Note on the Seismic Triangulation in Tokyo.

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With Plate XXIV.

In a former report on the seismic triangulation in Tokyo,[1] the present writer has given the transit velocity of the wave at the commencement of the principal portion of the earthquake motion, this wave being usually well defined so that it can easily be identified in the diagrams obtained at the different seismic stations. In the present note, I add the transit velocities of the other waves which have not formerly been discussed; namely, those of the preliminary tremor and the waves following the initial wave of the principal portion.

I. The preliminary tremor.

As it was difficult to identify the waves in this phase in the diagrams of the 8 earthquakes registered at the different stations,[2] the transit velocity has been determined according to the formula

$$\frac{1}{v}=\frac{1}{V}-\frac{t}{d},$$

where v and V represent the respective transit velocities of the initial waves of the preliminary tremor and principal portion, t the duration of the preliminary tremor, and d the epicentral distance. The result

1. The *Publications*, No. 7.
2. Loc.

is given in the following table, in which the duration of the preliminary tremor is taken from the diagrams given by one of the three Ewing type instruments.

Eqke. no.	Date.	t	d	v
		s	km	$\frac{\text{km}}{\text{s}}$
1	April 3, 1895.	2	110	3.5
2	Feb. 23, 1896.	18	160	5.3
3	March 6, 1896.	9	120	4.4
4	April 24, 1896.	8	70	5.4
5	Aug. 5, 1897.	14	450	3.7
6	Aug. 16, 1897.	12	300	3.8
7	Feb. 13, 1898.	7	60	6.0
8	July 12, 1898.	3	80	3.8

The initial wave in the registers of the eqkes. Nos. 1, 5, 6, and 8 is too large and does not probably represent the real commencement of the earthquake motion. The rocks of Archean formation, which have a transit velocity of seismic waves as high as 6–7 km. per sec., may form a part of the path for the wave in the present discussion.

II. The principal portion.

The eqke. no. 7 was one which gave the most appropriate diagrams for the deduction of the transit velocities of the successive waves of the principal portion. The waves F–G and P–S in E–W component, and h–i and o–s in N–S one being very distinct, I have divided the principal portion into three successive phases, each of which began with one of the above-mentioned waves. (See the accompanying figure.) The result is given in the following tables.

E–W COMPONENT.

Phase.	Wave.	Time of arrival.			
		Hongo.	Hitotsubashi.	Astro. Obs.	Komatsugawa.
		s	s	s	s
	A	7.57	8.22	8.83	8.87
	B	8.19	8.82	—	9.73
I	C	8.50	9.12	—	—
	D	8.91	9.60	—	—
	E	9.49	10.27	—	11.09
	F	10.17	11.00	—	11.70
	G	10.79	11.57	—	12.29
	H	11.63	12.18	—	12.88
	I	11.87	12.50	—	13.78
	J	12.19	12.90	—	14.09
II	K	12.63	13.52	—	14.88
	L	13.45	14.12	—	15.45
	M	13.79	14.48	—	16.00
	N	14.15	14.87	—	16.37
	O	14.37	15.23	—	16.70
	P	14.85	15.77	—	17.41
	Q	15.22	16.08	—	17.91
	R	15.66	16.51	—	18.46
	S	16.24	17.28	—	19.23
III	T	17.15	18.24	—	20.00
	U	17.59	18.74	—	—
	V	18.28	19.26	—	—
	W	19.26	20.30	—	21.90

N–S COMPONENT.

Phase.	Wave.	Time of arrival.			
		Hongo.	Hitotsubashi.	Astro. Obs.	Komatsugawa.
		s	s	s	s
	a	7.53	8.17	8.62	8.90
	b	7.87	8.52	9 00	9.26
	c	8.59	9.23	10.00	10.02
I	d	9.19	9.79	10.77	10.98
	e	9.55	10.11	11.41	11 51
	f	9.86	10.50	11.79	12.05
	g	10.65	11.03	12.61	—
	h	11.07	11.49	13.05	—
	i	11.36	11.93	13.67	13.62
	j	11.81	12.49	14.19	14.10
II	k	12.13	12.86	14.41	—
	l	12.82	13.45	15.02	15.14
	m	13.53	14 30	—	15.86
	n	14.00	14.62	—	16.50
	o	14.50	15.50	16.80	17.10
	p	14.88	15.90	17.62	17.52
	q	15 28	16.32	18.00	17.97
	r	15.91	16.77	18.21	18.55
III	s	16.24	17.22	18.65	—
	t	16.79	18.15	19 28	19.30
	u	17.24	18 56	19.75	19.88
	v	17.64	18.97	20.10	—
	w	18.37	19.83	—	20.91

The following table gives for each phase the mean times of arrival of the successive waves at the 3 local stations, referred to the time of arrival of the same waves at Hongo.

Station.	E-W component.			N-S component.			Mean.		
	I	II	III	I	II	III	I	II	III
	s	s	s	s	s	s	s	s	s
Hitotsubashi.	0.67	0.73	0.99	0.59	0 63	1.15	0.62	0.69	1.08
Astronomical Obs.	1.26	—	—	1.69	2.23	2.49	1.52	2.23	2.49
Komatsugawa.	1.38	1.91	2.76	1.69	2.34	2.61	1.62	2 05	2.68

From these data, it will be seen that the directions of propagation of the different phases of the earthquake motion coincided roughly with one another, the approximate value being N25°W. The transit velocities of the various phases thus come out to be 3.0, 2.3, and 1.8 km. per sec. Each of these different values may probably relate to one of the strata which are supposed to lie near the earth's surface parallel to the latter, the terms corresponding to the superficial layer, into which the waves propagated through the assumed stratum refract to reach our observing stations, being eliminated in the process of taking the difference of the times of arrival.

The different phases discussed in the present note may possibly have certain relation with the three phases following the most active part of the principal portion of large distant earthquakes.

May 24, 1904.

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Diagrams of Eqke. No. 7, reduced to a common time scale.

(Multiplication=5.)