NOTE ON THE PRELIMINARY DETERMINATION OF GEODETIC POSITIONS OF THE CHIUFENG SEISMIC STATION, PEIPING.

BY S. Y. TSENG 曾世英

The results of the present observations are only considered as preliminary as their probable errors given in the calculation below explain themselves.

The observations were executed in the evenings of 23rd and 24th September 1930 by the writer himself with the sub-surveyer Sun to keep records at a spot 28.01 meters S 62° 54′ 42″ W of the wireless post on the top of the Seismic Station. The instruments used were one $5\frac{1}{2}''$ triangulation theodolite, two half chronometers, one stop watch, one thermometer and two aneroids, besides the radio receiving set already installed at the Station.

The theodolite was made by E. W. Breithaupt and Son of Germany. As it is a triangulation theodolite the reading of the vertical circle is only to 10 seconds by two verniers which, however, will sometimes give opposite readings having a difference of as great as 30 seconds on certain portion of the circle while at other portions the readings of two verniers happen to be exactly the same. This is probably due to the faulty graduation of the circle or its eccentricity or the combination of both and it is most probably the main agent responsible for bringing down the accuracy of observations. The level attached to the vertical circle is stated to have a sensitivity of 10 seconds per division. The telescope can only be pointed to an altitude of less than 70° as no diagonal eye-piece for taking zenith observation is possible to be fitted onto it.

The half chronometers are both solor time piece (1) made by A. Lange and Son of Germany and (2) made by J. W. Benson, Ltd. of London. These two chronometers had been kept to run by winding up every evening at the same time for more than a month in the city of Peiping before the present observation was made. The following are the comparisons of the chronometer time with that of the Cavite Observatory (120th meridian time) which show in addition to the rate of chronometers, the degree of their accuracy:

Date	Cavite Time Signal	Chronometer Time Lange	Chronometer Time Benson
23-IX-1930	11 a.m.	10-57-57.9	10-58-11.8
23-IX-1930	10 p.m.	9-57-55.7	9-58-12.2
24-IX-1930	11 a.m.	10-57-52.9	10-58-16.5
24-IX-1930	10 p.m.	9-57-51.2	9-58-16.8
25-IX-1930	11 a.m.	10-57-50.5	10-58-24.8

As one chronometer gives 50 beats every 10 seconds and the other gives 54 beats every 10 seconds, it is difficult to keep the time by listening. A stop watch was therefore resorted to. After a star having been brought into the field of the telescope, the stop watch was started at any even 5-second of the chronometer and the chronometer time of that instant was recorded down. As the star passed through the cross-wire of the telescope, the stop watch was instantaneously stopped and its record was taken. The sound of the stopping action of the stop watch gave also as a signal to the recorder who recorded down the time by another chronometer for check. The stop watch ran apparently at the same rate of the chronometer. The time elapsed between the start and the stop of the stop watch seldom exceeded 30 seconds.

In making time observation the observer kept the Lange chronometer and the stop watch while the recorder kept the Benson chronometer. The differential difference of the time thus kept by two persons was usually less than half second. In making latitude observations only the recorder kept the time of the Benson chronometer.

The latitude was observed by circum-meridian passage of north and south stars of nearly equal altitude at a zenith distance between 25° and 31°. To every star five or six pointings were taken when it was on the east side of the meridian with telescope in one position and another number of pointings when it passed to the other side of the meridian with the telescope in the plunged position. The interval of time off the meridian was usually less than five minutes. The records were checked by reducing every pointing to the meridian altitude before final calculation was made and if the reduced meridian altitude of any pointing differs appreciably from the rest, it was rejected together with another pointing belonging to the other position of the telescope to balance the error due to culmination.

The reduction of altitude to that on the meridian was carried out to the first term only of the equation.

$$\zeta_1 = \zeta - \frac{\cos\varphi \cos\delta}{\sin \zeta_1} \cdot \frac{2 \sin^2 \frac{1}{2} t}{\sin 1''} + \left(\frac{\cos\varphi \cos\delta}{\sin \zeta_1}\right)^2 \cdot \frac{2 \cot \zeta_1 \sin^4 \frac{1}{2} t}{\sin 1''} + \ldots$$

The local time was observed by single altitude of east and west stars near the prime vertical at an altitude between 35° and 42°. To every star four pointings were observed with telescope direct and another four pointings with telescope plunged. Before computing the local time by the equation

$$\sin \tfrac{1}{2} t = \sqrt{\frac{\cos s \ \sin (s-h)}{\cos \zeta \ \sin p}}$$

the records were checked over by the rate of change of altitude between every two consecutive pointings and if the rate between certain pointings differs appreciably with the rest, the involved pointing was rejected together with another one belong to the other position of the telescope to balance the culmination error.

The refraction was reduced by both thermometer and aneroid readings. Although the aneroids may not be reliable, the result will not be affected as the observations were taken pair by pair of either east and west or north and south stars.

The following are the result of observations:

Date	Star	Location of Star	Observed Latitude	v	v^2
23-IX-1930	β Cephei	N	40-03-47.06	7.35	54.0
,,	ε Pegasi	S	52.05	2.36	5.6
24-IX-1930	β Cephei	N	59.01	4.60	21.2
,,	ε Pegasi	S	04-00.40	5.99	35.9
,,	α Pegasi	S	03-45.44	8.97	60.5
,,	o Cephei	N	04-01.71	7.30	53.3
		mean	04-03-54.41	Σ v^2	250.3

$$\text{Probable error} = 0.674\sqrt{\frac{250.3}{6 \times 5}}$$

$$= \pm 1''.86$$

Latitude of observation spot = 40°-03′-54″. 41 ± 1″. 86

Latitude of wireless post of

the Seismic Station = 40°-03′-54″. 82 ± 1″.86

Date	Star	Location of Star	Time difference (with 120th meridian)	v	v^2
23-IX-1930	β Pegasi	E	$15^m\ 36^s.27$	.02	.00
,,	α Corosae Bor.	W	36.72	.27	.07
,,	γ Pegasi	E	38.97	1.98	3.92
,,	δ Herculis	W	37.98	.99	.98
,,	β Arietis	E	37.43	.44	.20
,,	α Lyra	W	38.79	1.80	3.24

24-IX-1930	β Herculis	W	35.40	1.59	2.53
,,	γ Pegasi	E	37.86	.87	.76
,,	δ Herculis	W	35.84	1.15	1.32
,,	α Arietis	E	36.91	.08	.01
,,	41 Arietis	E	35.83	1.16	1.35
,,	β Cygni	W	35.14	1.85	3.42
		mean	$15^m\ 36.^s99$		Σv^2 17.80

$$\text{Probable Error} = 0.674\sqrt{\frac{17.80}{12\times 11}}$$

$$= \pm .248^s$$

Longitude of observation spot $= 116 - 05' - 45''.16 \pm 3''.71 \pm$ Personal Equation.

Longitude of wireless post of the Seismic Station $= 116 - 05' - 46''.21 \pm 3''.71 \pm$ Personal Equation.

The corrections to the Cavite time signal which sometimes amount to quite an appreciable fraction of a second are not yet informed and are therefore not taken into account in the above result. The difference of time due to the travel of broad casting wave is neglected.

SEISMOLOGICAL NOTICE

BY ZITZIN S. P. LEE 李善邦

I **Determination of constants** (Vertical component not included)

- M indicates the stationary mass (200 kg)
- H ,, the height of C. g. above the turning point. (96 cm).
- T_0 ,, the oscillation period of the instrument in sec.
- L ,, the equivalent pendulum length in metre.
- J ,, the equivalent indicator length in metre.
- V ,, the indicator magnification.
- R ,, the friction deviation in mm.
- R ,, the frictional force in mg.
- E ,, the damping ratio.

a. Determination of T_0

Touch any one component by the finger and start the stop-watch when the pen just passing through the line of rest, and stop it after three oscillations accomplished, i. e. the fourth time of the pen coming at the line of rest in the same direction; then read out the number of seconds.

Trial	Secs. in 3 osc.		T_0		Mean T_0	
	EW	NS	EW	NS	EW	NS
1	18	17 2/5	6	5.8	6 sec.	5.8 sec.
2	17 4/5	17 2/5	5.93	5.8		
3	18 1/5	17 2/5	6.07	5.8		

b. Determination of L.

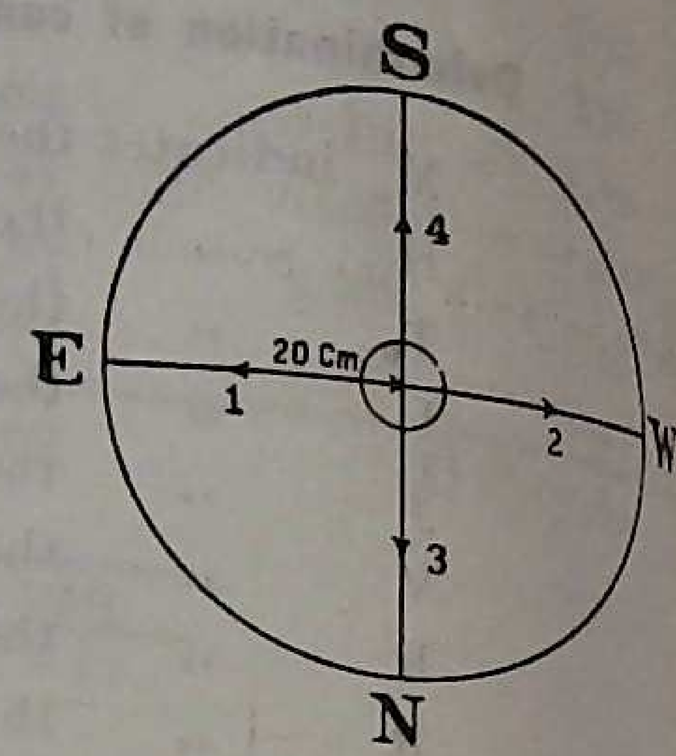
$$L = \frac{T_0^2\ g}{4} \quad \text{or} \quad L = \frac{T_0^2}{4} \text{ in metre}$$

L in m

EW	NS
9	8.4

c. *Determination of J.*

Make two lines along EW and NS on the upper surface of the stationary mass and mark 4 points 1, 2, 3, & 4, each 10 cm apart from the center. Place a 20g weight first on 1, after the deviation has completed take it to 2 and measure the arc of the total deviation; same way for the other component.



Trial	Total deviation (a) in mm.	
	EW	NS
1	19	16.5
2	18.5	17.5
3	20.5	17.0

Mean a	
EW	NS
19.3	17.0

Since J is given by

$$J = \frac{M.\ H.\ a}{m.\ d.} \quad \left(\begin{array}{l} m = 20\ g \\ d = 10\ cm \end{array} \right.$$

or $\frac{M.\ H.}{m.\ d.} = \frac{200 \times 1000 \times 96}{20\ .\ 20} = 48 \times 1000$

then

J in m	
EW	NS
926.4	816

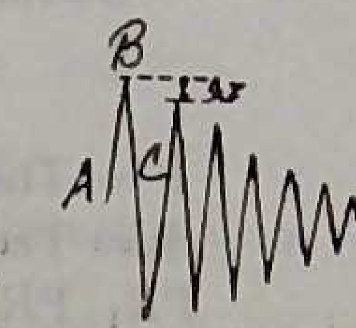
d. *Determination of V*

V is known as quotient of J/L

then

V	
EW	NS
103	93.

e. *Determination of r*



The difference of any two successive amplitudes is equal 4r —(like the right figure) from A to B lack by one r, B to C again lack by one r etc.

Trial	4r in mm	
	EW	NS
1	1.2	1.2
2	1.5	1.6
3	1.5	1.6

Mean r	
EW	NS
.35	.365

f. *Determination of R.*

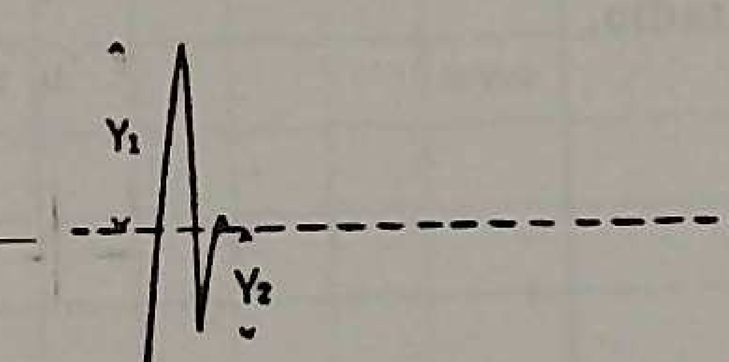
R is given by $\frac{r\ 1000\ M}{L\ \ V^2}$

so that

R in mg	
EW	NS
.73	.93

g. *Determination of E.*

$$E = \frac{Y_1 - r}{Y_2 - r}$$



Trial	EW			NS		
	Y_1 mm	Y_2 mm	E	Y_1 mm	Y_2 mm	E
1	4.5	1	3.08	5	1	3.40
2	3.25	.7	2.76	4.7	.8	4.72
3	6.5	1.3	3.73	4	.8	3.12

Mean E	
EW	NS
3.1	3.4

II Symbols adopted

P = The first phase (Primae undae) — wave of longitudinal type.

S = The second phase (secundae undae) — wave of transversal type

PR_1 PR_2 .... or PP, PPP .... = reflected wave of the first phase once twice .... ..

SR_1, SR_2 .... or SS, SSS........ = reflected wave of the second phase once twice ....

PS, SP, PSP .... = a longitudinal wave becomes transversal after reflection etc ....

L = the long wave (longae undae) or the surface wave (principal shock).

M_1, M_2, M_3.... = max. waves of the principal shock.

C = the later phase (cauda)

W_2, W_3, W_4........ = the max. wave coming again to the station after surrounding the earth once, twice etc.

F = end (finis)

i = sudden impulse of a phase (impetus)

e = gradual grow of a phase (emersio)

T = period of the ground movement

A = amplitude of the ground movement in W (micror=1/1,000 mm)

AN = N-S component of A (+ toward N, — toward S)

AE = EW component of A (+ toward E, — toward W)

Az = vertical component of A (+ toward the Zenith,—toward the epicentre)

△ = epicentral distance in KM.

III Time mark

The registering drum is turning about 12 mm per minute. The contact clock which gives the time mark is daily corrected with the time signal from Manila, by radio.

SEISMIC DATA PP.

φ 40° 3′ 55″ λ 116° 5′ 46″ *h* 155 m. Rock-foundation

Constants due to		V	T_0	ε	r/T^2
	AN	93	5.8	3.4	0.011
	AE	103	6.0	3.1	0.010
	Az				

Apparatus

I. 200kg Horizontal Wiechert

II. 80kg Vertical Wiechert

No. & Date	Phase	Time (Greenwich)	Period N-S	Period E-W	Period Z	Amplitude AN	Amplitude AE	Amplitude Az	△	Direction of true movement	Remark
		h m s	s	s	s	μ	μ	μ	km		
1 Sept. 20	PE	13 2 2									
,, ,,	FE	,, 9									
2 ,, 21	PE	23 8 51							2440		
,, ,,	SN	,, 12 51									
,, ,,	LN	,, 15 13									
,, ,,	ME1	,, 17 28									
,, ,,	ME2	,, 18 35									
,, 22	FE	0 22 8									
3 ,, ,,	PE	5 3 16									
,, ,,	FE	,, 18 9									
4 ,, ,,	PE	16 24 29							2500		
,, ,,	SN?	,, 28 34									
,, ,,	SRnl?	,, 29 14									
,, ,,	FN	,, 57 16									
5 ,, 25	PE	18 38 15							2350		
,, ,,	SE	,, 42 8									
,, ,,	FE	19 11									

SEISMIC DATA

PP. 3

Ø 40° 3′ 55″ λ 116° 5′ 46″ h 155 Rock-foundation

Constants due to Sept. 15		V	T_0	ε	r/T^2
	AN	93	5.8	3.27	.0108
	AE	103	6.0	3.18	.0097
	Az				

Apparatus
I. 200kg Horizontal Wiechert
II. 80kg Vertical Wiechert

No. & Date	Phase	Time (Greenwich)	Period N-S	Period E-W	Period Z	Amplitude AN	Amplitude AE	Amplitude Az	Δ	Direction of true movement	Remark
		h m s	s	s	s	μ	μ	μ	km		
6 Oct. 8	PE	10 30 57									
,, ,,	FE	11 39									
7 ,, 10	PN	0 41 51							2450		
,, ,,	SE?	,, 45 52									
,, ,,	ME	,, 48 37		8			9.4				
,, ,,	FE	1 12									
8 ,, 15	PE	19 31 26									
,, ,,	FE	22 8 31									
9 ,, 24	PE	20 21 50							3590		
,, ,,	iE	,, 22 5									
,, ,,	iSE	,, 27 13		5			147.5				
,, ,,	LE	,, 30 48									
,, ,,	ME	,, 36 20		17			4.				
,, ,,	FE	22 11									
10 ,, 25	PN	12 12 51									
,, ,,	FN	,, 5									
11 ,, 28	PE	21 17 10									
,, ,,	FN	22 28									

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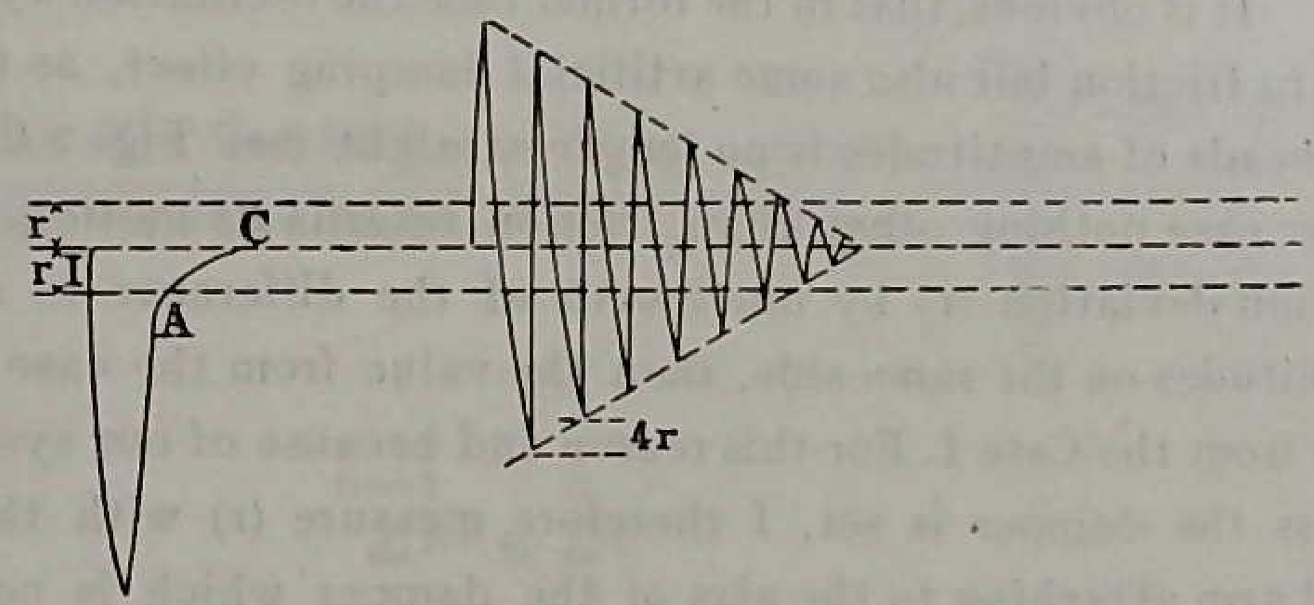
SEISMOLOGICAL NOTICE

BY ZIZIN S. P. LEE

I Correction for friction.

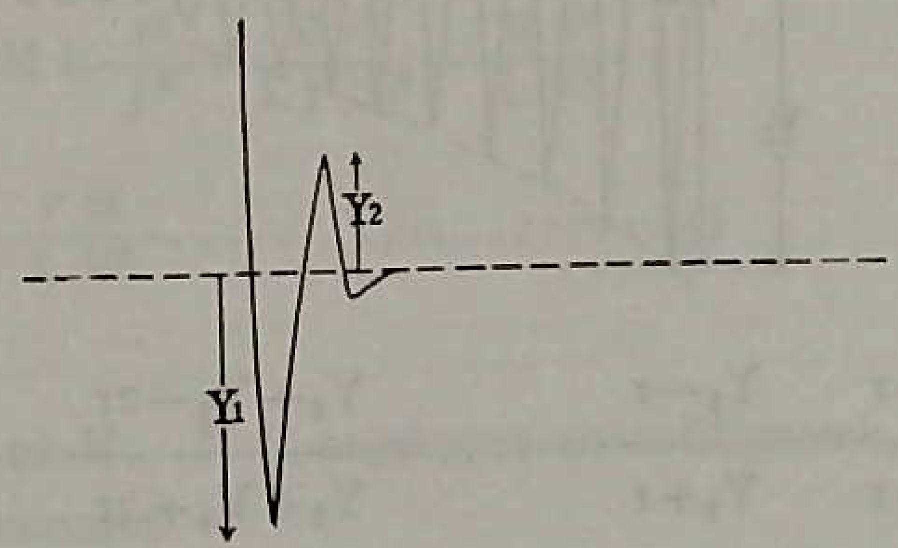
Experiments show that when an aperiodic pendul is displaced from its initial position I on the line oo', it will not return to its former place, but first

Fig. I



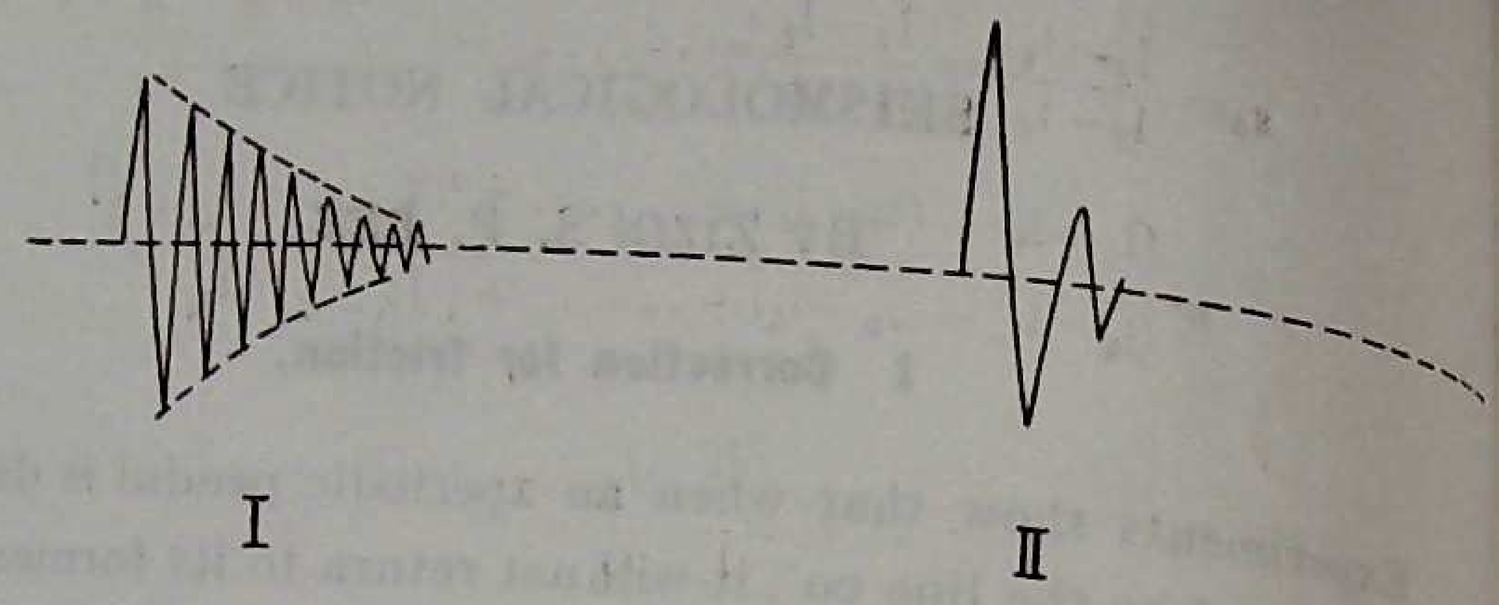
to A and then slowly back to C. The deviation (r) from oo' is plainly due to the writing pen being retarded by certain friction produced in describing the locus SA. Thus even the damping is cut, oscillation is still dying down as shown in fig. I on the right side. In every complete vibration the locus is dropped by 4r, and the heights of amplitudes is decreasing arithmetically so that the line terminating their heads is a straight one. This is the reason why r is measured by one fourth of the difference between any two successive amplitudes on the side and the damping ratio (ε) by

$$(1) \quad \varepsilon = \frac{Y_1 - r}{Y_2 - r}$$



In dealing with my apparatus, many trials have been made and the mode of oscillation is observed when the aluminum double level arm is attached to the axis of damper which is completely opened, and when not attached. The former gives more oscillations with shorter period than the latter as shown below.

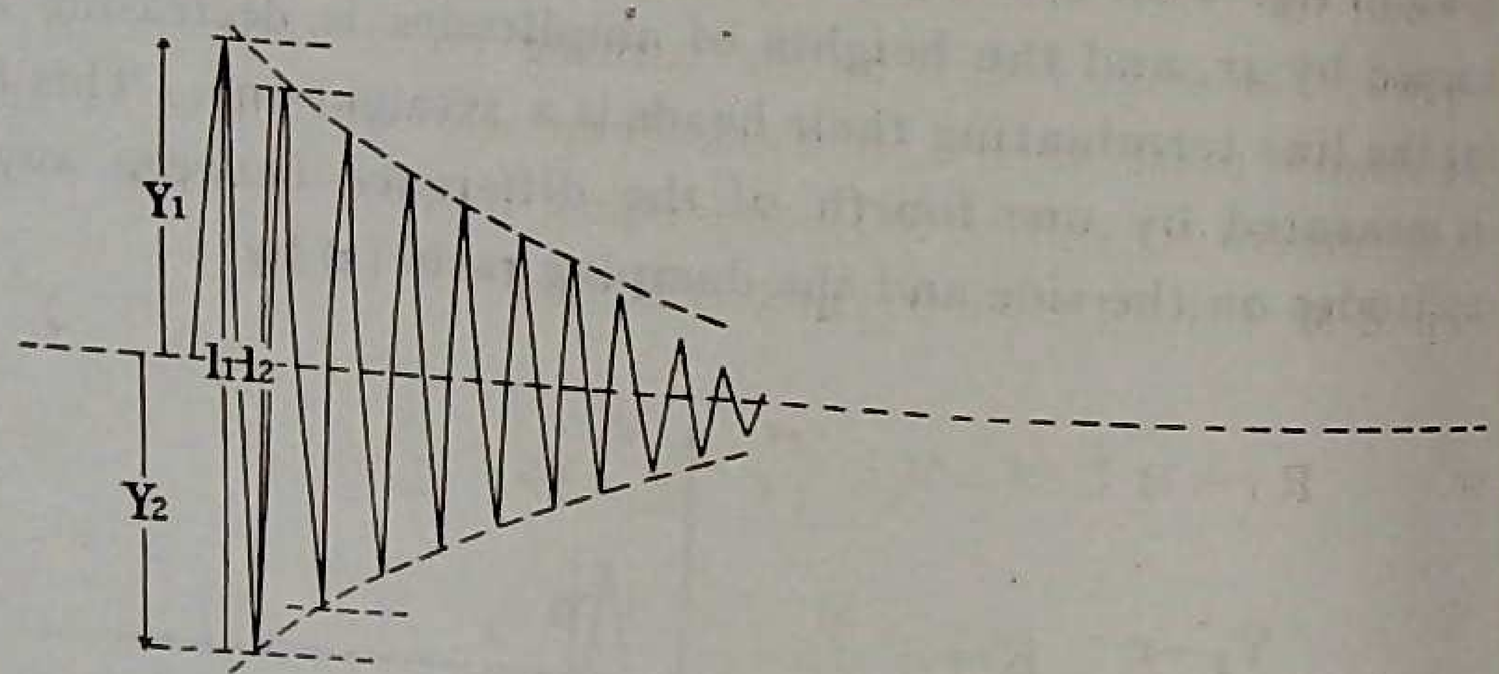
Fig. 2



It is obvious, that in the former case the oscillation dying down is not only due to friction but also some artificial damping effect, as the line terminating the heads of amptitudes is no longer straight (see Fig. 2 Case I); while in the latter case nothing other than friction retards its motion. If we measure the friction deviation (r) by one fourth of the difference of any two successive amplitudes on the same side, then the value from the case II will much exceed that from the Case I. For this reason and because of our system is not complete unless the damper is set, I therefore measure (r) with the aluminum double level arm attaching to the aixs of the damper which is completely open and reason as follows:

As the oscillation dying down is due to friction and some artificial damping, if Y_1 Y_2...... l_1 l_2......represent the successive amplitudes and ranges respectively (see Fig. 3), we have, by (I)

Fig. 3



$$\varepsilon_0=\frac{Y_1-r}{Y_2+r}=\frac{Y_2-r}{Y_3+r}=\ldots=\frac{Y_1+Y_2-2r}{Y_2+Y_3+2r}=\frac{Y_2+Y_3-2r}{Y_3+Y_4+2r}=\ldots$$

or

$$\varepsilon_0=\frac{l_1-2r}{l_2+2r}=\frac{l_2-2r}{l_3+2r}=\ldots\ldots=\frac{l_{n-1}-2r}{l_n+2r} \qquad (2)$$

By the foundamental laws of propertion, we can evaluate two unknowns ε_0 and r from (2) as follows:

$$\varepsilon_0=\frac{l_1-l_2}{l_2-l_3}=\frac{l_2-l_3}{l_3-l_4}=\ldots\ldots=\frac{l_{n-2}-l_{n-1}}{l_{n-1}-l_n}$$

$$=\frac{(l_1-l_2)+(l_2-l_3)+\ldots\ldots+(l_{n-2}-l_{n-1})}{(l_2-l_3)+(l_3-l_4)+\ldots\ldots+(l_{n-1}-l_n)}$$

or

$$\varepsilon_0=\frac{l_1-l_{n-1}}{l_2-l_n} \qquad (3)$$

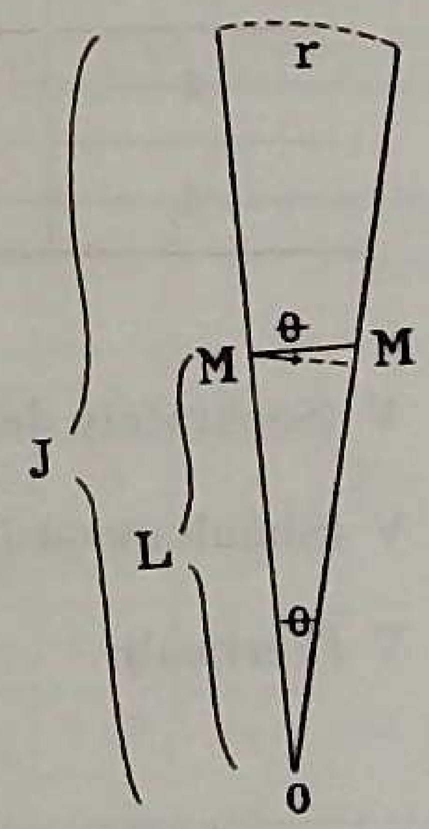
again

$$\varepsilon_0=\frac{(l_1-2r)+(l_2-2r)+\ldots\ldots+(l_{n-1}-2r)}{(l_2+2r)+(l_3+2r)+\ldots\ldots+(l_n+2r)}=\frac{\sum_{2}^{n-1} l-(n-1)2r}{\sum_{2}^{n} l-(n-1)2r}$$

or

$$r=\frac{\sum_{1}^{n-1} l-\varepsilon_0\sum_{2}^{n} l}{2(n-1)(\varepsilon_0+1)} \qquad (4)$$

So that by measuring l_1 l_2......, we first calculate the open damping ratio (ε_0) by (3) and then the value of (r) by (4). When (r) is found the frictional force (R) may be considered as follows: In Fig. 4 let o be the turning point and M the steady mass then the work done against R by a displacement (r) will be R-r and is equal to the potential drop of M, i. e. $M\cdot L\cdot\Theta\cdot\Theta$, since Θ is small.



or

$$R\,r=M\,L\,\Theta^2=M\,L\frac{r^2}{J^2}=\frac{M\,r^2}{L\,J^2/L^2}=\frac{M\,r^2}{L\,V^2}$$

$$R=\frac{r\,M}{L\,V^2}\ldots\ldots\ldots\ldots\ldots\ldots\ldots(5)$$

here R is in same unit as M. If R expresses in milligrams, r in mm, M in Kg, and L in m, then (5) becomes

$$R=\frac{r\,M.\,1000}{L\,V^2}\ \ldots\ldots\ldots\ \ldots\ldots\ldots\ldots\ldots(6)$$

This is the ordinary expression for R.

II **Determination of constants** Due Nov. 10, 1930.

Permanent constants

(a) of H. Components

M (Steady mass) 200 kg.

H (Heighth of c. g. of the steady mass above the turning point) 90 cm.

(b) of V. Component

M (Steady mass) 80 kg.

h (distance of c. g. of the steady mass from the turning point.) 54 cm.

h' (distance of the additing weight from the turning point.) 60 cm.

I To in sec. V

Trial	3.ToE	3.ToN	3.ToZ	Mean
1	17 4/5	17 1/5	14 4/5	To E=5.95
2	17 4/5	17 1/5	14 4/5	To N=5.74
3	18	17 1/5	14 4/5	To Z=4.7

V (Separately determined) $=192 \cdot \frac{a}{To^2}$

V (Simultaneously determined) $=\frac{192}{.707} \cdot \frac{a}{To^2}$ (points apart 20 cm. small weight used 20g.)

V (Vertical) $=144 \cdot \frac{a}{To^2}$ (Small weight used 2g.)

	AE		VE		AN		VN		AZ	VZ	Mean
	sep.	simul.	sep.	simul.	sep.	simul.	sep.	simul.			
1	17½	12½	94.9	95.05	16	12½	93	9463	13.5	88.4	VE=94.[illegible]
2	17	13	92.2	97.76	15¾	12½	91.64	9463	13.5	88.4	VN=93.1
3									13.5	88.4	VZ=88.4

II in mm

$$r = \frac{\sum_{1}^{n-1} l - \varepsilon_0 \sum_{2}^{n} l}{2(n-1)(\varepsilon_0+1)} \qquad \varepsilon_0 = \frac{l_1 - l_{n-1}}{l_2 - l_n}$$

	Trial	l_1	l_2	l_3	l_4	l_5	l_6	l_7	l_8	l_9	l_{10}	l_{11}
E	1	36	31.5	29	26.5	22	19	17	14	12	10	8
	2	33.5	29.5	23.5	20.5	18.5	16	14	12.5	10.5	9	7.5
	3	72.5	63	54.5	47.5	41.5	36.5	32	28.5	26	22.5	18.5
N	1	32	29	26	23.5	21	19	16.5	14.5	13	11.5	10
	2	36.5	33	30	27	24	21.5	19	17	14.8	13	11
	3	48.3	43.5	39.5	36	32.5	29.5	26.5	23.5	20.8	18	16.5
Z	1	20	17.5	15.5	13.5	11.5	10	8.5	7	5.5	4.5	3.5
	2	29.5	26.5	23.5	21	18.5	16	14	12.5	11	9	7.5
	3	35	31.5	28	25	22.5	20	17.5	15.5	13.5	11.5	10

l_{12}	l_{13}	l_{14}	l_{15}	l_{16}	l_{17}	l_{18}	l_{19}	l_{20}	$\sum_{1}^{n} l$	Eo	r	Mean
6.2	5	2.8	1.5						240.5	1.1	.22	
5.8	4.8	3	2.25						210.8	1.1	.17	rE=.18
15.5	13	11	9.5	8	6	4.5	3.25	2	515.7	1.1	.16	
9	7	6	5	4	3	2			252.5	1.07	.207	
9.5	8	7	5.5	4.5	3.5	2.5			287.3	1.08	.19	rN=.19
14.5	12.5	11	9.5	8	6.5	5	4	3	408.8	1.09	.18	
2	1.2	7							120.6	1.1	.18	
6	5	3.5	2.5	1.5	.6				208.1	1.08	.21	rZ=.19
8.5	7	6	5	4	2.7	2	1		266.2	1.08	.18	

III E

$$\varepsilon = \frac{Y_1 - r}{Y_2 - r}$$

	E			N			Z			Mean
Trial	Y_1	Y_2	ε	Y_1	Y_2	ε	Y_1	Y_2	ε	
1	6	1.5	3.4	7.5	1.5	4.3	9.5	2.2	3.9	$\varepsilon E = 3.5$
2	7.5	1.8	3.7	7	1.7	3.6	6.5	1.5	3.7	$\varepsilon N = 3.8$
3	6	1.5	3.7	7	1.5	4.0	8	1.8	3.7	$\varepsilon Z = 3.8$

IV R in mg.

R (Horizontal) $= 800000 . \dfrac{r}{To^2 \, V^2}$

R (Vertical) $= 320000 . \dfrac{r}{To^2 \, V^2}$

RE = .46 RN = .53 RZ = .38

SEISMIC DATA PP. 1

Ø 40° 3' 55" λ 116° 5' 46" h 155 m. Rock-foundation

Constants due to Nov. 10.		V	T_0	ε	r/T^2
	AN	93.1	5.74	3.8	.006
	AE	94.9	5.95	3.5	.005
	Az	88.4	4.7	3.8	.008

Apparatus

I. 200kg Horizontal Wiechert

II. 80kg Vertical Wiechert

No. & Date	Phase	Time (Greenwich)	Period N-S	Period E-W	Period Z	Amplitude AN	Amplitude AE	Amplitude Az	△	Direction of true movement	Remark
		h m s	s	s	s	μ	μ	μ	km		
12 Nov. 9'30	PN	19 16 36							3722		Phase L
,, ,, ,, ,,	SE?	,, 22 35									is quite
,, ,, ,, ,,	LE	,, 26 18									sure and
,, ,, ,, ,,	FN	,, 39									is found
13 ,, 10 ,,	PN	13 52 42							5400		accord-
,, ,, ,, ,,	SN?	,, 59 ,,									ing to
,, ,, ,, ,,	FN	15 49									L—S.
14 ,, 11 ,,	PE	8 33 30									
,, ,, ,, ,,	FE	10 25									
15 ,, 25 ,,	PE	19 7 12									This is
,, ,, ,, ,,	iSN	,, 10 37							2056	—	the late
,, ,, ,, ,,	SSE?	,, 11 2		7			538			+	Japanese
,, ,, ,, ,,	LE	,, ,, 51									earth-
,, ,, ,, ,,	MN_1	,, 12 13	15			12				+	quake of
,, ,, ,, ,,	ME_1	,, 14 35		12			35			+	which the
,, ,, ,, ,,	MN_2	,, ,, 43	12			20				+	epicentre
,, ,, ,, ,,	ME_2	,, 15 3		12			32			—	is in Izu
											province.

SEISMIC DATA

PP. 2

Ø 40° 3′ 55″ λ 116° 5′ 46″ h 155 m Rock-foundation

Constants due to Nov. 10.		V	T_0	ε	r/T^2
	AN	93.1	5.74	3.8	.006
	AE	94.9	5.95	3.5	.005
	Az	88.4	4.7	3.8	.008

Apparatus
I. 200kg Horizontal Wiechert
II. 80kg Vertical Wiechert

No. & Date	Phase	Time (Greenwich) h m s	Period N-S s	Period E-W s	Period Z s	Amplitude AN μ	Amplitude AE μ	Amplitude Az μ	Δ km	Direction of true movement	Remark
15 Nov. 25 '30	MN_3	19 15 33	10			44				+	
,, ,, ,, ,,	ME_3	,, ,, 38		10			42			—	
,, ,, ,, ,,	ME_4	,, 16 3		12			32			—	
,, ,, ,, ,,	MN_4	,, ,, 13	12			18				+	
,, ,, ,, ,,	ME_5	,, ,, 56		10			44			—	
,, ,, ,, ,,	ME_6	,, 18 5		,,			42			+	
,, ,, ,, ,,	MN_5	,, ,, 13	10			30				+	
,, ,, ,, ,,	ME_7	,, ,, 48		10			21			+	
,, ,, ,, ,,	MN_6	,, 19 41	10			23				—	
,, ,, ,, ,,	ME_8	,, ,, 55		10			19			—	
,, ,, ,, ,,	ME_9	,, 21 15		,,			12			+	
,, ,, ,, ,,	MN_7	,, ,, 38	10			14				—	
,, ,, ,, ,,	ME_{10}	,, 22 13		10			9			—	
,, ,, ,, ,,	FE	21 6									
16 Dec. 2 ,,	PZ	7 6 2							2622		
,, ,, ,, ,,	iZ	,, ,, 7								—	
,, ,, ,, ,,	PPZ	,, ,, 34									

SEISMIC DATA

PP. 3

Ø 40° 3′ 55″ λ 116° 5′ 46″ h 155 m. Rock-foundation

Constants due to Nov. 10.		V	T_0	ε	r/T^2
	AN	93.1	5.74	3.8	.006
	AE	94.9	5.95	3.5	.005
	Az	88.4	4.7	3.8	.008

Apparatus
I. 200kg Horizontal Wiechert
II. 80kg Vertical Wiechert

No. & Date	Phase	Time (Greenwich) h m s	Period N-S s	Period E-W s	Period Z s	Amplitude AN μ	Amplitude AE μ	Amplitude Az μ	Δ km	Direction of true movement	Remark
16 Dec. 2 '30	SN	7 10 8									
,, ,, ,, ,,	LN	,, 12 36									
,, ,, ,, ,,	ME	,, 14 20									
,, ,, ,, ,,	FE	,, 44									
17 ,, 3 ,,	PZ	18 57 28							3056		I. The
,, ,, ,, ,,	PPZ	,, 58 3									epicentre
,, ,, ,, ,,	PPPZ?	,, ,, 43									of this
,, ,, ,, ,,	iZ	19 1 8									earth-
,, ,, ,, ,,	SE	,, 2 11									quake is
,, ,, ,, ,,	iE	,, ,, 43									near Pyu,
,, ,, ,, ,,	SSE	,, 3 31		10			14			—	Burma.
,, ,, ,, ,,	SSSE	,, 4 18		12			17			+	II. Z
,, ,, ,, ,,	SSSSE?	,, 5 1		10			14			+	compon-
,, ,, ,, ,,	LE	,, 5 43									ent has
,, ,, ,, ,,	MZ_1	,, 7 29			7					+	not dam-
,, ,, ,, ,,	ME_1	,, ,, 38		10			111			+	ped. ($ε_∞$=
,, ,, ,, ,,	MZ_2	,, 8 6			7					+	1.11).

SEISMIC DATA

PP. 4

Ø 40° 3′ 55″ λ 116° 5′ 46″ h 155 m. Rock-foundation

Constants due to Nov. 10.		V	T_0	ε	r/T^2
	AN	93.1	5.74	3.8	1.006
	AE	94.9	5.95	3.5	1.005
	Az	88.4	4.7	3.8	1.008

Apparatus

I. 200kg Horizontal Wiechert

II. 80kg Vertical Wiechert

No. & Date	Phase	Time (Greenwich)	Period N-S	Period E-W	Period Z	Amplitude AN	Amplitude AE	Amplitude Az	Δ	Direction of true movement	Remark
		h m s	s	s	s	μ	μ	μ	km		
17 Dec. 3′30	ME_3	19 8 16		10			93			—	
,, ,, ,, ,,	MN_1	,, ,, 20	10			148.1				+	
,, ,, ,, ,,	MZ_3	,, ,, 41			12					—	
,, ,, ,, ,,	ME_3	,, ,, 53		10			167			+	
,, ,, ,, ,,	MN_2	,, 9 10	10			138.9				—	
,, ,, ,, ,,	MZ_4	,, ,, 26			10					—	
,, ,, ,, ,,	MN_3	,, ,, 43	10			157.4				+	
,, ,, ,, ,,	ME_4	,, 10 1		12			52			—	
,, ,, ,, ,,	MZ_5	,, ,, 6			7					—	
,, ,, ,, ,,	MN_4	,, ,, 50	10			111.1				+	
,, ,, ,, ,,	ME_5	,, 11 18		12			54			—	
,, ,, ,, ,,	MZ_6	,, ,, 31			10					+	
,, ,, ,, ,,	MN_5	,, ,, 55	10			97.2				—	
,, ,, ,, ,,	ME_6	,, 12 1		10			107			+	
,, ,, ,, ,,	MZ_7	,, ,, 30			7					—	
,, ,, ,, ,,	MZ_8	,, ,, 54			,,					—	
,, ,, ,, ,,	ME_7	13 18		10			70			—	

SEISMIC DATA

PP. 5

Ø 40° 3′ 55″ λ 116° 5′ 46″ h 115 m. Rock-foundation

Constants due to Nov. 10.		V	T_0	ε	r/T^2
	AN	93.1	5.74	3.8	.006
	AE	94.9	5.95	3.5	.005
	Az	88.4	4.7	3.8	.008

Apparatus

I. 200kg Horizontal Wiechert

II. 80kg Vertical Wiechert

No. & Date	Phase	Time (Greenwich)	Period N-S	Period E-W	Period Z	Amplitude AN	Amplitude AE	Amplitude Az	Δ	Direction of true movement	Remark
		h m s	s	s	s	μ	μ	μ	km		
17 Dec. 3′30	ME_8	19 13 21		12			32			—	
,, ,, ,, ,,	MN_6	,, ,, 48	10			56				+	
,, ,, ,, ,,	MZ_9	,, ,, 56			7					+	
,, ,, ,, ,,	MZ_{10}	,, 14 24			,,					+	
,, ,, ,, ,,	MN_7	,, ,, 31	10			51				—	
,, ,, ,, ,,	MN_8	,, 15 28	,,			58				+	
,, ,, ,, ,,	ME_9	,, ,, 36		10			83.4			—	
,, ,, ,, ,,	ME_{10}	,, 16 43		,,			15.8			+	
,, ,, ,, ,,	MN_9	,, 17 25		12		18				+	
,, ,, ,, ,,	ME_{11}	,, 18 1		7			53.8			+	
,, ,, ,, ,,	MN_{10}	,, ,, 23	10			19				+	
,, ,, ,, ,,	ME_{12}	,, ,, 44		12			18.9			+	
,, ,, ,, ,,	MN_{11}	,, 19 23	7			52				—	
,, ,, ,, ,,	MN_{12}	,, 20 32	7			72				+	
,, ,, ,, ,,	MN_{13}	,, 21 40	12			19				+	
,, ,, ,, ,,	FE	20 50									
18 ,, 5 ,,	PN	12 41 26									

SEISMIC DATA PP. 6

Ø 40° 3' 55" λ 116° 5' 46" h 155 m Rock-foundation

Constants due to Nov. 10.		V	T_0	ε	r/T^2
	AN	93.1	5.74	3.8	.006
	AE	94.9	5.95	3.5	.005
	Az	88.4	4.7	3.8	.008

Apparatus

I. 200kg Horizontal Wiechert

II. 80kg Vertical Wiechert

No. & Date	Phase	Time (Greenwich)	Period N-S	Period E-W	Period Z	Amplitude AN	Amplitude AE	Amplitude Az	△	Direction of true movement	Remark
		h m s	s	s	s	μ	μ	μ	km		
18 Dec. 5 '30	FN	12 46									
19 ,, 8 ,,	PN	6 23 52							2033		The epi-
,, ,, , ,,	SN	,, 27 16									centre
,, ,, ,, ,,	LN	,, 29 6									of these
,, ,, ,, ,,	FN	,, 47									earth
20 ,, ,, ,,	PN	8 4 59							1989		quakes
,, ,, ,, ,,	SN	,, 8 19									is most
,, ,, ,, ,,	LN	,, 10 1									probably
,, ,, ,, ,,	FN	,, 36									at south-
21 ,, 13 ,,	PZ	14 27 9									ern For-
,, ,, ,, ,	FN	,, 46									mosa.
22 ,, ,, ,,	PZ	16 3 57									
,, ,, ,, ,,	FN	,, 22									
23 ,, 16 ,,	PE	18 7 20									
,, ,, ,, ,,	FN	,, 19									
24 ,, 20 ,,	PE	14 5 50									
,, ,, ,, ,,	FE	,, 25									

SEISMIC DATA PP. 7

Ø 40° 3' 55" λ 116° 5' 46" h 155 m. Rock-foundation

Constants due to Nov. 10.		V	T_0	ε	r/T^2
	AN	93.1	5.74	3.8	.006
	AE	94.9	5.95	3.5	.005
	Az	88.4	4.7	3.8	.008

Apparatus

I. 200kg Horizontal Wiechert

II. 80kg Vertical Wiechert

No. & Data	Phase	Time (Greenwich)	Period N-S	Period E-W	Period Z	Amplitude AN	Amplitude AE	Amplitude Az	△	Direction of true movement	Remark
		h m s	s	s	s	μ	μ	μ	km		
25 Dec. 21'30	PN	12 17 49									
,, ,, ,, ,,	FN	,, 32									
26 ,, ,, ,,	iPN	14 55 52							2244		
,, ,, ,, ,,	iSN	,, 59 32								+	
,, ,, ,, ,,	iN	,, ,, 34									
,, ,, ,, ,,	FN	15 22									
27 ,, ,, ,,	PN	23 55 22									
,, ,, 22 ,,	PN	0 12 14									
,, ,, ,, ,,	FN	,, 49									
28 ,, ,, ,,	PZ	4 23 46							3556		
,, ,, ,, ,,	SE?	,, 28 54									
,, ,, ,, ,,	FN	,, 49									
29 ,, 23 ,,	PZ	23 59 30							2356		
,, ,, 24 ,,	SE?	0 3 18									
,, ,, ,, ,,	FN	,, 21									