Phases marked by groups of waves, most onsets not well defined. *eP* $11^m.9$ quite small. e*P'* 14^m30^s, ee$_Z$ 37^s, e_Z 58^s. *PP* 16^m34^s, ee 55^s. $e_{N,E}$ $17^m.7$. e_Z 18^m5^s. e_E $19^m.2$; e_Z $19^m.4$. *e* $20^m.1$, $20^m.4$, $21^m.7$. e_Z $23^m.9$. ee 24^m2^s. *PS* $26^m.9$, *PPS* $28^m.2$. e_E $30^m.5$, e_Z $31^m.4$, e_E $32^m.0$. *SS* $33^m.9$.

Nos. 35/7. May 1. 6^h. Japan. 3 shocks. *P* onsets very well defined on B.*Z*. ieP_I 10^m8^s, small and uncertain on G.-W. and Wi. instruments. *e* $10^m.3$. iiP_{II} 11^m51^s; ii 11^m56^s. *e* $13^m.0$. iP_{III} 14^m31^s; i_Z 14^m37^s. *e* $16^m.3$. iS_I 19^m48^s. e_Z $20^m.1$. eS_{II} 21^m34^s. S_I and S_{II} large and well defined. e_Z $22^m.4$. e_N 22^m50^s. *e* $24^m.0$; $24^m.4$; $25^m.4$; $26^m.4$. e_E $28^m.2$, $28^m.8$. *L* 31^m.

No. 39. May 2. 13^h. California; $\triangle$ = ca. 85°. ee*P* 27^m24^s quite small; i 27^m34^s. e_Z 28^m26^s, 29^m17^s; ie 30^m32^s. $e_{N,E}$ $37^m.8$. e_N 37^m51^s; i_E 37^m57^s. *e* $39^m.0$. e_N 40^m56^s, e_E 41^m6^s. *e* $43^m.1$, $46^m.0$.

No. 41. May 8. 1^h. Azores. Deeper than normal? e_Z 53^m9^s quite small; e 53^m10^s, i 11^s. $e_{N,E}$ i_Z 53^m12^s. *e* 54^m4^s. e_E 55^m27^s. ee 55^m42^s. e_E $57^m.7$. *iS* 58^m14^s large. e_Z 58^m26^s.

No. 48. May 17. 18^h. Pacific Ocean; $\triangle$ = ca. 90°. ie*P* 43^m36^s quite small on Galitzin records. ie*PP* 47^m17^s rather large. *SKS* 54^m7^s; e_N 54^m55^s. *PS* 55^m38^s, *PPS* $56^m.2$. *SS* $60^m.8$.

No. 55. May 27. 3^h. Birma. Depth about 60 km. ie*P* 56^m23^s small. ii*pP* 56^m40^s large on B.*Z*. *PP* $59^m.0$. *PPP* 60^m56^s. *S* 65^m3^s. e_N 65^m31^s, i_E 65^m37^s. *e* $66^m.6$. *e* $69^m.3$; e_N 69^m46^s, e_E 69^m55^s. *SSS* $72^m.9$.

No. 62. June 8. 21^h. Pacific Ocean; $\triangle$ = ca. 140°. Deep focus. eP'_Z 6^m5^s and e 6^m10^s small; i_Z 6^m15^s, i_Z 6^m46^s. $e_N i_Z$ 9^m7^s. $i_{N,E}$ 9^m52^s. *e* $10^m.4$, 10^m36^s. *e* 15^m31^s, $16^m.8$, $17^m.6$. *e* 19^m18^s. *e* $21^m.3$. e_E 22^m41^s; e_E 27^m17^s.

No. 73. July 5. 22^h. Fiji Basin; $\triangle$ = ca. 145°. Deep focus. ii*P'* 59^m33^s small; ii 59^m40^s large. i_Z 61^m57^s; i 62^m14^s, 62^m18^s. *e* 63^m0^s; 65^m13^s; $66^m.3$. e_N $68^m.8$. *e* $72^m.3$; $74^m.6$; $75^m.3$. e_E 81^m2^s; e_E 84^m57^s. *L* small.

No. 82. July 20. 2^h. Fiji Basin; $\triangle$ = ca. 145°. Deep focus. ii*P'* 41^m33^s very large on B.*Z*. e$_Z$ $44^m.0$. i 44^m13^s. *e* 44^m50^s; 48^m11^s, $48^m.9$. e_N 50^m45^s. *e* 55^m11^s; 58^m21^s.

No. 104. Sept. 8. 12^h. Aleutian Islands. Deeper than normal. eP_Z 16^m10^s, e_N 16^m12^s, i_Z 16^m17^s. i_Z 16^m50^s. PP_Z 18^m54^s. $e_{Z,N}$ $20^m.8$. e_N 24^m15^s, $25^m.5$. S_E 25^m38^s very large; S_N 25^m42^s. *e* $26^m.4$, $27^m.0$. e_E 29^m32^s. L_E 35^m, L_N 37^m. *L* not large.

No. 123. Nov. 21. 11^h. Hindu Kush. Large earthquake. Depth about 220 km. ii*P* 9^m31^s (x, -8.0, $+10.8$; x, $+15.0$, -18.3). e_N 9^m51^s. ii*pP* 10^m18^s; *sP* 10^m40^s larger. e_N 11^m2^s. *PP* 11^m20^s. *pPP* $11^m.9$. *sPP* and sP_cP 12^m17^s very large on *Z*. e_N 12^m40^s. *iS* 15^m44^s. $e_{N,E}$ 17^m3^s; *sS* $17^m.2$ large. S_cS and *SS* $19^m.1$; $19^m.3$ very large.

No. 130. Dec. 27. 0^h. Destructive in Anatolia. Dilatation. ii*P* 2^m33^s, i 2^m35^s. After the 3^m time-break very large oscillations; a second, larger shock? *eS* $7^m.0$, *i* 7^m9^s very large. L very large.

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Seismometric readings; Notation

P — normal first preliminary tremors, longitudinal waves.
P+ — first wave condensational (away from the epicentre).
P— — first wave dilatational (towards the epicentre).
P(± a, ± b, ± c) — a, b and c are trace amplitudes in mm. of first swing on NS, EW and vertical component Galitzin records respectively. + indicates ground motion directed to N, to E or up, — indicates ground motion to S, to W or down. When a second set of amplitudes is given it refers to the second swing. If an amplitude is not measurable the number is replaced by x.
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.
SKS — waves which traverse the mantle as transverse waves but are refracted through the core with longitudinal oscillation.
PKS — 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.
SKKS — 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, *i* — sharply defined beginning of a phase as recorded on Benioff seismograph and other seismographs respectively.
e, *e* — gradual beginning of a phase as recorded on Benioff seismograph and other seismographs respectively.
△ — 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.