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12. *Determination of Origin Times, Epicenters and Focal Depths of Aftershocks of the Niigata Earthquake of June 16, 1964. —A Preliminary Report of the Cooperative Study of Aftershocks of the Niigata Earthquake—*

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1. Introduction

A destructive earthquake occurred near the coast of Niigata Prefecture, the northern part of central Honshu, Japan, on June 16, 1964.

After the earthquake, field parties were dispatched for aftershock observation from Hokkaido University[1], Tohoku University, the Earthquake Research Institute of the University of Tokyo[2] and the Japan Meteorological Agency (JMA)[3].

Two to four parties were sent from each organization and some results obtained by them have been reported in their respective papers. However, it was considered to be most effective to analyse these observational data with the cooperation of all the parties participating in the field observation.

As the first step for further investigation of aftershocks of the Niigata Earthquake, the author was asked to collect all the data from each of the parties in order to undertake preliminary determination of origin times, epicenters and focal depths of the aftershocks.

On the basis of these data, the author carried out epicentral determination by several different methods and studied how the results are

1) Hokkaido University Group for Aftershock Observation, "Observation of the Aftershocks of Niigata Earthquake of June 16, 1964" (in Japanese), *Geophys. Bull. Hokkaido Univ.*, **16** (1966), 22-32.

2) The Parties for Aftershock Observation, Earthquake Research Institute, "Observation of Aftershocks of the Niigata Earthquake of June 16, 1964", *Bull. Earthq. Res. Inst.*, **46** (1968), 205-221.

3) "The Report on the Niigata Earthquake, 1964", *Technical Report of the Japan Meteorological Agency*, No. 43 (1965).

Table 1. Temporary

Code	Location	Institute	Latitude	Longitude	x	y
SH	Shibata	E. R. I.	37°58′20.3″	139°23′18.6″	12.186	24.672
OG	Oguni	〃	38°03′14.6″	139°44′52.6″	43.789	33.726
MU	Murakami	〃	38°12′57.1″	139°30′21.7″	22.490	51.703
AW	Awashima	〃	38°27′41″	139°15′12″	0.292	78.955
AWJ	Awashima	J. M. A.	38°27.7′	139°15.3′	0.438	78.985
SA	Sampoku	〃	38°30.7′	139°32.1′	25.098	85.545
AI	Aikawa	〃	38°01.2′	138°14.5′	−88.692	29.964
ON	Onabe	Hokkaido Univ.	38°32′11.1″	139°37′24.0″	32.427	86.946
IW	Iwakawa	〃	38°35′58.3″	139°34′46.2″	28.869	94.287
NA	Nakaura	〃	37°54′30.1″	139°18′27.6″	5.076	17.575
DE	Deyu	〃	37°48′57.1″	139°18′21.1″	4.920	7.309
AS	Asahi	Tohoku Univ.	38°16′41.4″	139°33′07.1″	26.515	58.618
AZ	Azumi	〃	38°02′59.7″	139°34′18.6″	28.302	33.285
AK	Akatani	〃	37°49′49.0″	139°26′19.0″	16.611	8.817
KA	Kakuda	〃	37°47′58.9″	138°49′59.9″	−36.714	5.515

Observation Stations

Period of Observation	Seismograph					
	Name	Component	T_o	T_g	Magnification	Recorder
June 20～ July 11	HES 1-0.2	Z, N, E	1.0	0.2	$V_{max}=50000$	Micro-Film
June 23～ Aug. 1	HES 1-0.2	Z, N, E	1.0	0.2	$V_{max}=50000$	Micro-Film
		Z	1.0	0.2	$V_{max}=5000$	
June 22～ July 11	HES 1-0.2	Z, N, E	1.0	0.2	$V_{max}=50000$	Micro-Film
June 21～ July 9	Accelerograph	Z, N, E	0.1		2.2 gal/mm	Smoked Paper
July 3～ July 9	HES 1-0.2	Z, N, E	1.0	0.2	$V_{max}=10000$	Micro-Film
July 4～ July 9	54 B		2.0		$V=55$	Smoked Paper
July 3～ July 10	62B Electro-magnetic	Z, N, E	1.0	1/15	$V_{max}=500$	Smoked Paper
Continuous	59 Electro-magnetic	Z, N, E	1.5	0.3	$V_{max}=1000$	Micro-Film
June 23～ July 11		Z	1.0	1/30	$V=28800$ (16 c/s)	Smoked Paper
June 19～ June 29		Tripartite*	1/3			"San'ei" Oscillograph
June 22～ June 25		Z*	1/3			"San'ei" Oscillograph
June 25～ June 27		Z*	1/3			"San'ei" Oscillograph
		N, E*	1.0			
June 29～ July 1		Z*	1/3			"San'ei" Oscillograph
		N, E*	1.0			
June 23～ July 7		Z, N, E	1/4.1			Smoked Paper
		Tripartite**				
June 23～ July 7		Z	1/4.1			Smoked Paper
June 23～ July 7		Z	1/4.0			Smoked Paper
		Tripartite**				
June 23～ July 7		Z	1/3.5			Smoked Paper

* At night only.

** 20^h～04^h

affected by the method of determination adopted.

This paper is a report of such work undertaken by the author and is published with the consent of all the members of the participating parties.

2. Data

The locations of temporary observation stations, the instruments used and the periods of observation are given in Table 1 and the distribution of the stations is indicated in Fig. 1.

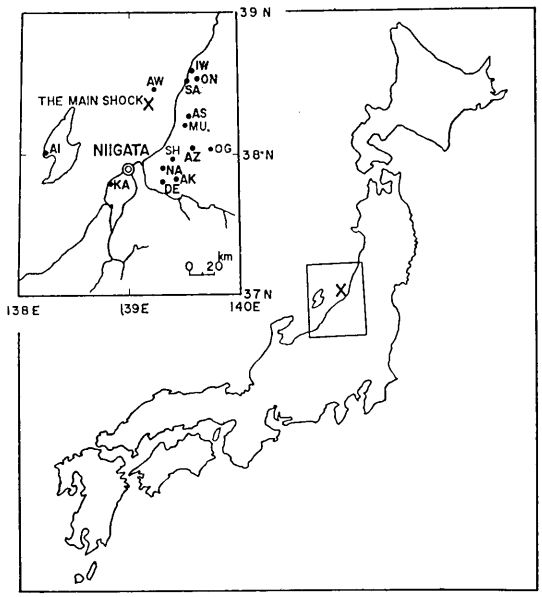

Fig. 1. Distribution of the temporary observation stations.

Making up for the lack of observation station to the north and the west of the aftershock region, the seismometrical data obtained at Aikawa Weather Bureau belonging to JMA were used together when available, through the courtesy of JMA. However, shocks of smaller magnitude were not recorded at this bureau due to low sensitivity of the seismographs installed there.[4]

Epicentral determination of the aftershocks was done for the period of fourteen days, from June 23 to July 6, when most of the temporary stations were in operation.

Arrival times of the P and S waves and/or P–S intervals at each station, which were read off by the members of each party, were sent to the Earthquake Research Institute and were compiled as "Collected Data of Temporary Observation of Aftershocks of the Niigata Earthquake".[5] Since the Type-59 Electromagnetic Seismograph was not used in routine work at Aikawa Weather Bureau, its seismograms were read off by the members of the

4) The Seismological Bulletin of the Japan Meteorological Agency.

5) This table was distributed among the members of the participating parties in blue print.

Earthquake Research Institute.

Time accuracy was kept within ± 0.1 sec at each station.

3. Determination of origin times, epicenters and focal depths.

On the basis of the data collected in the table mentioned above, origin times, epicenters and focal depths were determined.

For the sake of convenience, a Cartesian coordinate system is used taking the origin at 37°45'N and 139°15'E, x eastward, y northward and z downward, and the kilometer as the unit of length.

In the present paper, a homogeneous half space is assumed.

3.1. Determination of origin times, epicenters and focal depths from arrival times of the *P* wave.

At the first step, origin times, epicenters and focal depths were determined using only arrival times of the initial P wave at each station.

The relation between hypocenter, observation station, arrival time and the wave velocity is expressed as follows:

$$(1) \qquad (x-x_i)^2+(y-y_i)^2+(z-z_i)^2=v^2(t-t_i)^2 , \qquad i=1, 2, \cdots, N ,$$

where

x, y, z	:	coordinates of a hypocenter
t	:	origin time
x_i, y_i, z_i	:	coordinates of an observation station
t_i	:	arrival time
v	:	wave velocity
N	:	number of observation data.

If we put

$$x=x'+\Delta x,\ y=y'+\Delta y,\ z=z'+\Delta z,\ t=t'+\Delta t,\ v=v'+\Delta v,$$
$$r_i^2=(x-x_i)^2+(y-y_i)^2+(z-z_i)^2 ,$$

where x', y', z', t', and v' are trial solutions and $\Delta x, \Delta y, \Delta z, \Delta t$ and Δv are corrections to be added to them, we can linealize equation (1) as follows, neglecting terms of higher order,

$$(2) \qquad \frac{x'-x_i}{v'r_i'}\Delta x+\frac{y'-y_i}{v'r_i'}\Delta y+\frac{z'-z_i}{v'r_i'}\Delta z+\Delta t-\frac{r_i'}{v'^2}\Delta v=t_i-\left(\frac{r_i'}{v'}+t'\right) .$$

If $x'+\Delta x$, $y'+\Delta y$, $z'+\Delta z$, $t'+\Delta t$ and $v'+\Delta v$ are substituted into x', y', z', t', and v' in the next step, then x, y, z, t and v are expected to converge to some finite values after several iterations.

Observation data t_i is weighted with

$$p_i=\frac{\sigma_i^2}{\sigma_0^2},$$

where σ_i is the standard error of t_i, σ_0 is the standard error of the value with a unit weight, which may be an arbitrary value in the beginning of the procedure and in the present paper is assumed to be 1.0 sec. Strictly speaking, σ_i must be different for each observation, but it is practically impossible to estimate the value of σ_i individually. Then σ_i is assumed to be 0.1 sec for iP, 0.2 sec for P and 0.3 sec for eP. At the end of the process, σ_0 can be estimated as follows:

$$\hat{\sigma}_0=\sqrt{\frac{S}{N-m}},$$

where

S: weighted sum of squares of residuals,

i.e. $S=\Sigma p_i\varepsilon_i^2$, where $\varepsilon_i=t_i-\left(\frac{r_i}{v}+t\right)$,

m: number of unknowns.

The starting point of the first iteration was chosen at $x=0$, $y=60$ and $z=30$ in all cases. Iteration was stopped when the condition $\Delta x^2+\Delta y^2+\Delta z^2\leqq 0.01\ \mathrm{km}^2$ was satisfied, usually after three or four iterations.

For the shock of which arrival time of the P wave was observed at five or more stations, calculation was carried out letting x, y, z, t and v unknown, but in most cases reasonable solution was not able to be obtained. In some cases, solutions did not converge and in some cases depths and/or wave velocity resulted in unreasonable value.

In the course of iteration, the depth z often became negative. Then z was assumed to be 5 km (0 km in some cases), because the foci in such cases are considered to be very shallow.

The calculation was carried out for some thirty cases taking trially five values of the velocity, 4.5, 5.0, 5.5, 6.0 and 6.5 km/s. The smaller velocity makes the focus deeper and the origin time earlier, because the

smaller velocity lessen the differences between hypocentral distances. On the other hand, the larger velocity makes the focus shallower, while too large a velocity makes the depth impossible to be determined. The value 6.5 km/s for the velocity seems to be too large for the solution to be obtained. In many cases the velocity 4.5 or 6.5 km/s gave the minimum residual, while the velocity 5.0, 5.5 and 6.0 km/s rarely gave the minimum residual. As a trial, hypocenters were determined by the use of P–S intervals obtained at three or more stations and it is found that the depths of foci of most aftershocks are distributed between 20 km and 30 km[6] and the average velocity at depths shallower than 30 km is of value between 5.5 and 6.0 km/s. The value of velocity that gives the minimum residual is not necessarily the best approximation of the velocity, because it is apt to be greatly influenced by observational errors.

Considering these matters, the velocity 6.0 km/s was adopted and origin times, epicenters and focal depths of some 300 aftershocks were determined.

In order to examine the result, $\hat{\sigma}_0$, which is a measure of accuracy of observation, was checked. The distribution of $\hat{\sigma}_0$ is shown in Fig. 2(a). $\hat{\sigma}_0=1$ means that residuals are as large as observational errors assumed in the beginning, that is, for example, 0.1 sec for iP. In the case of which $\hat{\sigma}_0$ is large, a reliable result may not be given, because large $\hat{\sigma}_0$ suggests that there are some large observational errors or some mistakes in the interpretation of seismograms. Although the distribution of $\hat{\sigma}_0$ does not follow the normal law and it is not clear what criterion is suitable in the present case, the cases of $\hat{\sigma}_0$ larger than 3.0 were omitted refferring to the result in the next section.

Frequency distributions of standard errors of origin time, epicenter coordinates and focal depth are shown in Fig. 3a. The cases in which the standard error of the epicenter location is larger than 10.0 km, that of the depth is larger than 20 km or that of the origin time is larger than 2.0 sec were omitted, because they are considered to give inaccurate result.

The solutions obtained in good accuracy are listed in Table 2.

In the next place, x, y, z, t and v were calculated using the values of x, y, z and t obtained by the foregoing procedure as a starting point. Only 22 values of the velocity were obtained, but these values show large

6) 地震研究所余震観測班「新潟地震余震観測中報」地震研究所研究速報 **8** (1964), 7-14.

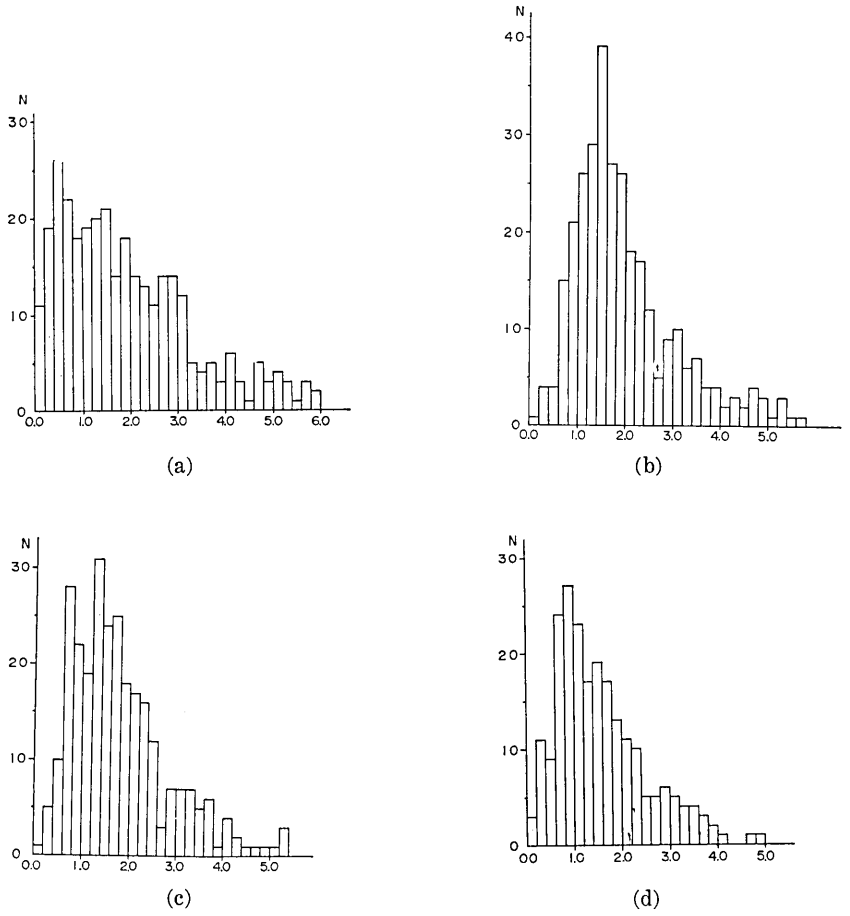

Fig. 2. Frequency distributions of estimates ($\hat{\sigma}_0$) of residuals with a unit weight. $\hat{\sigma}_0=1.00$ corresponds to 0.1 sec for iP

(a) The case in which t, x, y and z are calculated from P arrival time with V_p assumed at 6.0 km/s.

(b) The case in which t, x, y and z are calculated from P and S arrival times with V_p assumed at 6.0 km/s and V_p/V_s at 1.732.

(c) The case in which t, x, y, z and V_p are calculated from P and S arrival times with V_p/V_s assumed at 1.732.

(d) The case in which t, x, y, z, V_p and V_p/V_s are calculated from P and S arrival times.

fluctuation and large standard error. Therefore the result obtained here is not adequate to discuss the velocity of the P wave. In some cases, noticeable discrepancies are found between hypocentral distances deter-

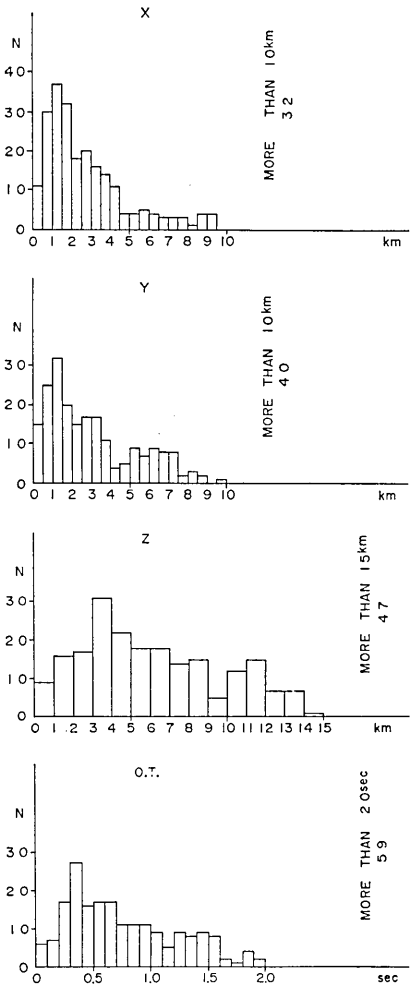

Fig. 3a. Frequency distributions of the standard errors of the epicenter location, origin time and focal depth determined from the arrival times of the P wave.

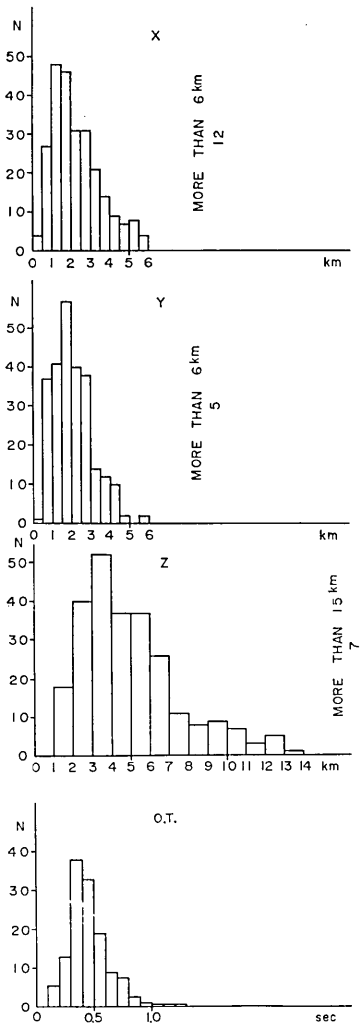

Fig. 3b. Frequency distributions of the standard errors of the origin time, epicenter location and focal depth determined from the arrival times of P and S waves.

mined by such procedure and P-S intervals at some stations. This fact suggests that slight observational errors cause large errors in hypocentral location when it is determined from only arrival times of the P wave.

3.2. Determination of origin times, epicenters and focal depths from arrival times of the P and S waves.

In order to avoid such difficulties as mentioned in the foregoing section, P-S intervals have been used by many seismologists.[7] Usually P-S intervals give reasonable hypocenters, because they give directly hypocentral distances. The use of only P-S intervals, however, does not allow determination of the origin time. Therefore, the author tried to use arrival times of both the P and S waves in a method similar to the previous section, adopting the following relation:

$$(3) \qquad (x-x_i)^2+(y-y_i)^2+(z-z_i)^2=\gamma^2 V_p^2(t-t_{s_i})^2 \ ,$$

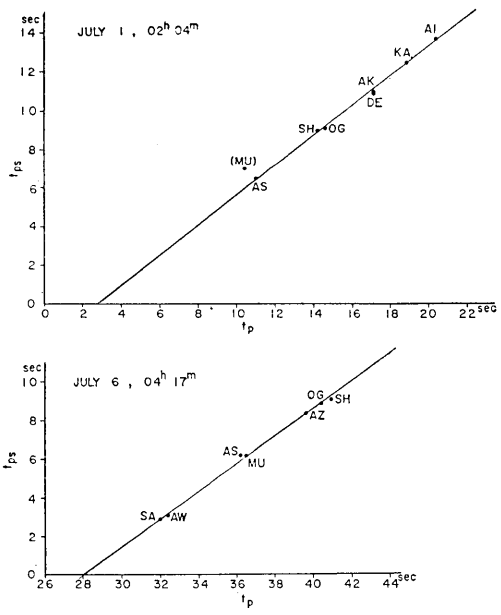

Fig. 4.

where $\gamma=V_s/V_p$ and t_{s_i} is the arrival time of the S wave at the i-th station.

On the assumption that $V_p=6.0$ km/s and $1/\gamma=V_p/V_s=1.732$, x, y, z and t were calculated for the shocks for which four or more arrival times of the P wave and three or more arrival times of the S wave were observed.

In order to find out misinterpretation of the S phase, t_p vs. t_{ps} diagrams (for example, Fig. 4) were drawn. On that diagram, the point (t_p, t_{ps}) should come on a straight line, if V_p/V_s is constant. The gradient of the line is $(V_p/V_s)-1$ and the line intersects t_p axis at $t_p=t$. Therefore the origin time can be directly determined on the diagram.[8] Strictly speaking, V_p/V_s is not

7) for example,
S. MIYAMURA, "Local Earthquakes in Kii Peninsula, Central Japan. Part 4. —Location of Earthquakes by the Temporary Network of Stations near Wakayama—" (in Japanese), *Bull. Earthq. Res. Inst.*, **38** (1960), 71-112.

8) H. WATANABE and A. KUROISO, "Some Properties of Microearthquakes in the West of Kii Peninsula, Central Honshu, Japan" (in Japanese), *Zisin (Journ. Seism. Soc. Japan)*, [ii], **20** (1967), 180-191.

constant. The line, however, can be safely regarded as straight within several tens of kilometers of the epicenter. If there is a misinterpretation of the S phase, the point will deviate from this straight line. Therefore such data that the point on the diagram deviates from the line by more than 1 sec were omitted.

For about 400 cases, the solution of x, y, z and t converged. The frequency distribution of $\hat{\sigma}_0$ is shown in Fig. 2(b). The distribution seems to follow the normal law with a mean of 1.5. The cases in which $\hat{\sigma}_0$ are larger than 3.0 were omitted, considering that they probably contain some erroneous observational data.

In some 60 cases, the depth became negative in the course of iteration. In such cases, the depth was assumed to be 5 km, because the foci of such shocks are considered to be shallow. The frequency distribution of standard errors of x, y, z and t are shown in Fig. 3b. The standard errors of x, y, z and t distribute around 1.5 km, 1.7 km, 3.5 km and 0.4 sec respectively and three-fourths of them distribute within the range of 3.1 km, 2.7 km, 6.4 km and 0.54 sec respectively. The accuracy is about twice higher than those determined from t_p only in the previous section. The results in which the standard errors are beyond 10 km with respect to epicenter and focal depth and 1.0 sec with respect to origin time were omitted, because such numerals can be considered to be unreliable.

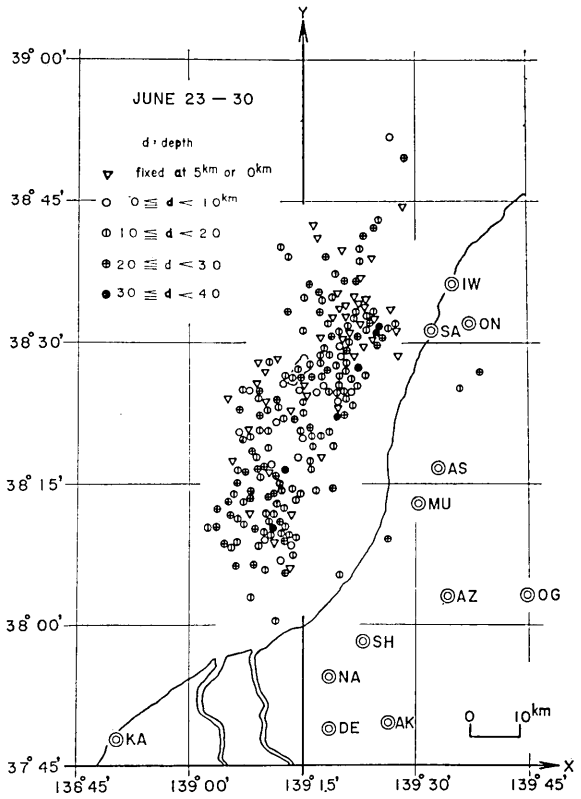

Fig. 5a.

Origin times, epicenter coordinates and focal depths of some 300 shocks determined in good accuracy are listed in Table 3.

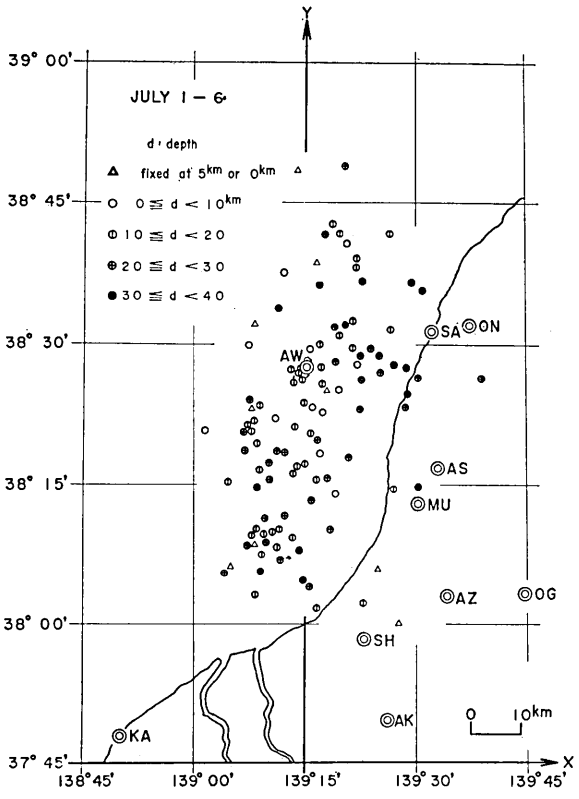

Fig. 5b.

The epicentral distribution of aftershocks in Fig. 5 shows that the aftershock domain has an elliptical shape with longer axis lying in the direction N30°E–S30°W. This direction is approximately parallel to the axis of the geological structure in this region and also to the fractures and faults found on the island of Awashima and its surrounding sea bottom.[9]

The epicenter of the main shock lies in the central part of the aftershock domain, in contrast with the common fact that the epicenter of the main shock lies on the border of the aftershock domain.[10]

Fig. 5 does not include the epicenters of aftershocks occurred in the period of seven and a half days following the main shock, during which as many as three-fourths of the total aftershocks which were detected by the JMA network in 45 days after the main shock occurred.[11] Moreover epicenters in marginal region might

9) 松田時彦・中村一明・恒石幸正「粟島の地質—新潟地震との関連」地震研究所研究速報 **8** (1964), 91-100.

中村一明・笠原慶一・松田時彦「新潟地震による粟島の地変」地震研究所研究速報 **8** (1964), 73-90.

A. MOGI, B. KAWAMURA and Y. IWABUCHI, "Submarine Crustal Movement due to the Niigata Earthquake in 1964, in the Environs of the Awa Sima Island, Japan Sea", *Journ. Geod. Soc. Japan*, **10** (1964), 180-186.

K. NAKAMURA, K. KASAHARA and T. MATSUDA, "Tilting and Uplift of an Island, Awashima, near the Epicentre of the Niigata Earthquake in 1964", *Journ. Geod. Soc. Japan*, **10** (1964), 172-179.

10) T. MATUZAWA, Study of Earthquakes, (Uno Shoten, 1964), pp. 78-103.

11) *ibid.*, 3)

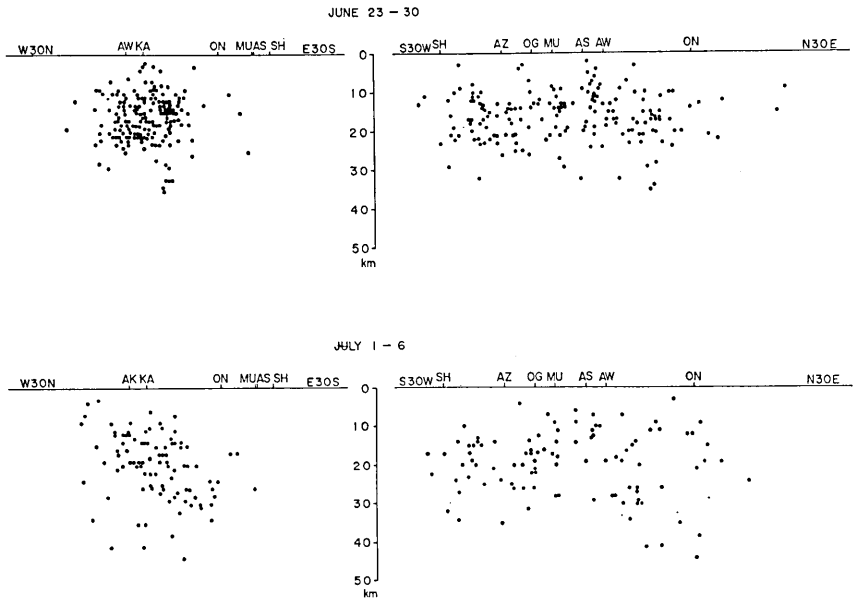

Fig. 6. Vertical Projection of hypocenters.

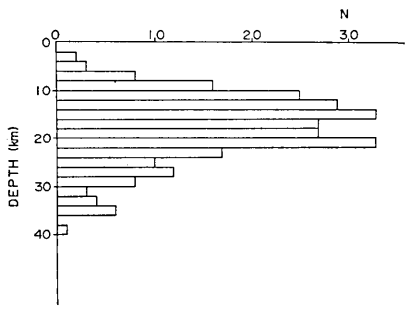

Fig. 7. Frequency distribution of the focal depths.

not be accurately determined due to the limited distribution of observation points. However, the epicentral distribution obtained in this section is similar to the epicentral distribution of 208 larger aftershcks located by the JMA routine network[12] and may be safely regarded as the general pattern of the aftershock activity in the present case.

It is noted that few aftershocks occurred near the epicenter of the main shock and in a region 20 km distant northeastward from it, nevertheless many aftershocks were occurring in their surrounding area.

The distribution of focal depths in Fig. 7 shows that foci of aftershocks lie mostly at depths between 10 km and 22 km and few aftershocks appear to occur in places shallower than 10 km. This may be partly due to difficulty in determining depths of shallower shocks, but

12) *ibid.*, 3)

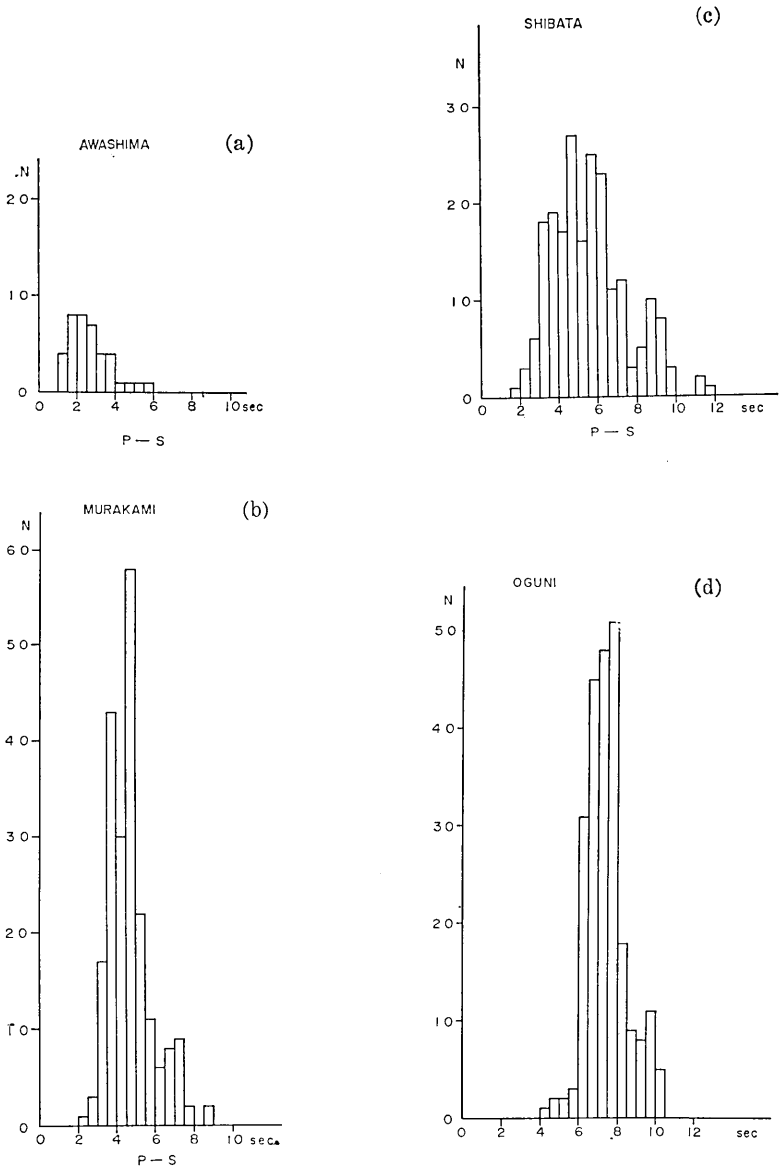

Fig. 8. Frequency distributions of the hypocentral distances from the stations, of which the data were used to determine the hypocenters. The abscissa is scaled as the P—S interval, that is, the hypocentral distances divided by 8.196.

the fact that P-S intervals shorter than 1.5 sec were rarely observed at Awashima, which lies in the midst of the aftershock area, supports

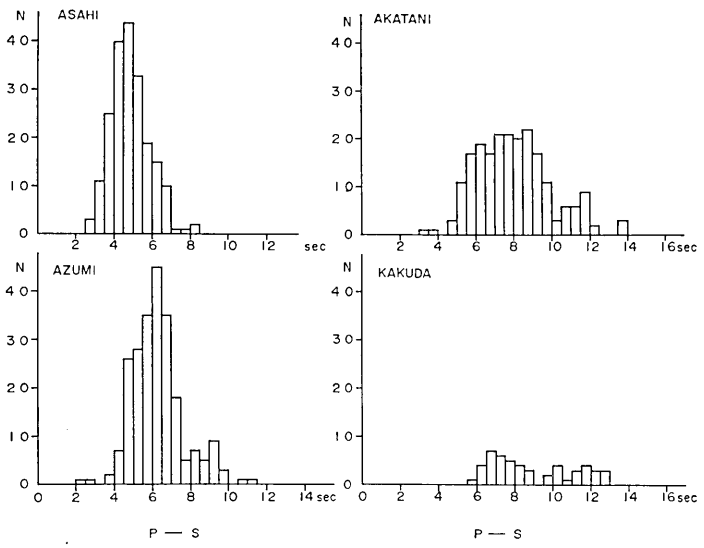

Fig. 8. (e)

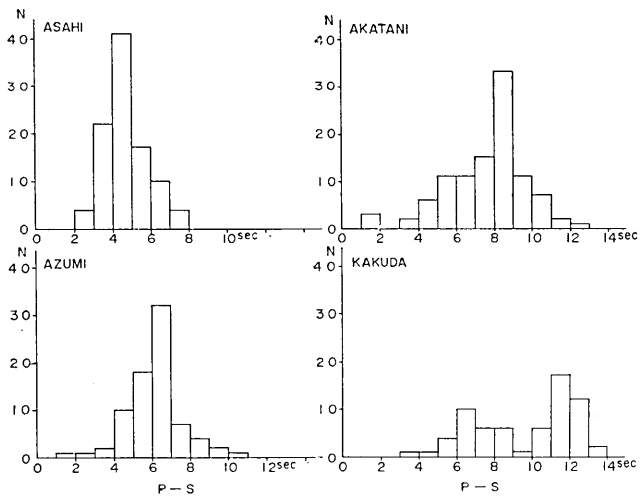

Fig. 9. Distribution of observed P-S intervals

the conclusion that few aftershocks occurred at depths shallower than 10 km. This may have some correlation with the fact that the focal depth of the main shock was 40 km.

In order to check the hypocentral distribution determined in this section, the frequency distribution of hypocentral distances from each

station was made as shown in Fig. 8. In the figure, the abscissa is scaled as the P–S interval, that is, the hypocentral distance divided by the Omori constant 8.196 calculated from $V_p=6.0$ km and $V_p/V_s=1.732$. Accordingly the figure corresponds to the frequency distribution of P–S intervals at the corresponding station indicated in Fig. 6 in the previous paper[13] and in Fig. 9. If the hypocentral distribution determined in this section gives general aspect, both the distributions should be the same in shape. Therefore, the similarity between these distributions assures that the hypocentral distribution determined in this section represents the general aspect of the aftershock activity.

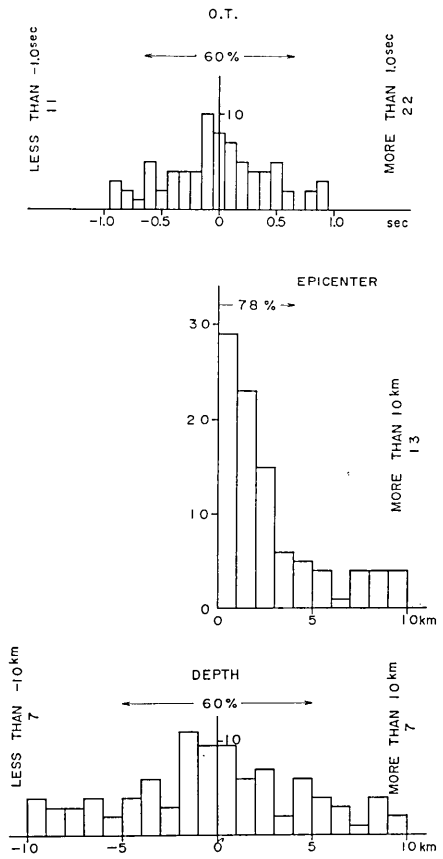

Fig. 10. Frequency distributions of the differences between the origin times, epicenter locations and focal depths determined from the arrival times of the P wave only and those determined from the arrival times of P and S waves together.

Epicenters of a group of shocks near Oguni, which might be independent from the aftershocks, were not determined.

In order to compare the results determined from t_p only with the results from t_p and t_s together, frequency distributions of the differences of the origin times, epicenter locations and focal depths determined in the two methods are shown in Fig. 10.

In a half of the cases, the results obtained by the two methods coincide with one another within a deviation of 0.5 sec for origin time, 2.2 km for epicenter and 4 km for depth. In some cases the two methods give results having larger discrepancy. In most cases, the result from combination of t_p and t_s seems to be more reliable, because hypocenters determined from only t_p is greatly affected by a slight observational error.

13) *ibid.*, 2)

3.3. The velocity of the P wave (V_p) and the ratio of velocity of the P wave to the S wave (V_p/V_s).

Next the velocity of the P wave as well as x, y, z and t were calculated from the same data on the assumption that V_p/V_s is 1.732. Some 250 solutions for the velocity of the P wave were obtained. The values of V_p and their standard error are shown in the column II in Table 3 and Fig. 11(a). The values of V_p with standard error exceeding 1.0 km/s were omitted in the table and in Fig. 11(a). The values of V_p calculated here were not determined from only t_p, but from both t_p and t_s using the relation $V_p/V_s=1.732$.

The ratio of the velocities of the P wave to S wave, in addition to x, y, z, t and V_p, were calculated on an assumption of a uniform half space for the shocks of which arrival times of S wave were observed at three or more stations. Some 180 solutions for V_p/V_s were obtained.

The values of V_p and V_p/V_s and their standard errors are shown in the column III in Table 3 and Figs. 11(b) and 12. The V_p with standard error exceeding 1.0 km/s and the V_p/V_s with standard error exceeding 0.1 were omitted in the table and in Figs. 11(b) and 12. In Fig. 12, the black parts of column indicate numbers of more reliable ones that

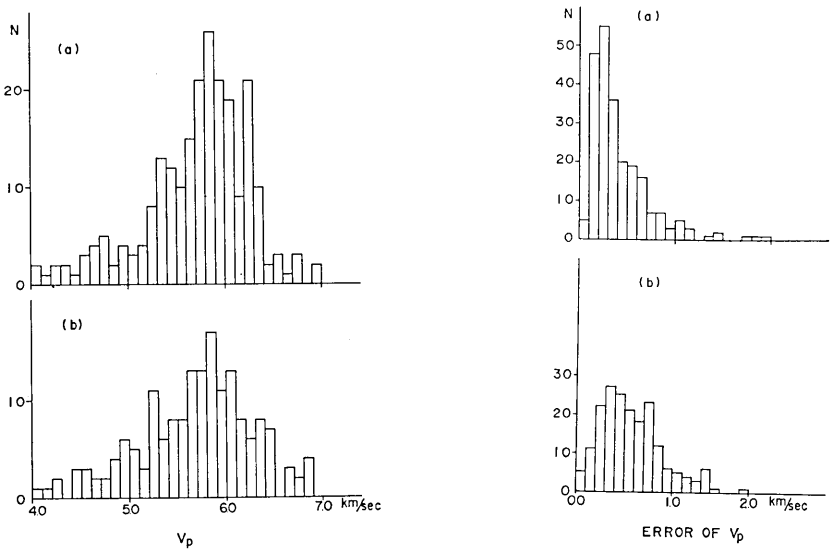

Fig. 11. Frequency distributions of the velocity of the P wave (V_p) determined from the arrival times of P and S waves and its standard error.
(a) V_p/V_s is assumed at 1.732. (b) V_p/V_s is variable.

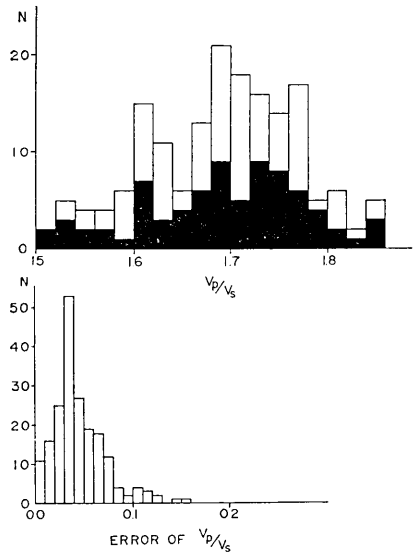

Fig. 12. Frequency distributions of the ratio of the velocities of *P* and *S* waves (V_p/V_s) and standard errors. Black parts incicate the values determined from the data including five or more *S* arrival times.

were determined from data including five or more arrival times of the *S* wave.

The values of V_p and V_p/V_s are scattered widely. Such scattering seems to be of unreal existence and to have come from observational errors. The mean value of V_p obtained in this section is about 5.8 km/s and the mean value of V_p/V_s is about 1.70, both the values being slightly smaller than those assumed in the beginning. If calculation is carried out again on the basis that $V_p=5.8$ km/s and $V_p/V_s=1.700$,[14] a different epicentral distribution will be given. However, such recalculation was not tried, as the difference is expected to be very small.

The epicentral distribution obtained by giving suitable values to V_p and V_p/V_s has less deviation than that obtained by putting V_p and V_p/V_s unknown.

4. Conclusion and acknowledgement

Origin times, epicenters and focal depths of some 400 small aftershocks of the Niigata Earthquake were given with sufficient accuracy on the basis of data obtained by temporary observation carried out by Hokkaido University, Tohoku University, the Earthquake Research Institute of the University of Tokyo and the Japan Meteorological Agency.

Epicenters are difficult to be determined from only arrival times of the *P* wave of a small number of stations, while the use of arrival times of the *P* and *S* waves gives good results.

The present author hopes that the results offerred in this paper will be useful for further investigation of the aftershocks.

14) R. YOSHIYAMA, "The Ratio of the Velocity of P and S Waves", *Bull. Earthq. Res. Inst.*, **35** (1957), 627-640.

Table 2. The origin times (O. T.), epicenter coordinates (x, y), focal depths (z) and the velocity of the P wave (V_p) determined from arrival times of the P wave.

I: O. T., x, y and z calculated with V_p assumed to be 6.0 km/s.

II: O. T., x, y, z and V_p were calculated. Only V_p is shown in the table.

$\hat{\sigma}_0$: Estimate of residual with a unit weight.

$\hat{\sigma}_0=1.00$ corresponds to the residual 0.1 sec for iP.

Differences: Differences between the origin times, epicenter locations (r) and focal depths determined from arrival times of the P wave only and those determined from arrival times of the P and S waves (in Table 3).

Italicized numerals are calculated with z assumed to be 5 km.

Date & Time			Number of the Data	I					II		Differences		
d	h	m		O. T.	x	y	z	$\hat{\sigma}_0$	V_p	$\hat{\sigma}_0$	O. T.	r	z
				sec	km	km	km		km/s		sec	km	km
June 23	00	14	5	*1.9±4.4*	*−7.9±0.3*	*71.0±0.4*	*5*	*0.64*					
		41	6	*18.8±0.3*	*−0.4±2.1*	*71.3±1.8*	*5*	*1.96*					
	01	26	5	*55.6±0.3*	*5.9±0.8*	*88.3±2.5*	*5*	*0.95*					
	03	28	5	*18.2±0.2*	*10.8±0.2*	*106.2±1.2*	*5*	*0.26*					
		52	5	*5.4±0.3*	*−4.6±0.9*	*66.1±4.5*	*5*	*2.30*					
	06	49	5	*41.1±0.4*	*−6.0±0.5*	*64.0±2.1*	*5*	*1.12*					
	07	00	5	55.0±0.3	−9.7±0.9	64.9±0.8	7.7±11.6	0.36					
	08	13	5	*10.2±0.6*	*8.9±1.7*	*88.1±4.1*	*5*	*1.05*					
	17	19	5	34.0±0.2	−8.4±0.9	4.1±1.7	10.3± 3.7	0.87					
		20	5	*44.8±0.2*	*11.7±1.2*	*34.3±1.5*	*5*	*2.98*					
	20	29	5	*34.7±3.6*	*−5.1±0.2*	*54.0±0.3*	*5*	*0.48*					
		56	5	*56.8±0.5*	*6.0±1.1*	*86.7±4.0*	*5*	*0.97*					
	21	38	5	*33.3±1.2*	*4.8±1.9*	*123.0±8.2*	*5*	*0.88*					

(to be continued)

Table 2. (continued)

Date & Time d	h	m	Number of the Data	I O. T.	x	y	z	$\hat{\sigma}_0$	II V_p	$\hat{\sigma}_0$	Differences O. T.	r	z
				sec	km	km	km		km/s		sec	km	km
June 23	22	40	7	42.6±0.05	4.6±0.4	64.8±0.2	8.3± 1.1	0.26			0.5	0.1	−5.6
	23	13	6	8.1±0.06	4.4±1.6	63.7±0.4	20.4± 1.8	0.24	5.07±0.04	0.01			
		35	5	7.7±0.7	5.4±3.1	57.2±3.1	10.3± 3.8	0.53			3.0	17.8	−9.9
		47	8	50.5±0.3	2.5±0.9	90.3±0.1	13.2± 0.6	1.14					
		52	6	37.5±0.3	2.8±1.9	79.9±0.8	14.7± 3.7	0.95			0.0	1.0	−1.1
24	02	40	6	48.0±0.4	7.6±1.3	73.6±2.6	4.0±10.2	1.18			−0.1	0.7	−0.1
	06	32	6	11.9±0.5	8.0±1.2	97.6±3.0	24.4± 3.4	0.89					
	14	05	5	32.6±0.5	20.7±3.0	54.7±2.0	12.7± 3.2	1.46			3.7	5.2	−17.5
		37	6	25.2±0.6	7.7±1.5	85.4±3.5	9.2± 8.0	1.44					
	15	59	6	15.6±0.9	7.4±2.5	77.2±4.7	15.8± 8.9	2.88					
	17	17	5	6.4±0.2	−2.8±0.4	42.8±0.4	11.1± 3.7	0.67					
	23	48	6	6.6±0.4	17.4±4.2	43.8±0.9	24.3± 2.7	1.14			0.2	1.0	−1.5
25	00	47	5	*59.9±1.2*	*−37.6±1.6*	*171.9±7.4*	*5*	*0.60*					
		53	5	23.7±0.8	23.9±4.0	82.5±1.8	29.2± 6.6	0.49			−0.9	16.1	21.7
	03	38	5	45.8±1.2	7.1±6.3	46.3±3.2	25.3± 8.3	0.95					
	07	07	6	42.7±1.3	4.6±2.7	92.2±6.3	32.9±12.7	1.83					
	08	50	6	57.4±0.7	−2.0±1.8	48.1±2.2	26.2± 8.1	2.93					
	10	13	6	41.5±1.0	14.4±2.8	95.9±6.5	9.9±18.6	2.27					
	11	19	6	34.4±0.1	5.4±0.3	93.9±0.9	18.6± 0.2	0.29			−0.4	2.4	1.1
	12	51	5	12.9±1.2	1.7±7.0	58.8±4.7	25.0± 5.3	0.97					
	13	30	5	34.6±0.05	6.4±0.1	75.8±0.3	6.2± 0.1	0.02			−0.4	3.8	−6.0
	15	56	7	32.0±0.9	−18.3±3.0	47.2±2.5	23.3±11.9	2.92			−0.3	1.3	1.9
	16	33	6	27.0±0.3	6.6±1.4	38.6±0.5	1.1±25.5	0.75			0.3	1.4	−9.0

(to be continued)

Table 2. (continued)

Date & Time d	h	m	Number of the Data	I O. T.	I x	I y	I z	I $\hat{\sigma}_0$	II V_p	II $\hat{\sigma}_0$	Differences O. T.	Differences r	Differences z
				sec	km	km	km		km/s		sec	km	km
June 25	16	36	6	*14.5± 3.3*	*−31.5±16.8*	*75.1±11.8*	*5*	*1.59*					
	17	55	5	*20.9± 0.7*	*18.8± 2.2*	*56.0± 4.4*	*5*	*1.27*					
	18	29	6	12.7± 0.6	2.9± 1.2	99.2± 0.3	36.8± 4.5	1.04	6.48±1.27	1.38	−1.2	5.5	8.0
	19	03	5	7.0± 0.8	7.3± 2.1	79.5± 6.1	5.9±11.9	1.58			0.0	1.7	−6.5
		57	7	*45.5± 1.7*	*7.6± 2.8*	*149.1±10.9*	*5*	*1.62*					
	20	23	5	30.4± 0.7	−34.3± 3.3	71.1± 1.6	39.0± 2.5	0.12			−6.7	33.7	24.9
	21	57	7	27.7± 0.4	6.6± 1.1	75.5± 2.8	8.6± 4.6	1.65			−0.1	1.0	−0.2
	22	08	7	40.7± 0.5	−8.8± 1.1	61.0± 1.2	8.1±17.7	1.14					
		23	6	29.6± 0.5	11.3± 1.1	87.9± 2.8	16.4± 3.0	0.85			0.0	1.0	−0.5
		32	6	54.0± 0.4	−17.0± 0.7	43.8± 1.1	25.6± 5.1	1.42					
		40	7	39.4± 0.5	10.2± 2.1	67.1± 2.4	10.6± 4.9	1.66			0.8	3.3	−4.3
	23	12	9	40.7± 0.7	−11.1± 1.6	57.5± 1.6	28.2± 8.6	2.96			−0.4	17.2	14.8
		30	5	*54.3±13.1*	*11.5±24.5*	*98.0±75.5*	*5*	*1.22*					
		32	5	13.4± 1.4	1.7± 0.7	31.1± 3.2	5.9±11.5	1.06			1.5	7.8	−7.5
		58	8	35.4± 0.8	−3.2± 2.0	69.2± 3.2	25.5± 8.9	2.95			−0.6	2.0	7.0
26	00	56	7	35.5± 0.6	−0.5± 2.2	48.6± 1.7	6.6±13.7	2.43					
		57	7	37.1± 0.4	−15.0± 1.3	43.2± 1.2	17.9± 5.3	1.26					
	01	09	5	*51.9± 0.5*	*5.5± 2.7*	*43.8± 2.3*	*5*	*1.20*					
		53	6	46.0± 0.9	5.0± 3.1	60.9± 3.6	8.9± 6.3	1.38					
	03	18	7	48.1± 0.3	−5.1± 0.9	39.0± 1.4	10.7± 6.8	1.83					
	04	10	6	48.1± 0.9	7.9± 1.9	105.4± 4.9	28.1± 7.1	1.41					
		56	6	4.2± 0.7	0.7± 2.6	56.8± 3.3	10.1±11.3	2.38			0.2	1.6	−3.2
	05	02	5	8.5± 0.5	4.3± 1.4	74.0± 3.5	22.3± 5.2	1.67					

(to be continued)

Table 2. (continued)

Date & Time d	h	m	Number of the Data	I O. T.	x	y	z	$\hat{\sigma}_0$	II V_p	$\hat{\sigma}_0$	Differences O. T.	r	z
				sec	km	km	km		km/s		sec	km	km
June 26	05	47	6	0.9±0.4	4.8±0.7	103.6±3.3	17.1± 3.1	0.48			−1.2	11.3	−3.4
	08	19	6	65.5±0.3	−10.1±0.5	58.0±1.2	22.0± 3.4	0.69					
	13	46	6	57.4±1.2	−1.0±2.3	96.8±1.0	21.8±10.4	2.11					
	14	26	5	17.2±0.3	−2.1±1.1	45.4±0.6	11.1± 3.0	0.49			0.2	1.9	0.8
	16	02	7	19.5±0.2	−7.6±0.5	38.4±0.6	7.5± 5.6	1.07					
		53	7	3.4±1.0	3.7±2.5	83.7±5.5	17.9± 8.0	2.13			−0.8	4.6	4.9
	20	53	5	31.8±1.3	−10.3±9.4	32.6±2.0	9.1±16.7	2.63					
	22	10	5	34.9±0.5	−4.4±2.4	44.1±0.6	13.9± 3.2	0.51			0.6	2.4	3.7
		11	5	18.6±1.4	−5.3±4.3	88.6±7.4	11.0± 3.5	0.36			2.4	15.7	−0.6
		23	5	49.6±1.3	2.8±4.8	62.0±5.5	16.6± 6.4	1.40			0.4	4.1	2.2
		42	6	47.3±0.6	−10.4±3.6	76.7±2.0	15.2± 8.8	1.60					
27	00	20	6	56.2±0.3	0.6±1.3	86.0±1.0	15.8± 2.7	0.56	4.92±0.80	0.47	−0.9	9.4	−1.4
		21	7	57.4±0.5	−4.4±2.8	75.6±1.4	14.3± 6.4	1.36			−0.2	1.5	−3.7
		50	6	21.8±0.6	−12.0±3.5	78.3±1.3	28.6± 3.3	0.76			−1.8	11.3	4.4
	01	34	6	18.2±0.8	−2.4±4.5	39.4±1.3	4.0±15.3	1.93			0.5	2.2	−5.7
		50	6	53.1±0.9	4.9±4.3	59.1±3.2	8.1± 6.1	1.27					
		55	6	11.4±0.7	2.2±3.0	64.9±2.7	8.4± 3.8	0.65					
	02	19	5	34.2±0.3	−12.8±1.7	42.9±0.5	12.7± 2.3	0.42			0.5	0.9	6.3
		27	6	14.3±0.3	18.3±0.8	64.9±1.8	5.2± 1.3	0.44					
		28	6	20.4±1.3	9.3±2.9	77.9±6.7	17.9± 3.9	0.68			0.1	1.5	+0.1
		31	5	10.2±0.3	−12.7±1.4	64.7±1.1	21.4± 1.5	0.21			−0.3	1.4	2.4
	04	06	6	26.2±1.1	7.0±4.3	54.8±4.0	9.4± 5.9	1.20			4.7	23.0	−10.6
	06	00	6	*19.1±1.1*	*−3.9±7.2*	*46.4±2.0*	*5*	*2.03*					

(to be continued)

Table 2. (continued)

Date & Time d	h	m	Number of the Data	I O. T.	I x	I y	I z	I $\hat{\sigma}_0$	II V_p	II $\hat{\sigma}_0$	Differences O. T.	Differences r	Differences z
				sec	km	km	km		km/s		sec	km	km
June 27	07	15	6	36.0±0.1	−0.8±0.4	60.8± 0.5	14.4± 1.4	0.38	5.73±0.47	0.46			
		19	5	16.5±0.6	8.8±1.8	73.6± 2.7	12.5± 1.4	0.23			1.4	7.4	−4.8
	21	03	7	42.5±0.4	−17.2±0.8	42.0± 1.8	20.9± 6.8	1.57					
		40	5	*39.1±4.3*	*8.1±4.4*	*94.9±27.7*	*5*	*2.04*					
		58	6	41.4±0.6	−2.5±1.5	53.4± 2.2	19.3± 7.6	2.06					
	23	15	9	44.3±0.4	−8.2±0.9	47.1± 1.3	32.9± 4.7	1.71	6.78±0.93	1.77			
28	00	00	8	9.9±1.3	0.6±2.8	84.5± 6.3	23.5±11.1	2.53			0.0	0.8	2.2
	04	51	6	16.8±1.5	10.7±3.4	66.4± 7.6	10.5±10.9	2.42					
		52	6	12.7±0.2	−2.9±0.6	54.1± 0.6	15.1± 2.1	0.42			1.0	2.8	8.4
	05	28	7	36.7±0.2	5.2±0.5	87.9± 1.5	19.8± 2.0	0.43	5.96±0.70	0.52	−0.3	1.8	1.4
		38	5	*13.1±0.5*	*11.8±2.3*	*62.7± 3.8*	*5*	*1.31*					
		54	6	1.0±1.0	−9.3±3.8	40.5± 2.4	19.5±10.1	2.86					
	06	58	6	31.7±0.3	−9.5±1.2	47.6± 0.8	17.9± 3.4	0.79	5.14±1.73	0.98	0.8	0.1	5.2
	16	56	5	0.6±0.9	−0.0±2.1	68.7± 2.3	20.0± 7.0	0.61			0.0	0.1	0.2
	17	33	7	0.7±0.6	−9.3±1.1	59.7± 1.7	34.5± 6.1	1.68			−0.6	0.9	8.9
	22	00	5	52.0±0.8	6.7±2.7	69.5± 7.4	32.5± 7.4	0.90			−0.1	0.7	0.4
		34	5	19.1±1.1	−4.4±5.8	31.4± 1.6	22.9± 5.5	0.88			−0.1	0.7	0.8
		43	5	32.2±1.4	−9.8±5.9	104.8± 6.5	9.4±10.4	0.62			−1.3	8.7	−3.1
29	02	04	5	31.1±0.8	8.1±1.4	73.9± 4.2	14.9± 4.3	0.84			0.6	2.9	3.5
		12	5	8.2±0.06	−89.1±0.3	74.3± 0.1	45.1± 0.2	0.01					
	05	41	6	47.5±0.7	−7.1±1.6	65.8± 3.1	19.4±11.5	2.48			−0.1	0.7	2.3
	09	50	8	20.6±0.2	−13.9±0.5	49.1± 0.7	25.4± 3.3	0.96			−0.3	0.6	4.8
	11	48	5	35.1±0.6	32.9±1.1	68.2± 2.8	16.7± 2.3	0.25			1.7	8.5	−6.6

(to be continued)

Table 2. (continued)

Date & Time d	h	m	Number of the Data	I O. T.	I x	I y	I z	I $\hat{\sigma}_0$	II V_p	II $\hat{\sigma}_0$	Differences O. T.	Differences r	Differences z
				sec	km	km	km		km/s		sec	km	km
June 29	15	04	6	2.3± 0.3	−8.8±0.9	56.8± 1.5	18.8± 4.3	0.82			0.3	1.0	−3.0
	17	08	7	17.6± 1.0	−8.7±3.4	59.1± 3.3	19.8± 8.0	1.88			−0.1	1.5	−1.2
		55	6	48.0± 0.4	5.0±0.8	83.8± 2.7	7.5± 2.8	0.38					
	19	15	8	43.1± 0.6	16.6±1.1	82.8± 3.5	12.1± 3.6	1.22			0.5	3.0	−3.3
	20	12	7	17.7± 0.5	−6.4±1.7	45.3± 1.1	20.7± 4.3	1.27			0.3	1.2	−1.6
		24	6	31.2± 1.6	−10.4±8.1	44.8± 2.0	11.6±12.7	1.55			−0.4	3.3	−0.8
	21	48	7	57.3± 0.3	−0.5±1.2	52.1± 1.0	16.0± 3.0	0.87			0.1	0.8	−1.0
	22	10	9	17.9± 0.4	0.8±1.1	77.7± 2.5	6.6±12.5	1.51	5.98±1.98	1.69	0.2	0.8	−7.0
		18	8	*10.7± 1.9*	*6.2±3.1*	*95.1±11.6*	*5*	*1.52*					
		50	7	42.8± 0.9	9.3±1.9	72.8± 5.0	13.9± 4.0	1.17			2.0	11.5	6.2
	23	11	9	5.5± 0.3	12.9±0.9	90.6± 1.8	18.2± 3.4	0.88					
30	01	29	5	55.2± 0.9	16.2±1.0	94.0± 5.4	10.6± 1.7	0.29			−0.8	5.0	0.4
	02	07	6	59.5± 1.2	−4.2±3.3	89.7± 6.4	11.9± 4.3	0.36					
	03	41	5	47.4± 1.5	11.9±2.6	77.8± 8.9	11.8± 6.8	1.48			0.9	7.1	1.1
	04	48	6	2.6± 1.0	6.5±2.6	60.5± 3.9	10.7± 9.9	1.93					
		49	5	55.2± 0.2	−2.4±0.6	39.4± 0.3	12.0± 4.4	0.46					
	05	06	5	53.0± 0.6	18.5±0.8	67.3± 3.7	8.8± 2.3	0.52					
		37	5	23.3± 1.4	−11.4±3.6	53.4± 2.7	32.9±12.2	1.82			−1.1	1.8	10.0
	06	08	6	6.1± 0.2	2.1±0.4	62.0± 1.0	18.6± 2.8	0.49			−0.2	0.6	5.6
		50	7	24.4± 0.3	−3.7±0.8	44.5± 1.0	22.7± 4.0	1.41			0.0	0.1	0.3
	09	40	5	15.2± 0.7	−14.1±1.8	41.0± 2.3	27.9± 7.5	0.77			−0.7	0.6	6.5
		41	7	2.2±1.4	11.0±3.7	59.3± 7.1	13.0± 7.2	2.66			2.8	3.0	−11.9
	10	06	7	35.0±1.9	−4.9±5.1	52.2± 2.5	33.3±19.7	2.44	6.96±1.65	2.77	−0.9	2.0	9.9

(to be continued)

Table 2. (continued)

Date & Time d	h	m	Number of the Data	I O. T.	I x	I y	I z	I $\hat{\sigma}_0$	II V_p	II $\hat{\sigma}_0$	Differences O. T.	Differences r	Differences z
				sec	km	km	km		km/s		sec	km	km
June 30	19	17	8	33.6±0.5	10.9±1.1	96.1± 3.0	24.9± 4.1	0.94	6.20±1.37	1.08	−0.5	1.8	4.0
		24	5	42.1±0.2	−10.3±1.2	32.8± 0.2	11.3± 1.7	0.32			0.0	0.2	−0.6
		45	8	18.6±0.5	1.2±1.4	66.9± 2.9	17.2± 6.5	2.01			−0.6	2.8	8.6
		51	5	*35.2±0.3*	*31.1±1.2*	*60.5± 2.2*	*5*	*1.19*					
	20	11	7	5.8±0.3	−2.3±1.0	44.5± 1.0	20.2± 3.6	1.17			−0.2	0.6	2.1
		59	8	43.7±0.9	10.8±2.1	98.0± 5.0	13.7±10.1	2.02			0.1	0.3	−0.8
	21	10	5	28.4±0.2	−17.4±7.4	66.4± 5.7	39.3± 8.1	0.27			−3.5	12.7	20.5
		18	7	38.8±0.4	7.1±1.1	73.5± 2.3	14.8± 4.6	1.41			−0.1	0.4	2.2
		40	6	24.3±0.9	15.4±1.6	73.9± 5.8	16.8± 3.1	1.03			1.6	9.1	−4.3
July 01	00	35	7	1.2±1.2	17.9±3.4	59.8± 6.1	13.5± 6.5	3.00			5.5	16.4	−13.0
	01	43	5	*7.3±0.7*	*28.9±5.9*	*51.5± 3.1*	*5*	*2.66*					
	06	10	6	33.2±1.2	16.6±2.5	108.9± 7.3	24.2± 8.1	1.46					
		17	5	*34.7±1.9*	*23.5±8.5*	*53.7±14.7*	*5*	*1.15*					
		55	5	43.7±0.1	6.0±0.2	75.9± 0.5	17.4± 0.6	0.16			0.4	0.2	−1.1
	07	52	5	*0.5±0.5*	*7.6±3.3*	*51.4± 2.2*	*5*	*2.02*					
		54	6	3.4±0.05	−10.6±1.2	44.7± 1.1	16.0± 9.9	1.74			0.1	0.6	−1.8
	08	02	7	26.2±0.6	9.1±1.8	68.2± 3.2	14.7± 5.9	2.35					
	10	27	5	15.9±1.1	7.7±4.6	54.8± 4.2	3.6± 8.6	2.53					
	11	59	6	53.1±1.0	0.5±3.6	53.4± 2.7	19.5± 5.8	1.45			1.9	9.7	−7.0
	15	03	7	36.1±0.3	−10.9±0.7	48.1± 1.2	17.0± 5.7	1.49			0.5	2.9	−8.7
	16	51	5	52.6±0.4	−2.9±1.7	56.2± 1.2	5.0± 4.8	0.42					
	17	59	6	16.5±0.4	−1.9±1.9	41.2± 0.7	8.7± 4.1	0.96			0.9	4.0	−6.9
	19	46	6	28.8±0.1	16.1±0.6	52.1± 0.5	4.1± 1.4	0.64	6.06±0.35	0.89			

(to be continued)

Table 2. (continued)

Data & Time d	h	m	Number of the Data	I O. T.	I x	I y	I z	I $\hat{\sigma}_0$	II V_p	II $\hat{\sigma}_0$	Differences O. T.	Differences r	Differences z
				sec	km	km	km		km/s		sec	km	km
July 01	23	17	6	41.5±0.2	2.6±0.5	54.8± 0.9	12.3± 2.3	0.72			0.2	0.9	−1.7
		37	5	30.8±0.01	20.0±0.1	53.6± 0.1	5.4± 0.1	0.08					
02	00	54	5	12.8±1.4	20.2±1.4	61.7± 5.7	21.9± 7.3	0.61					
		43	5	*29.1±0.3*	*17.7±2.7*	*53.4± 0.9*	*5*	*1.16*					
		52	6	*26.1±0.5*	*7.1±3.5*	*44.0± 1.6*	*5*	*2.75*					
	02	42	6	12.5±0.4	17.5±1.5	58.3± 1.8	10.6± 2.3	1.20			4.1	21.9	−16.8
		49	6	50.1±0.4	18.9±2.0	55.0± 2.1	0.8± 3.4	0.75					
	03	08	6	*17.9±0.7*	*14.9±4.9*	*52.3± 2.1*	*5*	*2.75*					
	04	02	6	4.9±0.2	21.6±1.1	53.3± 0.9	5.4± 1.5	1.29	5.57±0.26	0.94	5.1	5.5	−21.5
		46	5	12.8± 0.6	7.0±3.0	60.5± 2.1	13.2± 3.0	0.67			1.4	7.4	−4.8
		58	6	*28.9±0.6*	*16.8±1.7*	*61.7± 3.8*	*5*	*0.83*					
	06	18	5	12.1±1.6	−5.0±6.3	58.5± 5.6	12.1± 6.3	0.39			1.9	9.4	−9.1
		27	5	*14.1±2.0*	*10.5±7.1*	*59.4±11.6*	*5*	*1.54*					
	12	32	5	37.8±1.5	5.6±7.5	53.6± 3.9	11.5± 8.4	1.99			1.6	8.0	−8.2
	19	22	5	23.1±0.8	8.9±2.8	41.8± 2.3	5.4±15.6	1.29					
	21	26	5	9.3±1.8	6.0±5.5	54.1± 4.6	25.1±10.5	1.93			0.4	2.6	−1.8
03	00	03	5	12.1±1.3	6.9±3.6	52.1± 2.8	29.1± 7.3	0.95					
	01	27	6	33.0±0.6	8.1±3.1	30.5± 1.3	10.1± 4.6	2.74					
	03	08	5	11.4±0.3	13.6±1.4	73.6± 1.6	36.1± 1.7	0.48					
	04	16	5	40.5±1.2	15.6±1.8	69.4± 5.7	27.0± 4.7	0.55					
	11	47	7	21.4±1.4	8.1±1.7	88.7± 6.5	44.4± 6.7	1.50			−0.6	2.4	2.8
	12	24	6	21.7±0.2	−2.6±0.8	42.2± 0.6	21.3± 1.7	0.58					
	13	00	5	*26.6±0.3*	*29.8±2.0*	*57.3± 2.3*	*5*	*2.49*					

(to be continued)

Table 2. (continued)

Date & Time d	h	m	Number of the Data	I O.T.	I x	I y	I z	I $\hat{\sigma}_0$	II V_p	II $\hat{\sigma}_0$	Differences O.T.	Differences r	Differences z
				sec	km	km	km		km/s		sec	km	km
July 03	15	47	6	48.3± 0.3	0.8±1.2	42.8±0.6	21.3± 1.8	0.46	4.69±0.50	0.21			
	16	17	5	35.5± 0.1	4.1±0.4	31.4±0.6	12.6± 1.2	0.70			1.1	0.6	5.7
		21	5	46.9± 0.8	9.1±2.2	55.3±3.3	16.4± 3.9	0.78					
	17	16	5	35.4± 0.3	8.9±1.2	33.8±0.4	7.6± 2.7	0.31					
		29	5	30.7± 0.2	7.5±1.1	30.2±3.5	13.6± 1.2	0.64			2.7	1.3	−9.8
		33	6	24.3± 0.7	5.2±3.4	32.8±1.2	12.9± 5.1	2.46					
		39	6	33.9± 0.3	−2.3±1.1	29.5±0.9	26.1± 2.3	0.92	4.22±1.41	0.71			
	19	56	7	36.5± 1.5	20.0±2.5	78.3±7.8	30.4± 6.6	2.28			−0.1	0.4	0.2
	21	35	5	41.3± 0.5	32.7±5.2	74.6±1.5	24.7± 3.0	0.69			0.4	2.5	−2.0
	23	55	5	5.8± 0.1	−3.9±0.5	69.1±0.3	33.1± 0.6	0.10			−2.4	0.9	16.5
04	00	58	6	59.6± 1.4	18.4±3.7	53.8±3.2	43.5±11.2	2.76			2.0	4.1	−15.8
	02	20	5	41.4± 0.5	4.3±2.4	36.8±1.0	12.6± 3.7	1.36					
	04	39	5	*3.3± 0.2*	*−18.4±1.4*	*19.9±2.2*	*5*	*2.53*					
	06	43	5	59.7± 1.2	39.1±3.6	109.6±3.9	74.6± 5.9	0.20					
	08	24	5	27.6± 0.8	−4.1±2.8	48.2±1.2	30.4± 3.9	0.22			−0.5	8.0	5.2
		43	7	43.5± 0.2	6.6±1.2	45.7±0.5	7.9± 3.6	1.21					
		47	5	41.4± 0.5	4.3±2.4	36.8±1.0	12.6± 3.7	1.36			2.0	13.6	−1.4
	10	14	6	32.5±10.5	22.8±3.4	50.1±3.5	22.0± 7.1	2.30			0.9	25.6	4.5
	16	28	5	9.3± 0.3	21.1±0.2	172.0±1.6	31.7± 0.4	0.02					
		50	6	45.6± 0.1	−5.3±0.5	63.4±0.4	32.6± 0.9	0.19	6.67±0.27	0.11	−1.2	2.7	10.0
	17	17	6	27.9± 0.5	11.9±2.1	31.5±1.2	9.3± 9.2	2.64			0.1	0.2	0.8
	18	34	5	*32.9± 0.3*	*−2.6±2.2*	*67.1±1.2*	*5*	*1.29*					
	22	45	5	40.5± 1.8	19.1±1.6	91.4±6.9	9.3± 6.6	1.05					

(to be continued)

Table 2. (continued)

Date & Time d	h	m	Number of the Data	I O. T.	I x	I y	I z	I $\hat{\sigma}_0$	II V_p	II $\hat{\sigma}_0$	Differences O. T.	Differences r	Differences z
				sec	km	km	km		km/s		sec	km	km
July 05	00	19	5	*11.6±0.3*	*11.6±1.0*	*91.3±2.5*	*5*	*1.77*					
	03	33	5	*42.9±1.5*	*8.6±2.2*	*96.5±9.5*	*5*	*2.59*					
	05	45	6	17.1±1.0	0.3±3.7	86.5±5.2	10.8± 4.6	1.91			1.6	2.7	−8.3
		57	5	41.4±1.5	−5.2±3.5	72.5±5.4	28.6±10.4	2.01					
		58	6	37.7±0.3	−3.4±0.7	57.6±0.5	17.7± 2.8	0.69			−0.1	1.0	−0.2
	15	09	7	4.2±1.0	7.0±1.9	85.4±4.8	17.5± 5.8	1.56				4.3	1.7
		23	8	26.2±1.3	6.0±2.9	85.8±5.0	20.4± 7.4	2.33			0.0	0.2	0.0
		40	6	*26.9±1.1*	*−9.1±6.8*	*78.5±3.8*	*5*	*2.88*					
	16	15	7	25.5±0.2	−11.3±0.8	61.1±0.4	18.1± 2.2	0.48	6.33±0.21	0.40	0.3	0.8	−2.0
	17	44	7	2.8±0.5	−5.6±1.8	42.2±1.0	9.8±10.2	2.33					
	18	25	5	50.6±0.6	−6.6±2.7	45.5±1.3	10.6± 4.2	0.76			0.1	0.1	−2.4
	19	44	7	4.3±1.8	17.2±1.6	92.1±8.4	20.4± 9.3	2.01	6.40±0.42	2.12	−1.4	6.7	9.0
		50	5	18.9±1.8	−7.4±3.7	79.3±6.8	29.7± 9.9	1.53					
	23	28	7	40.2±1.3	9.5±1.5	78.5±7.3	11.4± 6.2	2.24					
06	00	12	7	49.1±1.2	−9.0±6.0	71.8±2.8	10.8± 7.9	2.61					
		28	7	10.5±0.6	3.1±2.1	61.0±1.7	8.0±11.1	2.43			0.0	0.1	0.8
		29	7	44.8±0.7	22.0±1.3	85.2±3.3	14.3± 4.8	1.38	5.32±0.21	0.64			
	01	07	8	47.0±0.9	5.6±2.4	75.0±3.4	15.2± 7.5	2.50			−0.6	1.9	4.7
	02	42	7	38.2±0.4	−3.6±1.7	78.2±1.2	13.5± 2.1	0.88	6.03±0.25	1.08	−0.2	1.3	1.4
		59	8	16.1±0.6	5.3±1.9	54.6±1.1	22.6± 5.3	2.42					
	08	53	7	10.0±0.2	12.0±0.5	46.4±0.3	20.9± 1.8	0.69					
	12	23	8	*40.5±0.9*	*11.9±1.9*	*92.9±5.9*	*5*	*2.87*					
	21	11	6	24.5±0.5	7.8±1.6	31.8±1.7	13.2± 5.5	1.61	6.04±1.37	2.28			

(to be continued)

Table 3. The origin times (O.T.), epicenter coordinates (x, y), focal depths (z), the velocity of the P wave (V_p) and the ratio between the velocities of the P and S waves (V_p/V_s) determined from arrival times of the P and S waves.

I: O.T., x, y and z calculated on the assumption that $V_p=6.0$ km/s and $V_p/V_s=1.732$.

II: O.T., x, y, z and V_p were calculated with V_p/V_s assumed to be 1.732. Only V_p is shown in the table.

III: O.T., x, y, z, V_p and V_p/V_s were calculated. Only V_p and V_p/V_s are shown in the table.

$\hat{\sigma}_0$: Estimate of residual with a unit weight.
$\hat{\sigma}_0=1.00$ corresponds to the residual 0.1 sec for iP.

The occurrence time of the shocks for which more than ten arrival times of the P and S waves were obtained, and number of arrival times larger than six are indicated in bold type. Italicized numerals are calculated with z assumed to be 0 or 5 km, or calculated in the method II or III mentioned above.

Date & Time			Number of the Data		I					II		III		
d	h	m	P	S	O.T.	x	y	z	$\hat{\sigma}_0$	V_p	$\hat{\sigma}_0$	V_p	V_p/V_s	$\hat{\sigma}_0$
					sec	km	km	km		km/s		km/s		
June 23	00	14	5	5	*1.9±0.4*	*−8.3±2.3*	*70.9±3.5*	*0*	*1.02*					
		20	5	4	*31.3±0.4*	*−7.3±2.3*	*77.0±4.0*	*0*	*0.98*					
	01	40	4	3	13.9±0.4	14.9±2.8	85.5±4.2	34.0±5.7	1.31	5.04±0.32	0.74	4.93±0.50	1.708±0.023	0.97
	02	19	4	4	51.5±0.4	−10.8±1.1	63.7±2.8	10.9±9.9	1.55			5.86±0.01	1.615±0.000	0.02
	03	00	4	3	38.1±0.3	8.0±1.2	94.1±3.6	24.9±6.7	1.03	5.83±0.83	1.24	5.78±0.21	1.669±0.000	0.27
		28	5	3	*19.1±0.3*	*8.0±0.9*	*100.6±1.9*	*0*	*1.45*					
	04	17	4	3	*30.5±0.7*	*3.1±1.7*	*103.2±4.3*	*5*	*2.06*					
	07	00	5	3	*55.1±0.1*	*−10.1±0.3*	*64.8±0.4*	*0*	*0.27*					
		31	4	3	16.6±0.3	19.7±1.1	118.8±1.4	15.3±4.4	0.52	5.75±0.37	0.59	5.30±0.25	1.633±0.015	0.28

(to be continued)

Table 3. (continued)

Date & Time d	h	m	Number of the Data P	S	I O.T.	I x	I y	I z	I $\hat{\sigma}_0$	II V_p	II $\hat{\sigma}_0$	III V_p	III V_p/V_s	III $\hat{\sigma}_0$
					sec	km	km	km		km/s		km/s		
June 23	08	13	5	4	*10.5±0.2*	*7.9±0.6*	*86.1±1.2*	*0*	*0.93*					
	10	53	3	2	8.4±0.1	10.8±0.5	77.5±1.7	32.2± 1.4	0.18					
	19	01	4	4	*58.5±0.1*	*−6.4±0.6*	*43.9±2.0*	*0*	*1.39*					
		25	4	4	12.7±0.4	8.7±1.3	79.3±2.6	9.5± 9.5	1.27	6.57±0.53	1.26			
	20	29	5	3	*34.0±0.3*	*−6.3±1.1*	*54.1±0.5*	*10.1± 5.2*	—	5.68±0.15	0.73	5.86±0.17	1.767±0.001	0.55
		31	4	4	1.2±0.3	9.3±1.3	85.6±2.9	12.4± 9.0	1.29			5.43±0.28	1.721±0.098	0.99
		56	5	5	*56.7±0.3*	*5.6±0.9*	*87.4±2.5*	*0*	*1.39*					
	21	38	5	3	*35.8±0.6*	*2.3±1.7*	*105.4±4.0*	*0*	*1.31*					
	22	37	4	3	*2.3±0.2*	*0.5±0.6*	*72.2±2.1*	*0*	*1.46*					
		40	**7**	**6**	*42.1±0.2*	*4.7±0.9*	*64.7±0.5*	*13.9± 2.0*	—	5.78±0.80	0.72	5.27±0.26	1.625±0.020	0.61
		43												
	23	02	4	3	*48.0±0.2*	*3.4±1.2*	*59.7±1.1*	*5*	*0.98*					
		04	5	3	6.1±0.8	1.4±2.3	65.5±3.5	27.1± 7.2	2.96					
		26	5	4	*38.1±0.4*	*7.7±1.1*	*89.2±3.2*	*5*	*1.64*					
		35	5	5	4.7±1.4	−5.4±3.3	71.2±1.8	20.2± 5.3	0.79	5.61±0.66	0.93			
		49	4	4	1.1±0.4	3.6±5.8	90.8±1.8	17.9± 9.1	0.80	5.97±0.21	0.95	5.84±0.48	1.691±0.034	1.13
		52	**6**	3	37.5±0.2	3.8±1.0	79.8±0.8	15.8± 3.4	1.11	6.13±0.15	1.05	5.72±0.33	1.638±0.033	0.81
24	00	22	4	4	53.8±0.3	4.0±1.7	64.2±1.5	15.4± 2.7	1.15	5.78±0.50	1.29	5.24±0.38	1.616±0.027	0.68
	02	18	4	4	1.5±0.3	−0.1±7.3	52.4±2.0	14.9±10.3	0.89					
		40	**6**	**6**	48.1±0.3	7.3±1.2	73.0±1.6	4.1± 8.4	1.26					
	04	40	5	4	10.7±0.7	−13.7±4.1	52.6±2.4	19.4± 8.6	2.35					
	05	**11**	**6**	**6**	41.7±0.3	−13.5±0.6	38.8±0.9	23.1± 4.0	1.22	6.18±0.11	1.06	6.20±0.58	1.736±0.038	1.15
		43	4	4	56.3±0.4	10.4±2.5	87.5±2.5	15.9± 4.0	1.39	5.31±0.59	1.45	4.94±0.07	1.605±0.015	0.18

(to be continued)

Table 3. (continued)

Date & Time d	h	m	Number of the Data P	S	I O.T.	x	y	z	$\hat{\sigma}_0$	II V_p	$\hat{\sigma}_0$	III V_p	V_p/V_s	$\hat{\sigma}_0$
					sec	km	km	km		km/s		km/s		
June 24	10	20	4	4	*36.1±0.7*	*−2.0±4.2*	*79.5±5.1*	*6.5±15.7*	—	5.45±0.39	1.55			
	11	45	4	4	*−3.6±0.3*	*−10.6±1.7*	*49.3±0.9*	*5*	*0.88*					
	14	05	5	3	*28.9±0.4*	*16.0±2.1*	*56.8±1.4*	*26.2± 1.2*	—	4.68±0.22	0.95	4.87±0.14	1.825±0.024	0.42
		09	4	4	50.5±0.6	1.4±2.0	75.8±2.5	21.5± 7.3	2.05	6.80±1.00	1.88	6.06±0.51	1.594±0.037	0.86
	15	40	4	4	*5.7±0.3*	*−4.2±1.6*	*41.0±0.5*	*11.3± 4.3*	—	5.88±0.21	0.75	5.87±0.45	1.729±0.035	0.92
	23	42	**7**	3	*58.5±0.7*	*22.9±6.8*	*91.3±3.5*	*23.1± 5.9*	—	6.65±0.43	2.96	6.11±0.72	1.623±0.042	2.92
		47	**7**	**6**	39.9±0.7	−7.2±6.3	58.5±1.8	4.6±32.2	2.49					
		48	**6**	3	6.4±0.3	16.4±3.9	43.6±0.9	25.8± 2.3	1.10	5.66±0.19	0.78	5.38±0.75	1.647±0.068	0.87
25	**00**	**43**	**7**	**6**	14.2±0.2	−16.9±1.3	49.8±1.3	20.8± 2.4	0.76	6.09±0.11	0.76	5.98±0.39	1.706±0.036	0.81
		46	5	5	17.4±0.3	6.8±1.0	74.0±2.0	9.5± 4.7	1.73	6.12±0.17	1.23			
		53	5	5	24.6±0.3	7.8±3.2	81.5±1.1	7.5±12.9	1.14					
		55	4	4	43.0±0.4	2.0±3.2	64.3±3.2	11.2± 5.6	1.80	4.84±0.17	0.67	4.93±0.26	1.766±0.021	0.74
	04	13	4	4	16.2±0.4	−3.8±2.1	46.3±1.5	17.2± 4.3	1.59	5.23±0.12	0.53	5.27±0.29	1.745±0.024	0.63
		37	4	4	*59.7±0.5*	*11.1±4.2*	*95.0±3.3*	*0*	*1.83*					
		59	4	4	53.4±0.4	−6.5±2.9	44.9±1.6	12.0± 6.0	1.82	4.99±0.65	1.42	4.18±0.75	1.588±0.053	1.11
	05	12	4	4	8.1±0.3	8.6±2.7	81.6±2.9	20.9± 3.4	1.16	4.78±0.65	1.09	4.44±0.33	1.604±0.016	0.53
		48	4	3	4.7±0.9	6.3±5.9	73.1±4.2	18.3± 5.4	2.27					
	06	28	5	3	42.1±0.1	−6.5±0.9	48.2±0.5	14.1± 2.1	0.61	6.48±0.34	0.52	6.34±0.60	1.710±0.040	0.61
	07	07	**6**	4	43.8±0.6	3.1±2.1	88.5±4.3	23.7± 9.8	1.85	6.30±0.20	1.42	5.71±0.59	1.611±0.033	1.38
		23	**6**	**6**	59.1±0.3	6.8±1.5	84.6±2.0	10.6± 6.9	1.58	5.87±0.22	1.65	5.28±0.39	1.606±0.028	1.42
	08	**10**	5	5	21.6±0.3	6.6±1.0	71.6±1.8	8.7± 6.3	1.46	5.96±0.22	1.60	5.79±0.44	1.694±0.029	1.77
		15	4	4	*37.8±0.2*	*2.4±1.1*	*53.7±1.0*	*14.5± 2.2*	—	5.57±0.15	0.61	5.69±0.43	1.766±0.037	0.71
		31	4	3	46.7±0.3	−6.2±1.1	46.2±1.7	32.0± 3.7	1.49	6.32±0.36	1.41	5.82±0.29	1.627±0.018	0.72

(to be continued)

Table 3. (continued)

Date & Time d	h	m	Number of the Data P	S	I O.T.	x	y	z	$\hat{\sigma}_0$	II V_p	$\hat{\sigma}_0$	III V_p	V_p/V_s	$\hat{\sigma}_0$
					sec	km	km	km		km/s		km/s		
June 25	09	21	5	3	21.3±0.2	−0.5±0.6	76.8±1.3	6.8± 8.1	1.12	6.04±0.18	1.28	5.85±0.39	1.686±0.028	1.41
	10	13	6	4	*42.5±0.4*	*12.3±1.3*	*90.0±2.5*	*0*	*1.83*					
		38	5	5	30.6±0.3	5.0±1.0	73.2±3.0	7.5±11.3	1.83	5.96±0.29	2.01	6.12±0.59	1.772±0.037	2.15
	11	19	6	5	34.8±0.3	5.4±0.9	91.5±2.4	17.5± 6.0	1.47	6.19±0.13	1.26	6.44±0.25	1.797±0.018	1.10
	13	24	5	4	*49.0±0.2*	*11.0±0.9*	*82.6±1.1*	*0*	*0.84*					
		30	5	5	35.0±0.6	7.9±3.0	72.0±5.6	12.2± 5.8	2.07	5.71±0.73	2.19	5.32±0.77	1.524±0.059	2.05
		44	6	6	*1.6±0.3*	*−14.6±1.5*	*71.7±1.4*	*0*	*1.08*					
	14	22	5	5	53.3±0.2	1.2±1.6	59.3±1.1	13.0± 3.2	1.23	5.91±0.34	1.35	6.00±0.60	1.758±0.038	1.50
		25	4	3	50.4±0.4	−4.8±5.9	54.1±1.8	13.4±11.8	1.60	5.35±0.35	1.26	4.50±0.20	1.526±0.018	0.33
	15	00	5	4	*17.0±0.8*	*−8.9±3.2*	*78.7±3.9*	*0*	*1.99*					
		20	6	6	12.6±0.4	−12.0±3.1	73.3±2.0	14.2± 8.2	1.72					
		56	7	5	32.3±0.3	−17.2±1.5	46.5±1.5	21.4± 4.7	2.15	6.16±0.22	2.15	5.67±0.82	1.632±0.063	2.26
	16	05	6	6	47.2±0.4	−5.0±3.6	70.2±1.9	13.6± 6.6	1.54					
		21	6	5	58.6±0.4	−18.8±2.9	46.3±1.2	10.9± 8.7	1.47					
		31	6	6	18.1±0.3	−10.7±2.6	73.1±1.7	9.8± 9.4	1.43					
		33	6	5	26.7±0.3	7.0±1.8	37.3±0.9	10.1± 2.8	1.61	6.01±0.44	1.74	5.26±0.92	1.563±0.071	1.84
		51	5	4	13.0±0.4	2.6±6.2	73.3±2.2	2.7± 5.3	1.68					
	17	18	6	6	58.1±0.5	−5.9±3.8	49.0±1.8	15.0± 8.1	2.68					
		19	7	5	*38.3±0.3*	*2.0±1.1*	*74.8±2.4*	*0*	*2.72*					
		03	7	5	14.4±0.4	−9.6±1.8	60.3±1.9	17.9± 5.6	2.44	6.19±0.24	2.48	6.05±0.87	1.704±0.062	2.68
		55	5	5	13.2±0.3	4.3±2.7	99.3±2.7	20.3± 7.1	1.62					
	18	14	5	5	44.4±0.2	12.3±1.3	87.9±2.1	17.2± 4.3	0.93					
		29	6	6	13.9±0.2	*1.1±0.8*	94.0±1.8	28.8± 3.3	1.27	6.30±0.07	0.66	6.39±0.18	1.752±0.012	0.68

(to be continued)

Table 3. (continued)

Date & Time d	h	m	Number of the Data P	S	I O.T.	x	y	z	$\hat{\sigma}_0$	II V_p	$\hat{\sigma}_0$	III V_p	V_p/V_s	$\hat{\sigma}_0$
					sec	km	km	km		km/s		km/s		
June 25	19	03	5	5	7.0±0.3	8.4±1.4	78.2±1.9	12.4± 4.6	1.61			5.79±0.43	1.701±0.031	1.86
		41	6	6	23.0±0.4	13.0±2.1	86.3±2.3	20.4± 4.9	1.82			5.58±0.42	1.617±0.030	1.71
	20	13	5	5	37.1±0.4	−4.8±3.0	54.8±1.5	14.1± 5.0	1.94					
	21	03	6	6	*32.4±0.4*	*4.0±1.3*	*68.5±1.9*	*5.9± 9.1*	—	5.89±0.15	1.61	5.85±0.47	1.722±0.033	1.74
		11	6	5	30.4±0.4	−4.1±1.9	74.8±1.7	9.2± 3.4	1.92	6.47±0.25	1.49	6.33±0.33	1.665±0.030	1.55
		20	5	5	*17.4±0.6*	*14.4±2.8*	*89.2±3.5*	*0*	1.94					
		57	7	7	27.8±0.3	6.3±0.8	74.6±1.5	8.8± 2.8	1.79	6.02±0.16	1.88	5.82±0.30	1.678±0.024	1.94
	22	08												
		23	6	6	29.6±0.2	10.4±0.8	87.5±1.3	16.9± 2.3	0.86	6.08±0.09	0.82	5.77±0.15	1.663±0.011	0.61
		40	6	5	38.6±0.6	9.2±2.9	70.3±3.3	14.9± 5.9	2.93	4.74±0.35	1.97	4.54±0.63	1.675±0.053	2.16
	23	00	8	8	53.3±0.3	−0.1±0.9	70.8±1.4	13.4± 3.3	2.09	6.34±0.19	1.85	6.31±0.40	1.722±0.026	1.94
		12	9	5	41.1±0.3	−11.9±1.0	57.2±1.2	21.2± 5.1	2.44	6.27±0.24	2.36	6.36±0.73	1.753±0.054	2.50
		17	5	5	10.4±0.3	13.7±4.0	105.0±2.5	22.0± 6.0	1.13					
		29	5	5	53.6±0.4	11.0±4.1	101.1±3.3	13.6±10.1	1.56					
		32	5	5	11.9±0.2	−5.5±1.0	28.2±0.7	13.4± 1.8	0.77	5.56±0.19	0.57	5.61±0.34	1.748±0.028	0.64
		58	8	4	36.0±0.4	−4.2±1.4	67.5±2.2	18.5± 6.5	2.68	6.32±0.24	2.38	6.49±0.72	1.775±0.042	2.57
26	00	10	9	3	50.1±0.5	−4.8±1.4	47.0±1.6	23.0± 6.4	2.77	6.42±0.66	2.80			
		48												
		55	6	6	22.4±0.3	−8.9±1.7	71.6±1.5	14.5± 4.6	1.09	5.51±0.55	1.14	5.04±0.70	1.632±0.026	1.13
		56	7	6	*34.7±0.6*	*−1.4±1.9*	*49.0±1.6*	*14.4± 5.8*	—	5.83±0.27	2.62	5.63±0.76	1.679±0.063	2.80
		57	7	6	36.9±0.3	−15.4±1.4	43.2±1.6	21.0± 4.4	1.75	5.91±0.17	1.82	5.69±0.78	1.682±0.065	1.96
	01	21	5	5	8.3±0.4	16.7±2.3	85.4±2.9	17.3± 4.0	1.57		1.75	4.04±0.85	1.518±0.049	1.31
	02	01	6	5	53.5±0.5	−10.3±1.8	53.0±2.2	21.9± 7.2	2.22	6.12±0.26	2.23	4.96±1.00	1.495±0.074	2.10

(to be continued)

Table 3. (continued)

Date & Time d	h	m	Number of the Data P	S	I O. T.	x	y	z	$\hat{\sigma}_0$	II V_p	$\hat{\sigma}_0$	III V_p	V_p/V_s	$\hat{\sigma}_0$
					sec	km	km	km		km/s		km/s		
June 26	04	56	6	5	4.0±0.3	1.4±1.44	58.2±1.6	13.3± 4.1	1.72					
	05	47	5	5	2.1±0.3	3.1±1.2	92.4±2.8	20.5± 6.0	1.62	6.31±0.24	1.33	6.03±0.33	1.663±0.036	1.21
	14	26	6	5	17.0±0.3	−4.0±2.0	45.4±1.0	10.3± 4.6	1.56	5.81±0.41	1.67	5.71±0.94	1.705±0.067	1.83
	16	02	7	7	19.3±0.1	−7.3±0.5	38.1±0.6	12.3± 2.8	1.10	5.96±0.11	1.16	5.89±0.31	1.714±0.035	1.20
		53	7	7	4.2±0.4	3.3±1.7	79.1±2.2	13.0± 5.9	1.79	6.23±0.23	1.87	6.35±0.24	1.763±0.001	1.84
	18	20	6	5	20.2±0.3	−12.5±1.8	69.4±1.2	22.4± 2.7	0.87	6.49±0.55	0.87	6.62±0.18	1.794±0.044	0.81
	20	41	6	5	*23.9±0.7*	*13.4±4.0*	*98.9±3.8*	*5*	*2.23*					
	21	13	6	5	9.9±0.3	−7.2±0.8	69.3±1.3	16.9± 4.4	1.51	6.26±0.08	0.61	6.23±0.19	1.724±0.015	0.67
		21	5	5	*36.7±0.5*	*10.5±2.1*	*86.5±3.0*	*5*	*1.81*					
		30	4	4	43.0±0.4	−5.2±2.6	50.9±1.5	13.8± 5.0	1.78					
	22	10	5	4	34.3±0.2	−6.8±0.9	44.3±0.6	17.6± 1.7	0.73	5.74±0.42	0.79	5.50±0.66	1.688±0.034	0.89
		11	5	4	21.0±0.2	3.1±1.6	75.4±1.4	11.6± 4.0	1.21					
		23	7	4	49.2±0.3	−0.1±1.0	64.8±1.5	14.4± 4.1	1.83	6.27±0.22	1.71	6.44±0.39	1.781±0.028	1.77
		42												
		56												
	23	19	8	5	35.6±0.5	14.4±5.6	105.8±2.6	12.7±10.4	1.84	5.74±0.36	1.96	5.59±0.50	1.646±0.063	2.04
		59												
27	00	19	7	7	57.3±0.4	9.4±2.8	82.7±1.6	17.2± 5.1	2.51	5.93±0.26	2.64	5.71±0.73	1.683±0.051	2.82
		20	8	8	57.6±0.2	−2.9±1.6	75.7±0.8	18.0± 3.5	1.36	5.90±0.16	1.40	5.67±0.50	1.684±0.035	1.46
		23	7	7	28.9±0.4	−3.1±2.8	75.6±2.1	19.5± 5.3	2.11	6.24±0.89	2.23			
		29	5	5	58.5±0.4	9.2±3.1	75.5±2.6	15.0± 3.6	1.84	6.38±1.00	1.98	5.77±0.85	1.553±0.039	1.60
		36	6	5	16.3±0.3	−4.0±2.2	50.2±1.1	16.2± 3.3	1.53	6.38±0.67	1.60			
		50	6	6	23.6±0.4	−0.9±2.8	75.9±1.2	24.2± 4.0	1.98	5.98±0.25	2.11	6.19±0.95	1.774±0.058	2.23

(to be continued)

Table 3. (continued)

Date & Time d	h	m	Number of the Data P	S	I O. T.	x	y	z	$\hat{\sigma}_0$	II V_p	$\hat{\sigma}_0$	III V_p	V_p/V_s	$\hat{\sigma}_0$
					sec	km	km	km		km/s		km/s		
June 27	01	20	5	4	42.1±0.4	11.6±3.6	103.4±3.2	21.9± 6.0	1.43					
		34	**6**	3	17.7±0.3	−4.5±1.8	39.9±0.8	9.7± 4.2	1.45	5.55±0.42	1.45	5.04±0.71	1.630±0.045	1.48
		50												
	02	19	5	3	33.7±0.3	−13.7±1.8	43.0±0.9	19.0± 3.2	1.33	5.70±0.60	1.47	4.77±0.36	1.552±0.022	0.68
		27												
		28	**7**	**7**	20.3±0.3	7.8±1.2	78.0±1.6	17.8± 2.8	1.33			6.27±0.39	1.760±0.039	1.41
		29	5	4	14.2±0.6	−4.9±4.6	67.1±3.2	9.2±12.5	2.12					
		31	5	4	10.5±0.1	−11.8±0.4	63.7±0.9	19.0± 2.5	0.96	6.11±0.56	0.64	5.97±0.15	1.704±0.010	0.63
		40												
		51	4	4	6.4±0.5	0.6±3.5	77.3±3.7	11.8± 7.1	1.53	5.43±0.83	1.74	4.97±0.57	1.567±0.050	1.09
		56	5	5	34.4±0.3	10.7±2.5	83.6±2.1	21.2± 2.6	1.17	6.34±0.76	1.27	5.95±0.81	1.644±0.035	1.20
	03	16	5	5	*59.1±0.4*	*0.9±6.1*	*61.7±4.1*	*17.3± 6.5*	—	5.68±0.55	1.42	4.84±0.75	1.533±0.047	1.26
		43	5	5	22.2±0.4	1.5±2.3	65.1±1.5	14.9± 3.2	1.31	5.38±0.52	1.32	5.00±0.70	1.641±0.050	1.24
	04	03	5	4	29.3±0.4	−6.8±3.2	78.6±2.5	10.5±11.6	2.14	5.51±0.99	2.37			
		06	**6**	5	21.5±0.4	−8.7±3.1	72.5±2.3	28.0± 3.8	1.43	4.76±0.41	1.29	4.40±0.52	1.613±0.039	1.19
		15	5	5	57.9±0.3	−13.0±2.5	55.0±1.2	21.8± 4.7	1.00	5.27±0.28	0.81	4.62±0.66	1.579±0.064	0.75
		28	5	4	42.7±0.3	3.4±1.8	78.1±1.7	18.1± 3.1	1.23	5.31±0.37	1.03	5.14±0.61	1.695±0.026	1.18
	05	**19**	**6**	**6**	35.6±0.5	−14.6±3.6	51.3±1.9	23.8± 5.6	2.26					
		41	**6**	**6**	23.0±0.4	−1.7±2.5	67.5±1.9	21.3± 3.8	1.75	5.25±0.68	1.73	4.66±0.71	1.584±0.043	1.64
	06	**00**	**6**	5	17.4±0.6	−13.3±4.5	48.2±2.4	11.8±13.4	2.20	4.73±0.49	1.97	3.92±0.75	1.506±0.078	1.86
		29	**6**	5	54.1±0.9	−4.5±5.9	101.4±6.0	19.0±15.5	3.00					
	07	19	4	3	15.1±0.3	5.1±3.2	80.0±2.5	17.3± 3.0	1.04					
	08	**54**	5	5	*3.6±0.7*	*−0.4±2.8*	74.4±3.3	*5*	*2.45*					

(to be continued)

Table 3. (continued)

Date & Time d	h	m	Number of the Data P	S	I O.T.	x	y	z	$\hat{\sigma}_0$	II V_p	$\hat{\sigma}_0$	III V_p	V_p/V_s	$\hat{\sigma}_0$
					sec	km	km	km		km/s		km/s		
June 27	**09**	**03**	5	5	*17.9±0.3*	*−2.5±1.3*	*69.4±1.4*	*5*	*0.91*					
		49	5	4	51.0±0.8	10.4±4.1	74.3±3.2	19.8±5.4	2.25					
	11	16	**6**	4	*56.3±0.3*	*6.7±1.2*	*92.1±1.8*	*5*	*1.13*					
	12	22	5	4	*56.8±0.4*	*−6.6±2.6*	*58.1±1.7*	*5*	*1.92*					
		40	**7**	**6**	*45.3±0.6*	*17.8±2.0*	*85.0±4.0*	*5*	*2.39*					
	14	44	**6**	4	*49.6±0.9*	*17.0±2.7*	*88.9±5.8*	*5*	*1.95*					
	19	55	4	4	18.8±0.4	−12.2±2.5	57.4±1.6	15.7±6.3	1.49					
	21	03	7	3	42.5±0.3	−17.2±0.5	42.0±1.2	20.8±4.1	1.11					
	23	43	4	4	5.7±0.3	−11.7±1.3	46.7±1.6	17.3±5.4	1.60	5.90±0.18	1.66	6.04±0.87	1.764±0.073	1.95
		56	**6**	3										
28	**00**	**00**	**8**	**7**	9.9±0.7	−0.2±2.3	84.7±3.4	21.3±8.7	2.47	6.18±0.34	2.46			
		01	**8**	5	*51.9±0.6*	*8.4±1.4*	*87.5±3.8*	*5*	*2.35*					
	01	01												
		25	**7**	**6**	*19.8±0.9*	*6.5±2.8*	*84.7±6.9*	*30.8±5.8*	—	5.27±0.39	2.03			
	02	08	**6**	3	31.0±0.5	−11.1±1.7	51.6±2.3	16.3±9.1	2.34	5.48±0.35	2.07			
		42												
		57												
		36	5	4	*35.5±0.7*	*3.3±1.9*	*62.2±3.3*	*22.3±4.0*	—	4.54±0.25	2.01			
	04	**51**	**6**	5	*15.0±0.4*	*10.0±1.5*	*69.0±2.7*	*20.8±2.9*	—	5.45±0.24	1.46	5.56±0.68	1.766±0.062	1.60
		52	**6**	5	11.7±0.4	−5.0±1.7	56.0±1.5	23.5±3.9	1.52	5.56±0.15	1.01	5.03±0.51	1.605±0.051	0.94
	05	06	5	4	*13.1±0.5*	*5.8±1.4*	*62.2±2.2*	*15.8±3.7*	—	—	—	4.26±0.38	1.556±0.036	0.97
		13	4	3	*7.9±0.4*	*−8.6±2.2*	*74.7±1.8*	*5*	*1.01*					
		28	**7**	**6**	37.0±0.2	4.8±0.6	86.1±1.2	*18.4±2.8*	0.82	6.10±0.11	0.81	6.13±0.26	1.739±0.038	0.85

(to be continued)

Table 3. (continued)

Date & Time d	h	m	Number of the Data P	S	I O. T.	x	y	z	$\hat{\sigma}_0$	II V_p	$\hat{\sigma}_0$	III V_p	V_p/V_s	$\hat{\sigma}_0$
					sec	km	km	km		km/s		km/s		
June 28	05	38	5	4	*10.8±0.6*	*7.9±1.8*	*61.5±4.3*	*15.3± 6.3*	—	4.89±0.31	1.26			
	06	**53**	**6**	**6**	*59.7±0.4*	*−8.9±2.2*	*39.3±1.8*	*26.9± 3.6*	—	5.51±0.24	1.85			
		58	**6**	4	*30.9±0.3*	*−9.4±1.6*	*47.5±1.1*	*23.1± 7.8*	—	5.65±0.19	1.12	5.83±0.68	1.775±0.034	1.19
	07	51	**6**	3	*57.5±0.5*	*−6.5±1.6*	*61.2±3.6*	*5*	*2.14*					
	10	06	5	4	*33.8±0.7*	*9.9±1.9*	*91.5±4.4*	*5*	*1.81*					
	16	46	4	3	12.1±0.3	−14.6±2.2	42.7±3.9	16.1± 6.8	0.89					
		56	5	3	0.6±0.3	−0.1±0.9	68.6±0.6	19.8±22.3	0.58	6.07±0.26	0.65			
	17	**33**	**7**	5	1.3±0.3	−10.1±0.7	61.0±1.7	25.6± 4.8	1.34	6.22±0.12	0.99	6.23±0.46	1.734±0.039	1.07
	18	54	4	3	6.3±0.3	−6.9±2.1	44.7±4.0	8.3±12.2	0.85					
	19	46	5	4	*10.3±0.8*	*−21.1±7.3*	*86.9±6.3*	*12.6±11.2*	—	—	—	6.84±0.56	1.619±0.015	0.59
	21	23	4	3	*1.0±0.4*	*−13.9±1.8*	*59.7±1.8*	*5*	*1.15*					
	22	00	5	3	52.1±0.2	6.6±1.5	68.8±3.8	32.1± 5.3	0.67	5.98±0.18	0.77			
		26	4	3	45.4±0.3	5.6±1.6	54.1±1.0	26.1± 2.1	0.65	5.43±0.41	0.72	5.28±1.11	1.693±0.084	1.01
		34	5	4	19.2±0.3	−3.7±1.3	31.5±1.0	22.1± 2.1	0.78	5.76±0.43	0.78	5.79±0.74	1.740±0.034	0.89
		43	5	4	33.5±0.5	−3.1±4.7	99.3±3.0	12.5±12.4	1.42					
	23	**04**	**6**	5	*48.6±0.2*	*−8.5±1.4*	*49.2±1.1*	*5*	*1.40*					
		39	**7**	**6**	*9.4±0.4*	*−4.8±1.0*	*79.3±2.7*	15.2	*2.53*					
29	01	06	5	3	*10.4±0.6*	*−12.0±3.5*	*58.8±2.2*	*5*	*2.20*					
		10												
	02	04	5	4	30.5±0.4	8.0±1.7	76.8±2.1	18.4± 3.2	1.07	5.95±0.32	1.21	5.51±0.55	1.606±0.061	1.04
	05	41	**6**	3	47.6±0.4	−7.4±1.0	65.2±1.8	17.1± 6.8	1.85	6.15±0.30	1.97	5.91±0.84	1.673±0.070	2.15
		54	5	4	43.4±0.7	−12.5±4.3	64.6±3.0	7.4±23.3	2.51					
	06	28	5	3	39.5±0.7	6.8±3.1	95.9±3.2	18.0± 6.2	2.13					

(to be continued)

Table 3. (continued)

Date & Time d	h	m	Number of the Data P	S	I O. T.	x	y	z	$\hat{\sigma}_0$	II V_p	$\hat{\sigma}_0$	III V_p	V_p/V_s	$\hat{\sigma}_0$
					sec	km	km	km		km/s		km/s		
June 29	07	04	4	4	*54.5±0.7*	*9.8±3.9*	*85.4±3.3*	*5*	*2.02*					
	09	42	5	3	*28.4±0.5*	*7.9±1.3*	*83.7±3.8*	*3.0*	*2.10*					
		50	**8**	**3**	20.9±0.3	−14.3±0.7	48.6±1.1	20.6±4.4	1.56	6.30±0.24	1.38			
	11	48	5	4	33.4±0.4	34.4±3.7	76.6±2.4	23.3±2.2	1.31	5.64±0.38	1.27	5.46±0.33	1.589±0.030	0.92
	12	08	4	3	40.4±0.4	13.3±3.3	88.5±3.9	11.7±9.4	1.18					
		54	5	4	2.3±0.3	−0.2±1.4	73.4±1.3	9.6±5.3	0.96					
	13	22	4	3	*47.3±0.4*	*3.6±2.1*	*83.5±2.3*	*5*	*0.83*					
		58												
	15	**04**	**7**	**6**	2.0±0.2	−9.2±0.7	57.7±0.8	21.8±2.0	0.87	6.01±0.11	0.91	5.48±0.21	1.612±0.030	0.58
		21	**8**	**6**	*21.5±0.6*	*19.4±2.3*	*109.0±3.5*	*5*	*2.02*					
		45	5	3	56.0±0.5	−6.2±2.9	47.1±1.7	14.2±6.4	1.75					
		56	5	4	50.4±0.3	12.0±1.2	76.0±1.8	18.6±2.0	0.88	5.91±0.56	0.97	5.98±0.72	1.764±0.036	1.14
	17	08	**7**	4	17.7±0.3	−8.0±1.7	57.8±1.6	21.0±3.0	1.21	5.85±0.27	1.29			
	18	04	**6**	4	*21.7±0.4*	*−4.8±0.8*	*38.2±0.8*	*13.7±3.0*	—	5.91±0.17	1.30	5.94±0.35	1.741±0.035	1.44
		08	5	3	48.9±0.1	0.1±1.0	91.4±1.2	18.2±2.8	0.58	5.85±0.51	0.66	5.77±0.57	1.700±0.033	0.69
		19	**8**	**6**	37.7±0.3	−3.8±1.0	45.2±1.3	13.1±5.4	2.24					
		29	**6**	5	14.9±0.5	16.7±4.5	122.9±4.1	9.1±5.7	1.86					
		58	**6**	3	31.2±0.3	−8.6±2.3	68.1±1.4	21.1±5.1	0.83	5.83±0.27	0.83	5.98±0.72	1.778±0.072	0.97
	19	**15**	**7**	5	42.6±0.5	17.5±1.9	85.7±3.4	15.4±5.1	2.07	5.70±0.26	1.85	5.73±0.51	1.741±0.034	2.01
	19	53	5	3	*24.5±0.4*	*0.0±0.6*	*50.3±3.0*	*20.4±3.9*	—	5.35±0.54	1.43	4.83±0.47	1.582±0.047	0.92
	20	12	**7**	4	17.4±0.3	−7.6±1.4	45.5±1.1	22.3±2.8	1.39	5.74±0.20	1.20	5.87±0.66	1.763±0.035	1.27
		24	**6**	3	31.6±0.4	−7.1±3.2	45.2±1.2	12.4±4.9	1.45	6.02±0.65	1.62	5.78±1.27	1.661±0.100	1.87
	21	48	**7**	4	57.2±0.3	−1.3±1.7	52.2±1.3	17.0±3.3	1.56	5.82±0.27	1.56	5.63±0.44	1.682±0.032	1.74

(to be continued)

Table 3. (continued)

Date & Time d	h	m	Number of the Data P	S	I O. T.	x	y	z	$\hat{\sigma}_0$	II V_p	$\hat{\sigma}_0$	III V_p	V_p/V_s	$\hat{\sigma}_0$
					sec	km	km	km		km/s		km/s		
June 29	22	10	9	8	17.7±0.3	1.3±0.8	78.3±1.7	13.6± 4.8	1.54	5.93±0.14	1.60	5.46±0.27	1.615±0.030	1.28
		18	8	7	18.4±0.4	6.1±2.5	96.1±2.7	10.4±10.6	1.78					
		21	4	3	*22.1±0.4*	*7.7±2.7*	*89.7±2.3*	*5*	*1.05*					
		50	7	5	40.8±0.3	6.3±1.6	83.9±1.9	20.1± 3.0	1.20	5.39±0.17	0.81	5.27±0.33	1.699±0.028	0.85
	23	11	9	5	*6.1±0.4*	*12.0±1.0*	*88.6±2.5*	*5*	*1.95*					
		37	5	5	26.7±0.5	−9.9±2.2	39.2±2.1	29.0± 5.2	1.43	7.70±1.18	1.12			
30	00	05	5	5	*11.3±0.4*	*1.2±0.9*	*41.0±0.9*	*15.8± 3.8*	—	5.43±0.18	1.05			
	00	30	5	3	*47.4±0.8*	*13.4±3.5*	*87.0±5.0*	*5*	*1.32*					
		59												
	01	04	5	3	*0.6±0.6*	*11.7±1.6*	*89.4±4.1*	*5*	*1.62*					
		08	6	4	*8.0±0.8*	*4.4±3.0*	*48.2±2.4*	*17.6± 5.3*	—	5.08±0.44	2.88			
		28	5	1	56.0±0.1	17.0±0.4	89.1±0.8	10.2± 1.4	0.30					
		53	5	5	40.7±0.3	−2.3±1.7	41.5±1.1	18.2± 3.0	1.28	5.71±0.32	1.21	6.06±0.77	1.821±0.037	1.30
	02	07	6	3	*3.7±0.3*	*6.7±1.2*	*70.0±1.6*	*5*	*1.03*					
		15	5	4	*46.0±0.6*	*13.3±3.1*	*86.6±3.6*	*5*	*1.63*					
	03	29	6	5	41.7±0.6	−8.6±2.3	65.4±2.5	12.0±10.9	1.94	6.07±0.37	2.09			
		41	5	4	46.5±0.6	11.9±2.5	84.9±3.7	10.7± 7.6	1.65	5.88±0.76	1.82			
	04	28	5	5	*13.8±0.3*	*8.4±1.3*	*80.6±2.2*	*5*	*1.00*					
		32	5	4	1.2±0.2	−2.7±1.1	44.1±0.6	11.6± 2.6	0.78	5.65±0.22	0.76	5.54±0.47	1.703±0.032	0.86
		48	6	6	*1.8±0.5*	*7.0±1.1*	*59.8±1.5*	*17.8± 3.8*	—	5.60±0.19	1.59	5.41±0.65	1.681±0.059	1.67
		50	6	3	*55.4±0.3*	*−2.6±2.0*	*38.7±1.1*	*3.2*	*1.86*					
	05	37	5	4	24.4±0.4	−10.5±2.1	51.9±1.3	22.9± 4.7	1.33	6.47±0.38	1.22			
	06	08	5	3	6.3±0.1	1.8±0.4	62.5±1.0	13.0± 3.4	0.49	6.07±0.04	0.40	6.04±0.22	1.726±0.015	0.50

(to be continued)

Table 3. (continued)

Date & Time d	h	m	Number of the Data P	S	I O.T.	I x	I y	I z	I $\hat{\sigma}_0$	II V_p	II $\hat{\sigma}_0$	III V_p	III V_p/V_s	III $\hat{\sigma}_0$
					sec	km	km	km		km/s		km/s		
June 30	06	50	**7**	**1**	24.4±0.3	−3.8±0.7	44.5±0.9	22.4± 3.6	1.31					
		54	5	4	41.7±0.5	−5.8±3.1	52.6±2.8	26.4± 6.2	1.35	6.30±0.60	1.54			
	08	56	**6**	4	37.2±0.3	−2.0±1.3	53.7±1.3	14.8± 2.8	1.15	5.72±0.16	0.85	5.47±0.39	1.665±0.030	0.84
	09	36	8	3	*2.5±0.5*	*9.8±1.7*	*82.7±4.0*	*5*	*2.93*					
		40	5	4	*15.9±0.6*	*−13.6±2.6*	*40.7±3.9*	*21.4± 8.7*	—	6.04±0.44	1.57			
		40	**7**	**6**	*59.4±0.4*	*9.3±1.5*	*61.8±2.6*	*24.9± 2.0*	—	5.06±0.20	1.57	5.00±0.50	1.714±0.050	1.69
	10	**06**	**7**	**6**	35.9±0.5	−6.9±1.9	51.9±1.8	23.4± 7.5	2.32	6.40±0.53	2.38	6.71±0.81	1.819±0.045	2.38
	11	00	**7**	4	19.0±0.5	14.4±2.2	84.3±3.7	35.9± 4.0	1.97	6.40±0.37	1.96	6.65±0.66	1.808±0.044	1.94
		04	5	4	24.2±0.6	6.4±2.9	66.7±2.7	20.1± 5.0	2.20					
	13	39	**6**	2	*41.2±0.5*	*13.8±1.8*	*83.3±3.9*	*5*	*2.68*					
	17	24	5	4	21.2±0.2	−6.8±0.7	61.8±1.0	14.7± 2.7	0.82	6.02±0.11	0.91	6.15±0.34	1.764±0.038	0.97
	19	*17*	**8**	**7**	34.1±0.3	10.4±1.0	94.3±2.1	20.9± 4.9	1.38	6.17±0.15	1.30	6.37±0.28	1.782±0.041	1.21
		24	5	2	42.1±0.1	−10.3±0.6	32.6±0.3	11.9± 1.0	0.21	5.97±0.14	0.26	5.85±0.27	1.703±0.034	0.26
		45	**8**	4	19.2±0.4	−0.03±1.3	64.3±2.3	8.6± 9.3	1.94	6.30±0.24	1.73			
		51	5	2	32.8±0.2	30.7±1.2	73.4±1.4	15.0± 1.8	0.71	6.22±0.50	0.82	6.20±0.73	1.694±0.077	1.15
	20	11	**7**	4	6.0±0.2	−2.7±0.8	44.9±0.7	18.1± 2.5	1.07	6.14±0.11	0.97	6.46±0.42	1.807±0.042	1.07
		52	**6**	3	28.2±0.4	4.3±3.6	76.5±2.2	24.8± 5.5	1.12	6.33±0.52	1.15	5.97±0.57	1.619±0.036	0.99
		59	**8**	1	43.6±0.7	10.9±1.7	98.3±4.1	14.5± 8.0	1.82					
	21	10	**6**	3	31.9±0.5	−8.7±3.3	57.2±2.5	18.8±10.2	2.06					
		18	**7**	2	38.9±0.4	6.8±1.1	73.2±2.3	12.6± 5.3	1.59					
		40	**6**	5	22.7±0.4	14.3±2.2	82.9±3.0	21.1± 3.5	1.43	5.58±0.28	1.26			
		45	5	3	54.1±0.4	7.6±2.1	69.2±2.5	20.9± 3.0	1.58					
	22	38	5	4	23.2±0.7	−7.9±5.4	43.0±2.2	30.5± 7.1	2.28					

(to be continued)

Table 3. (continued)

Date & Time d	h	m	Number of the Data P	S	I O.T.	I x	I y	I z	I $\hat{\sigma}_0$	II V_p	II $\hat{\sigma}_0$	III V_p	III V_p/V_s	III $\hat{\sigma}_0$
					sec	km	km	km		km/s		km/s		
June 30	23	11												
		45	7	5	47.9±0.4	−3.6±2.0	57.6±1.8	3.7±21.1	2.24	5.93±0.32	2.39	5.64±0.80	1.647±0.064	2.64
July 01	00	01	5	5	19.1±0.5	17.6±2.5	53.9±2.0	17.9± 3.0	2.59	6.50±0.65	2.58	5.69±0.12	1.567±0.088	2.80
		34	6	6	55.7±0.5	14.9±3.3	76.1±2.9	26.5± 3.1	2.39	4.38±0.19	1.07	4.24±0.31	1.685±0.025	1.11
	01	03	4	4	21.7±0.5	10.8±5.1	69.6±2.9	29.4± 3.3	1.56					
		09	4	4	35.1±0.1	19.9±1.7	70.0±1.8	28.3± 2.2	0.28					
		18	6	6	31.9±0.5	11.4±2.9	94.7±3.6	35.9± 4.9	2.85	6.16±0.36	2.97			
		43	4	4	1.4±0.4	13.0±8.4	81.4±3.7	29.9± 6.0	1.19	5.14±0.55	1.04	5.44±0.76	1.817±0.041	1.08
	02	04	7	6	*1.8±0.3*	*1.9±1.1*	*98.3±1.9*	*3.3*	*1.26*					
		24												
		39	6	5	22.8±0.3	2.1±1.2	98.4±1.7	26.9±3.9	2.20					
	03	06	5	5	*33.0±0.7*	*−10.5±3.1*	*86.2±4.2*	*0*	*2.94*					
		35	7	7	10.1±0.4	2.8±2.0	94.0±2.5	41.8± 3.4	1.98	6.08±0.27	2.06	6.11±0.66	1.738±0.041	2.18
	05	40	5	5	22.7±0.3	5.0±1.5	45.7±1.3	24.4± 1.7	1.11	5.68±0.16	0.81	5.95±0.46	1.806±0.037	0.81
	06	10												
		54	6	5	3.3±0.2	−10.3±0.7	45.2±0.8	17.8± 3.6	1.43	6.07±0.18	1.50	6.18±0.53	1.757±0.037	1.62
		55	4	4	43.3±0.1	5.8±0.6	78.9±1.0	18.5± 1.8	0.66	5.90±0.06	0.53	5.85±0.17	1.721±0.014	0.64
	08	02												
		28	4	4	39.1±0.3	22.3±4.8	75.7±2.0	26.2± 1.7	1.06	5.94±0.80	1.22	5.93±1.00	1.698±0.041	1.49
	11	59	6	4	51.2±0.3	−7.4±2.3	59.0±1.5	26.5± 3.2	1.73	5.40±0.41	1.62	6.16±0.46	1.979±0.030	1.05
	12	17	6	4	30.9±0.5	−5.3±3.9	89.4±2.8	34.0± 4.9	1.85	5.84±0.87	2.02			
	15	03	6	5	35.6±0.5	−8.0±1.5	48.2±2.3	25.7± 5.7	2.94					
	17	36	6	5	*49.5±0.4*	*7.8±2.5*	*62.5±3.4*	*18.1± 2.7*	—	5.41±0.36	1.64	5.26±0.55	1.684±0.040	1.74

(to be continued)

Table 3. (continued)

Date & Time d	h	m	Number of the Data P	S	I O.T.	I x	I y	I z	I $\hat{\sigma}_0$	II V_p	II $\hat{\sigma}_0$	III V_p	III V_p/V_s	III $\hat{\sigma}_0$
					sec	km	km	km		km/s		km/s		
July 01	17	59	**6**	**2**	15.6±0.3	−5.7±2.3	42.3±0.9	15.6±3.1	1.39	5.45±0.29	1.11	6.23±0.67	2.051±0.068	1.06
	18	23	4	4	8.5±0.2	−2.5±1.1	44.3±0.7	15.8±1.7	0.89	5.15±0.56	0.84	5.26±0.74	1.768±0.036	0.98
	21	**21**	**6**	**6**	21.2±0.4	2.4±2.8	63.5±2.1	20.1±4.0	2.47	5.17±0.41	2.20			
		37	4	4	34.4±0.5	10.9±0.9	80.0±2.9	26.3±5.0	1.63	4.86±0.10	0.32	4.78±0.16	1.706±0.014	0.35
		39	5	5	*46.3±0.5*	*18.9±1.7*	*42.1±0.8*	*17.1±1.8*	—	4.01±0.22	2.17			
	22	**31**	**6**	**5**	18.6±0.3	9.3±1.2	86.8±1.9	11.5±5.5	1.18					
	23	07												
		13	5	4	*47.5±0.1*	*37.2±0.5*	*15.0±0.5*	*4.0±3.3*	—	5.47±0.11	0.57	5.21±0.33	1.669±0.027	0.60
		17	5	5	41.3±0.1	2.2±0.5	55.6±0.7	14.0±1.5	0.83	5.86±0.07	0.62	5.86±0.20	1.732±0.046	0.69
		32												
02	00	32	4	3	59.4±0.7	8.6±3.2	60.2±2.6	28.1±5.3	2.29	5.09±0.21	1.03	5.63±0.02	1.906±0.001	0.03
		40	4	2	*55.2±0.1*	*18.7±5.3*	*27.5±0.6*	*0*	*1.01*					
	01	13	5	4	3.9±0.2	−15.7±1.5	37.4±0.9	22.7±2.1	1.01	6.05±0.45	1.14	5.69±0.69	1.665±0.037	1.24
		23	**6**	**6**	51.9±0.5	23.3±4.3	93.0±3.5	44.8±3.2	2.17					
		42	5	4	9.0±0.7	−9.9±5.2	33.1±2.7	17.5±5.8	2.82	4.80±0.74	2.64			
		43	5	2	*25.1±0.6*	*15.3±3.2*	*51.0±2.3*	*19.4±2.8*	—	4.00±0.36	2.00	4.18±0.91	1.810±0.010	2.81
	02	04	5	4	34.9±0.5	−9.8±5.0	45.9±2.2	19.2±7.5	2.13	5.81±0.78	2.35			
		18	5	3	*52.7±0.4*	*−1.9±3.7*	*116.5±2.3*	*0*	*1.70*					
		24	5	3	*58.2±0.8*	*16.0±2.9*	*45.1±4.5*	*18.2±3.0*	—	4.48±0.32	2.43	4.46±0.48	1.715±0.078	2.99
		36	4	3	*8.7±0.2*	*−10.2±1.0*	*43.1±1.0*	*0*	*0.71*					
		42	**6**	**6**	8.4±0.7	14.6±3.9	80.1±4.3	27.4±4.5	3.01	4.94±0.24	1.88	4.98±0.51	1.745±0.044	2.02
	03	43	**6**	4	*51.7±0.7*	*6.2±4.8*	*42.4±2.2*	*2.3±2.8*	—	4.47±0.60	2.83			
		53	**6**	5	*56.7±0.5*	*10.8±2.7*	*53.8±2.2*	*21.3±1.7*	—	4.65±0.32	1.71			

(to be continued)

Table 3. (continued)

Date & Time			Number of the Data		I					II		III		
d	h	m	P	S	O. T.	x	y	z	$\hat{\sigma}_0$	V_p	$\hat{\sigma}_0$	V_p	V_p/V_s	$\hat{\sigma}_0$
					sec	km	km	km		km/s		km/s		
July 02	04	01	6	6	*59.8±0.4*	*18.8±1.6*	*58.0±3.0*	*26.9±1.9*	—	4.33±0.29	2.22	4.58±0.46	1.844±0.044	2.28
		46	5	3	11.4±0.3	1.0±2.4	64.8±1.4	18.0±2.3	0.95	5.32±0.19	0.51	5.28±0.32	1.713±0.036	0.62
		58	6	4	21.4±0.4	3.8±2.6	103.8±2.9	21.0±6.7	1.46					
	05	39	5	4	45.3±0.5	−5.6±3.2	61.4±2.8	22.1±5.0	2.43					
	06	18	5	4	10.2±0.1	−11.7±1.0	65.1±0.9	21.2±1.9	1.73	5.55±0.62	0.69	5.30±0.31	1.634±0.011	0.33
		27	5	5	12.6±0.2	6.1±1.2	67.7±1.3	9.0±3.4	1.08					
	11	17	6	5	*13.0±0.4*	*4.1±1.7*	*73.2±2.2*	*5*	*1.51*					
		56	4	4	41.3±0.2	−11.5±2.9	42.9±0.9	27.6±3.1	0.74	6.37±0.36	0.67			
	12	32	5	5	36.2±0.4	−0.4±2.5	58.8±1.4	19.7±2.8	1.37	5.43±0.68	1.46			
	18	15	5	4	50.0±0.6	1.2±3.2	51.6±1.8	26.8±4.2	2.18					
		53												
	21	26	5	5	8.9±0.4	4.4±2.5	56.0±1.8	26.9±3.0	2.09	5.90±0.91	2.27			
03	04	46	5	1	*9.1±0.9*	*5.2±4.6*	*32.9±1.7*	*16.6±4.2*	—	5.56±0.74	2.03			
	11	47	7	3	22.0±0.5	7.9±1.3	86.3±2.7	41.6±3.0	1.24	6.07±0.26	1.34	6.01±0.65	1.716±0.036	1.53
	12	46	5	5	6.0±0.5	1.3±2.9	30.5±1.6	17.5±3.0	1.96	5.86±0.76	2.12			
		58	5	3	33.4±0.2	0.9±1.0	34.8±0.8	24.0±1.4	0.83	6.08±0.41	0.93	6.41±0.49	1.841±0.041	0.74
	13	00	5	3	18.7±0.6	21.0±6.1	94.7±5.8	38.7±5.3	2.07					
	16	17	5	4	*34.4±0.4*	*3.9±0.7*	*30.8±0.8*	*18.3±1.9*	—	5.49±0.18	1.27	5.28±0.50	1.681±0.028	1.30
	17	04	5	4	*57.3±0.6*	*−14.7±3.5*	*38.7±1.5*	*5*	*2.05*					
		29	5	2	*28.0±0.2*	*6.3±0.5*	*30.6±0.3*	*23.4±0.7*	—	4.66±0.87	0.50	5.21±0.08	1.901±0.001	0.09
	18	25	4	4	41.0±0.3	−0.3±2.1	36.1±2.5	34.0±2.8	0.78	5.54±0.25	0.62	4.88±0.40	1.571±0.024	0.38
		27	5	3	47.5±0.7	−4.9±3.0	40.1±3.0	20.3±6.3	2.85	6.37±0.61	2.79			
	19	56	7	4	36.6±0.5	20.1±1.4	77.9±2.7	30.2±2.6	1.53	5.92±0.21	1.65	5.77±0.53	1.684±0.033	1.87

(to be continued)

Table 3. (continued)

Date & Time d	h	m	Number of the Data P	S	I O.T.	x	y	z	$\hat{\sigma}_0$	II V_p	$\hat{\sigma}_0$	III V_p	V_p/V_s	$\hat{\sigma}_0$
					sec	km	km	km		km/s		km/s		
July 03	20	27												
		45	4	3	16.7±0.5	0.9± 3.6	81.6±1.7	50.1± 3.5	1.92	6.15±0.68	2.49			
	21	35	5	1	40.9±0.3	35.0± 4.5	75.6±1.2	26.7± 2.3	0.67	5.89±0.28	0.83			
	22	20	**6**	3	37.5±0.4	17.7± 1.9	78.3±2.3	30.4± 2.0	1.37	5.41±0.32	1.18	5.35±0.52	1.705±0.057	1.41
		48	**7**	4	47.4±0.5	−7.7± 1.6	43.5±1.7	23.6± 5.2	2.50	6.08±0.41	2.70			
	23	55	5	3	*8.2±0.2*	*−4.7± 2.1*	*69.5±1.1*	*16.6± 2.4*	—	7.08±0.15	0.50	6.89±0.66	1.695±0.048	0.62
04	00	23	**7**	4	*13.4±0.6*	*12.0± 2.5*	*82.9±2.7*	*10.5± 7.7*	—	6.80±0.31	2.49			
		25	**7**	4	*39.9±0.5*	*7.4± 3.4*	*87.0±4.1*	*15.2± 6.5*	—	7.11±0.43	2.29			
		57	**6**	4	57.6±0.6	22.5± 2.8	54.2±2.2	59.3± 4.0	2.79	5.39±0.23	1.93	5.81±0.73	1.856±0.062	2.03
	01	12	5	4	41.6±0.3	−1.2± 1.9	41.8±1.3	20.6± 2.5	1.60	4.82±0.48	1.30	5.11±0.78	1.817±0.051	1.41
	02	**20**	5	5	*5.6±0.2*	*20.7± 0.6*	*28.3±0.5*	*13.7± 1.2*	—	5.70±0.20	1.08	6.21±0.92	1.845±0.061	1.12
	03	10	4	4	32.7±0.6	16.7±23.6	104.0±2.9	19.3±12.3	1.94					
	04	47	5	3	42.4±0.5	11.2± 4.3	75.3±2.2	28.6± 3.4	2.22	7.03±0.69	1.79			
	07	04	5	4	14.1±0.3	3.4± 1.2	74.6±0.8	10.5± 4.9	1.17	5.88±0.20	1.25	5.87±0.56	1.728±0.043	1.44
		22	**6**	3	*8.2±0.4*	*12.6± 0.9*	*42.2±0.6*	*22.4± 1.4*	—	4.19±0.12	1.44			
		45	**7**	5	27.4±0.3	−9.5± 1.8	54.2±1.5	35.2± 2.6	1.56	6.48±0.34	1.44	7.03±0.87	1.853±0.052	1.39
	08	24	5	4	27.1±0.5	−7.1± 3.1	55.7±2.6	25.2± 4.5	2.33					
		43	5	3	*39.3±0.4*	*10.2± 0.9*	*48.0±0.5*	*21.9± 1.5*	—	3.91±0.10	1.37	3.32±0.43	1.356±0.056	1.13
		47	5	3	39.4±0.1	−6.3± 0.9	45.4±0.6	14.0± 1.6	0.68	6.30±0.21	0.56	6.34±0.39	1.741±0.022	0.69
	09	05	5	3	57.3±0.3	−11.4± 1.8	66.2±1.5	12.2± 5.6	1.24					
	10	**14**	**6**	5	31.6±0.5	−1.5± 0.8	58.3±0.9	17.5± 1.7	0.87	5.85±0.12	0.85	5.32±0.15	1.614±0.011	0.42
	11	58	4	3	25.4±0.4	−0.4± 2.3	70.6±2.2	14.2± 3.5	1.17	6.68±0.31	0.64	6.70±0.53	1.738±0.032	0.89
	16	**50**	**6**	6	46.8±0.4	−4.0± 2.1	61.0±1.7	22.6± 4.1	2.08	6.40±0.33	1.97	7.51±0.61	1.992±0.035	1.27

(to be continued)

Table 3. (continued)

Date & Time			Number of the Data		I					II		III		
d	h	m	P	S	O. T.	x	y	z	$\hat{\sigma}_0$	V_p	$\hat{\sigma}_0$	V_p	V_p/V_s	$\hat{\sigma}_0$
					sec	km	km	km		km/s		km/s		
July 04	17	17	6	2	27.8±0.3	11.7±1.4	31.4±0.8	10.1± 5.2	1.94	5.70±0.33	2.01			
	20	26	4	4	4.5±0.8	−2.3±5.2	74.8±4.6	11.4± 6.5	2.78					
	22	22	5	4	56.8±0.4	−0.7±1.6	75.4±1.2	13.1± 2.8	1.65	6.84±0.19	0.62	6.86±0.33	1.735±0.016	0.71
	23	35	5	1	23.5±1.0	−19.7±5.1	65.4±2.2	4.6±22.8	2.13					
05	00	06	4	4	*48.6±0.3*	*9.3±1.6*	*77.2±2.0*	*7.9± 7.4*	—	5.80±0.20	1.03	5.56±0.25	1.648±0.031	0.71
		19	5	3	10.4±0.5	10.2±1.0	97.5±2.7	12.3± 3.0	1.39					
		35	4	4	4.1±0.4	1.3±1.8	70.0±2.0	6.3± 6.7	1.48	5.84±0.38	1.70			
	01	10	4	3	35.0±0.7	−8.6±2.3	41.0±1.3	14.8±10.4	2.19	6.79±0.92	0.33	6.83±0.52	1.740±0.047	0.46
	03	33	5	3	40.9±0.7	5.3±2.3	106.2±4.1	15.2± 3.4	1.63					
	04	32	4	4	28.6±0.3	−4.1±1.3	48.7±0.8	21.0± 3.8	1.20	6.33±0.28	1.02	5.68±0.65	1.594±0.032	0.87
	05	45	**6**	4	*15.5±0.8*	*−2.0±2.8*	*87.8±6.8*	*19.1± 4.3*	—	5.58±0.50	2.01			
	06	36	4	4	33.3±0.4	−8.9±1.8	37.9±2.5	32.0± 4.5	1.21	6.36±0.20	0.75	7.22±0.82	1.925±0.051	0.53
	07	25	4	3	32.4±0.1	6.0±0.61	52.9±0.6	31.5± 1.0	0.32	5.96±0.14	0.36	5.57±0.59	1.636±0.62	0.36
	09	29	**7**	4	20.5±0.5	6.6±1.7	104.4±2.7	19.7± 2.8	1.67	6.24±0.27	1.63	6.21±0.39	1.691±0.077	1.81
		52	**6**	4	58.2±0.3	10.4±0.8	78.4±1.0	7.5± 3.7	1.39	5.99±0.22	1.53	5.84±0.44	1.684±0.034	1.60
	12	03	**6**	3	26.3±0.8	−4.4±3.9	96.5±4.3	9.6± 5.9	2.88					
		33	**7**	5	14.4±0.6	6.7±2.1	84.3±2.6	14.8± 3.8	2.37	6.62±0.22	1.43	6.64±0.40	1.741±0.044	1.54
	14	**28**	**7**	**6**	10.4±0.4	−9.0±1.8	70.3±1.6	11.8± 4.6	1.90	6.48±0.25	1.53			
		58	**6**	**6**	37.8±0.3	−2.4±1.1	57.3±0.7	17.9± 2.5	1.32	6.21±0.23	1.33			
	15	**08**	**6**	**6**	56.6±0.4	9.3±2.5	81.7±1.8	15.8± 3.7	1.48	6.38±0.16	0.99	6.47±0.29	1.766±0.042	1.06
		23	8	4	26.2±0.4	5.8±1.6	85.8±1.8	20.4± 2.7	1.96	6.06±0.29	2.08	5.97±0.64	1.700±0.071	2.23
		40	5	4	26.2±0.4	−11.4±2.1	82.3±1.8	7.9± 3.0	1.17					
		59	**6**	4	*7.6±0.4*	*−11.0±2.2*	*69.5±1.1*	*5*	*2.23*					

(to be continued)

Table 3. (continued)

Date & Time			Number of the Data		I					II		III		
d	h	m	P	S	O. T.	x	y	z	$\hat{\sigma}_0$	V_p	$\hat{\sigma}_0$	V_p	V_p/V_s	$\hat{\sigma}_0$
					sec	km	km	km		km/s		km/s		
July 05	16	15	**6**	3	25.2±0.2	−12.0±0.9	61.5±0.5	20.1±1.7	0.63	5.79±0.14	0.70			
	17	**43**	**7**	**6**	*56.6±0.3*	*−8.6±1.4*	*40.5±0.7*	*14.4±3.5*	—	5.90±0.21	1.56			
		54	**6**	4	39.9±0.2	−9.1±1.1	57.7±0.7	20.0±2.2	1.04	5.99±0.18	1.14	6.03±0.47	1.743±0.040	.127
	18	25	5	4	50.5±0.2	−6.5±1.4	45.5±0.9	13.0±2.6	0.95	6.01±0.36	1.07	5.62±0.44	1.635±0.031	0.86
	19	05	4	5	25.4±0.2	−15.4±1.2	55.3±0.7	14.1±4.3	0.54	5.96±0.57	0.60	5.11±0.31	1.533±0.026	0.26
		44	**7**	5	5.7±0.4	17.0±0.9	85.4±1.6	11.4±2.9	1.66	6.32±0.20	1.59	6.44±0.25	1.788±0.041	1.48
	20	04	4	4	43.9±0.3	−9.6±1.6	63.2±0.8	16.3±2.3	0.77	5.88±0.14	0.78	5.82±0.47	1.705±0.034	0.92
	21	17	5	4	7.2±0.6	8.2±4.2	102.4±3.0	9.6±7.8	1.97					
	22	40	4	4	10.3±0.3	−11.0±1.2	65.5±0.8	17.5±2.4	0.98	6.18±0.15	0.71	6.08±0.37	1.704±0.037	0.85
	23	36	4	4	37.1±0.6	−8.4±3.6	45.3±2.4	15.0±6.5	2.37					
06	00	28	**7**	3	10.5±0.4	3.1±1.6	60.9±1.0	7.2±7.7	1.83					
		58	5	4	41.4±0.4	1.5±2.0	76.7±1.9	11.7±2.5	1.70	6.18±0.31	1.69	6.02±0.33	1.663±0.036	1.57
	01	**07**	**8**	5	47.6±0.6	6.7±1.9	73.4±2.2	10.5±6.5	2.62	6.10±0.34	2.81			
	02	**37**	5	5	11.4±0.5	−10.1±2.7	67.4±1.2	16.4±3.5	1.81	6.34±0.32	1.69			
		42	**7**	4	38.4±0.3	−2.6±1.1	77.3±0.8	12.1±1.6	1.11	6.16±0.15	0.91	6.04±0.22	1.694±0.000	0.89
	03	**45**	5	5	26.5±0.6	3.2±4.6	77.8±4.6	19.5±3.6	2.57	6.02±0.40	2.81			
	04	**17**	**7**	**7**	28.2±0.5	10.3±1.8	99.0±2.9	12.4±3.9	2.17					
	10	58	**8**	4	1.1±0.5	3.5±1.9	68.9±1.3	9.4±6.4	2.52	5.64±0.38	2.49	5.41±0.76	1.664±0.059	2.63
	12	**18**	**9**	**7**	22.3±0.7	−2.2±2.1	66.2±2.0	14.9±6.5	2.48	6.19±0.46	2.53	6.04±0.98	1.689±0.073	2.65
		23	**8**	**6**	35.9±0.4	7.8±2.1	117.2±2.1	24.6±3.2	1.50					

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Numerical computations were carried out on an OKITAC 5090 of the Data Processing Center of the University of Tokyo and on an HITAC 5020 of the Computation Center of the University of Tokyo.

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12. 昭和 39 年 6 月 16 日新潟地震余震の発震時，震源位置の決定
——新潟地震余震共同研究序報——

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昭和 39 年 6 月 16 日の新潟地震の余震観測のため，北海道大学，東北大学，地震研究所，気象庁より，それぞれ，2 乃至 4 の臨時観測班が送られた．これらの観測班により得られた観測資料を総合して，震源の決定が行われた．

P 波の到達時刻のみを用いるときは，適当な解が得られないか，または誤差が著るしく大きくなる場合が少くないので，P 波及び S 波の到達時刻を併用して，約 400 個の余震の震源が求められた．半数は，誤差が，発震時で 0.4 秒，震央位置で約 2 km，深さで 3.5 km 以内である．

余震域は，N 30 E—S 30 W 方向に長軸をもち，長径約 100 km，短径約 50 km の楕円形の地域で，本震はほぼその中央に位置する．震源の深さは，大部分 10～22 km の範囲に集中している．

P 波の速度，P 波と S 波との速度比も求められた．この地域で，平均して，P 波の速度は 5.8km/s，P 波と S 波との速度比は 1.70 である．