

### III. MOVEMENT OF THE ICE SHEET OBSERVED BY A TRIANGULATION CHAIN

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#### 1. Introduction

Resurvey of the triangulation chain which was installed in 1969 along the parallel of 72°S in Mizuho Plateau, was conducted during the period from 20 December 1973 to 16 January 1974 (see Fig. A and report I in this volume). The chain stretched for a distance of 250 km between S240 (A164) and two nunataks (A001 and A002) at the south end of the Yamato Mountains; the chain was composed of 162 triangles and 164 stations.

The basic methods of survey and computation are almost the same as those described in detail in JARE Data Reports No. 17 (Naruse *et al.*, 1972). Summarized in the following chapters are only the essential parts of the methods and results.

#### 2. Method of Survey

The survey was based on the standards of the fourth order triangulation of the Geographical Survey Institute of Japan.

As markers of triangulation stations, metal or bamboo stakes, 1.5 m-2 m in height, were set up on the ice or snow surface in 1969 by JARE-10. Twenty-two stakes among 164 stations were

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found missing during the resurvey in 1973-1974 by JARE-14; it is considered that the stakes had been buried under the accumulated snow. To make up for the missing stakes and accomplish the continuous survey of the triangulation chain, 25 additional stations denominated in such a notation as A523 or A658 etc., were employed in the resurvey bringing the total number of surveying stations to 167.

The methods of observation are summarized as follows:

1) Angle measurements

Horizontal angle: All the interior angles of 165 triangles;

Vertical angle: From each station to four neighboring stations.

Wild T2 theodolites were used.

2) Distance measurements

On the ten sides of the triangulation chain; with an electrotape instrument (Cubic DM-20).

3) Azimuth observations

At nine stations by sun shots.

4) Procedure of survey

The field party was split into four groups (the same as in the case of the first survey), each with a theodolite and a tripod target which could be extended in height from 3.7 m to 4.7 m above the snow surface. Each group carried out measurements of horizontal and vertical angles from one station to four neighboring stations where the targets were placed upright by the other groups.

Personnel who assisted in observations are as follows: Masayuki Kuwashima, Masaru Ayukawa, Hitoshi Shirane, Yoshinori Murayama and Shigeo Shiga.

### 3. Computation of Elevation and Position

#### 3.1. Basic data

- 1) Datum point: A001 ..... adopted position  $71^{\circ}47'28.1''S$ ,

36°12'12.2"E (obtained by the astronomic observation in 1969).

2) Reference ellipsoid: Bessel's Ellipsoid (Radius of equator: 6377397 m; flattening: 1/299.15).

3) Projection: Gauss-Krüger projection.

### 3.2. Correction of observed distance

Observed distances were corrected in the following order:

1) Meteorological correction with the air temperature and atmospheric pressure.

2) Slope correction with the vertical angle.

3) Sea level correction with the ratio of elevation above mean sea level to the radius of curvature of the earth.

### 3.3. Computation of elevation

The elevation difference between two neighboring stations,  $\underline{\Delta h}$ , was calculated by the following equation:

$$\underline{\Delta h} = \frac{1}{2} \underline{d} (\tan \alpha_1 - \tan \alpha_2) + \frac{1}{2} (\underline{i}_1 + \underline{f}_1) - \frac{1}{2} (\underline{i}_2 + \underline{f}_2),$$

where  $\underline{d}$  is the horizontal distance between two stations,  $\alpha$  the vertical angle,  $\underline{i}$  the height of the instrument, and  $\underline{f}$  the height of the target. Suffix 1 or 2 refers to station 1 or 2.

The elevation of each triangulation station was obtained by accumulating the elevation differences successively onto the elevation of a preceding station, whereby the elevation of the datum point A001 was taken as 0.00 m.

### 3.4. Computation of net adjustment

Latitudes and longitudes of all triangulation stations were calculated separately by the data of JARE-10 and JARE-14 by means of the net adjustment with the computer program developed by Harada (1966).

The triangulation chain was divided into three parts. In each part, computation of net adjustment was made by the least squares method from the observation equations, whose unknown factors were the correction terms to approximate values of the latitude and longitude of unknown stations.

#### 4. Results

Table 1 shows the results of calculations for ice movements. Latitudes, longitudes and relative elevations (above the altitude of the datum point A001) of all triangulation stations are tabulated separately in November-December 1969 and December 1973-January 1974. The horizontal displacement of the ice movement for four years and its direction were obtained at each station from the difference between two geodetic positions in 1969 and 1973-1974. The direction of the displacement is indicated in Table 1 by the azimuth ( $0^\circ$ : north,  $90^\circ$ : east,  $180^\circ$ : south, and  $270^\circ$ : west in true). The vertical displacement was obtained by subtracting the thickness of net accumulation for four years (see report IV in this volume) from the difference of elevations in 1969 and 1973-1974; the positive sign represents the upward motion of ice, the negative sign downward motion. The period in days shown in Table 1 indicates a time interval between two observations in 1969 and 1973-1974.

#### 5. Surface Slope of the Ice Sheet

Measurements of surface slopes of the ice sheet were carried out at every triangulation station in 1973-1974. The vertical angle of the skyline was measured by a theodolite with the accuracy of one minute in such a direction that has a  $45^\circ$  interval between one another starting at a northward direction in true. Table 2 shows the minimum and maximum values of inclinations which represent the downhill and uphill slopes, and their directions.

### References

- Harada, T. (1966): Universal program to be used with electronic computer for net-adjustment of any geodetic figure. Bull. Geogr. Surv. Inst., 12, Part 1, 21-39.
- Naruse, R., A. Yoshimura and H. Shimizu (1972): Installation of a triangulation chain and a traverse survey line on the ice sheet in the Mizuho Plateau - West Enderby Land area, East Antarctica, 1969-1970. Glaciological Research Program in Mizuho Plateau - West Enderby Land, Part 1, 1969-1971. JARE Data Rep., 17 (Glaciology), 111-131.

Table 1. Positions and elevations of the stations of a triangulation chain in November-December 1969 and December 1973-January 1974; surface movement of the ice sheet for four years.

Station	24 November-30 December 1969			20 December 1973-16 January 1974			Movement for 4 years			
	Latitude (S)	Longitude (E)	Elevation (m)	Latitude (S)	Longitude (E)	Elevation (m)	Horizontal displacement (m)		Vertical displacement (m)	Period (days)
							displacement (m)	azimuth		
A001	71°47' 28" .100	36°12' 12" .200	0.00	71°47' 28" .100	36°12' 12" .200	0.00	0.0	—	—	
002	71 47 11 .857	36 11 01 .873	25.42	71 47 11 .857	36 11 01 .873	25.42	0.0	—	—	
003	71 48 02 .590	36 11 17 .458	- 3.48	71 48 02 .564	36 11 17 .420	-3.58	0.89	335°27'	+0.13	1453
004	71 48 33 .777	36 13 07 .215	14.88	71 48 33 .736	36 13 07 .173	14.74	1.33	342 15	+0.08	"
005	71 48 23 .846	36 16 12 .604	27.38	71 48 23 .797	36 16 12 .553	27.51	1.60	341 59	+0.33	"
006	71 49 46 .454	36 17 14 .416	63.72	71 49 46 .368	36 17 14 .276	63.70	2.99	333 03	+0.27	"
007	71 48 44 .223	36 20 14 .483	40.11	71 48 44 .153	36 20 14 .349	40.23	2.53	329 07	+0.20	1454
008	71 48 47 .059	36 16 09 .103	32.30	71 48 47 .005	36 16 09 .037	32.19	1.79	339 06	+0.15	"
009	71 48 57 .068	36 19 54 .387	41.86	71 48 56 .998	36 19 54 .241	41.81	2.59	326 55	+0.21	1457
010	71 50 00 .057	36 19 56 .070	84.24	71 49 59 .977	36 19 55 .876	84.16	3.11	322 53	+0.18	"
011	71 49 42 .780	36 22 30 .955	79.86	71 49 42 .669	36 22 30 .726	79.79	4.09	327 13	+0.10	"
012	71 50 26 .440	36 22 11 .125	96.78	71 50 26 .352	36 22 10 .831	96.72	3.94	313 49	+0.18	1458
013	71 50 28 .007	36 17 56 .047	82.25	71 50 27 .929	36 17 55 .791	82.19	3.46	314 20	+0.15	1466
014	71 50 36 .302	36 21 55 .362	96.48	71 50 36 .230	36 21 55 .072	96.84	3.58	308 31	+0.14	"
015	71 51 44 .749	36 23 18 .260	99.13	71 51 44 .652	36 23 17 .926	99.20	4.41	312 59	+0.26	"
016	71 50 46 .923	36 26 43 .101	116.16	71 50 46 .814	36 26 42 .797	116.28	4.48	318 59	+0.30	"
017	71 52 34 .249	36 26 59 .415	121.86	71 52 34 .093	36 26 59 .019	121.94	6.16	321 41	+0.24	"
018	71 50 47 .837	36 30 59 .846	122.80	71 50 47 .634	36 30 59 .498	122.84	7.13	331 52	+0.24	1468
019	71 51 52 .552	36 34 28 .039	133.44	71 51 52 .307	36 34 27 .714	133.54	8.22	337 33	0.00	"
020	71 50 53 .324	36 36 25 .133	133.90	71 50 52 .870	36 36 24 .830	133.72	14.37	348 15	-0.03	"
021	71 51 18 .918	36 39 18 .862	137.59	71 51 18 .448	36 39 18 .445	137.56	15.11	344 33	+0.03	1471
022	71 50 05 .525	36 38 55 .184	121.18	71 50 04 .938	36 38 54 .834	120.97	18.50	349 28	-0.04	1474
023	71 50 16 .475	36 43 44 .535	127.94	71 50 15 .956	36 43 44 .179		16.45	347 56		1475
523				71 50 21 .336	36 43 31 .837	129.34				
024	71 51 20 .661	36 47 01 .640	128.54	71 51 20 .146	36 47 01 .213	127.94	16.48	345 31	-0.45	"
025	71 50 31 .747	36 47 42 .344	123.30	71 50 31 .231	36 47 41 .971	123.36	16.39	347 18		"
026	71 51 45 .583	36 49 59 .996	140.88	71 51 45 .068	36 49 59 .586	140.59	16.44	346 04	-0.18	1476

Station	24 November-30 December 1969			20 December 1973-16 January 1974			Movement for 4 years				
	Latitude (S)	Longitude (E)	Elevation (m)	Latitude (S)	Longitude (E)	Elevation (m)	Horizontal		Vertical displacement (m)	Period (days)	
							displacement (m)	azimuth			
A027	71°50' 32" .069	36°51' 05" .205	122.09	71°50' 31" .538	36°51' 04" .669	121.52	17.25	342° 32'	-1.13	1476	
028	71 52 10 .333	36 54 40 .452	143.44	71 52 09 .811	36 54 40 .088	142.94	16.55	347 45	-0.87	"	
029	71 51 04 .480	36 57 00 .673	140.70	71 51 03 .950	36 57 00 .180	140.36	17.10	343 50	-0.22	"	
030	71 52 45 .474	36 59 55 .332	160.38	71 52 44 .948	36 59 55 .134	159.90	16.41	353 19		1477	
031	71 51 35 .688	37 03 00 .467	156.32	71 51 35 .191	37 03 00 .397	155.78	15.42	357 29	-0.34	"	
032	71 53 05 .222	37 04 55 .870	161.88	71 53 04 .696	37 04 55 .829	161.64	16.31	358 37	-0.90	1478	
033	71 52 26 .050	37 09 39 .437	157.30	71 52 25 .523	37 09 39 .610	157.08	16.42	5 50	-1.01	"	
034	71 53 20 .290	37 10 03 .592	170.68	71 53 19 .745	37 10 03 .800	170.82	17.01	6 46	-0.39	"	
035	71 53 12 .928	37 12 07 .737	169.43	71 53 12 .353	37 12 08 .137	168.89	18.23	12 13	-0.39	"	
036	71 53 48 .646	37 11 55 .286	179.10	71 53 48 .091	37 11 55 .669	178.91	17.59	12 07	-0.41	"	
037	71 53 36 .423	37 13 53 .797	173.89	71 53 35 .830	37 13 54 .303	173.22	19.01	14 52	-0.52	"	
038	71 54 34 .372	37 15 17 .311	178.18	71 54 33 .789	37 15 17 .793	177.91	18.65	14 24	-1.04	"	
538				71 54 27 .659	37 15 08 .588	178.01					
039	71 53 35 .872	37 20 23 .968	166.46	71 53 35 .168	37 20 24 .616	165.66	22.69	15 59	-0.68	"	
040	71 54 57 .292	37 24 20 .067	172.74	71 54 56 .549	37 24 20 .676	172.58	23.76	14 17	-1.43	1480	
041	71 53 37 .885	37 29 03 .914	158.12	71 53 36 .987	37 29 04 .620	157.96	28.65	13 44	-1.06	"	
042	71 54 51 .304	37 33 55 .161	160.70	71 54 50 .304	37 33 55 .648	160.02	31.34	8 36	-1.28	"	
043	71 53 33 .417	37 35 54 .571	151.14	71 53 32 .330	37 35 55 .206	151.08	34.24	10 18	-1.12	"	
044	71 54 43 .119	37 41 12 .511	158.33	71 54 42 .023	37 41 12 .965	158.20	34.25	7 20	-1.13	"	
045	71 53 24 .120	37 46 01 .499	145.58	71 53 22 .944	37 46 01 .909	145.79	36.66	6 11	-0.77	"	
046	71 54 33 .921	37 49 07 .493	155.76	71 54 32 .806	37 49 07 .751	155.81	34.64	4 07	-0.58	"	
047	71 53 56 .672	37 51 58 .195	156.74	71 53 55 .519	37 51 58 .487	156.61	35.84	4 30	+0.05	"	
048	71 54 53 .492	37 54 09 .086	161.95								
548				71 54 54 .821	37 53 52 .182	163.73					
049	71 54 13 .943	37 59 08 .463	158.71	71 54 12 .691	37 59 08 .848	158.70	38.98	5 27	+0.18	1481	
050	71 55 32 .919	38 02 06 .925	169.08								
550				71 55 29 .995	38 01 32 .679	170.19					
051	71 54 31 .283	38 08 20 .560	161.26	71 54 29 .840	38 08 21 .259	161.84	45.22	8 34	+0.06	1482	
052	71 55 55 .959	38 12 21 .795	172.92	71 55 54 .378	38 12 22 .652	172.83	49.69	9 33	-0.36	"	
053	71 54 42 .547	38 13 48 .112	156.90	71 54 40 .838	38 13 49 .157	156.63	53.91	10 45	-0.84	"	

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							(m)	azimuth		
A054	71° 55' 42" .255	38° 19' 31" .082	163.82	71° 55' 40" .315	38° 19' 31" .871	163.31	60.60	7° 12'	-0.92	1486
055	71 54 30 .329	38 18 38 .102	151.92	71 54 28 .366	38 18 39 .048	150.86	61.51	8 31	-0.92	"
056	71 55 30 .013	38 24 20 .387	160.48	71 55 27 .819	38 24 21 .130	160.12	68.37	6 00	-0.97	1486
057	71 53 57 .567	38 29 27 .888	145.44	71 53 55 .201	38 29 28 .666	144.80	73.71	5 50	-0.60	1486
058	71 55 15 .620	38 29 59 .852	154.60							
558				71 55 11 .843	38 30 28 .200	154.62				
059	71 53 42 .533	38 35 22 .112	138.92	71 53 40 .079	38 35 22 .804	138.60	76.34	5 01	-0.96	"
060	71 54 54 .646	38 39 15 .847	151.16	71 54 52 .225	38 39 16 .307	150.61	75.16	3 23	-1.32	"
061	71 54 03 .254	38 43 05 .792	144.36	71 54 00 .746	38 43 06 .310	143.32	77.89	3 40	-1.18	"
062	71 55 23 .416	38 47 23 .854	152.98	71 55 20 .912	38 47 24 .214	151.91	77.68	2 33	-1.18	"
063	71 54 00 .479	38 50 37 .772	134.51	71 53 57 .882	38 50 38 .148	133.06	80.57	2 35	-2.06	"
064	71 55 33 .343	38 51 30 .767	155.70	71 55 30 .794	38 51 31 .129	154.06	79.07	2 32	-1.60	"
065	71 54 19 .024	38 56 56 .407	131.27	71 54 16 .342	38 56 56 .580	128.56	83.14	1 09	-3.60	"
066	71 55 35 .795	39 00 38 .470	170.90	71 55 33 .131	39 00 38 .658	168.30	82.58	1 15	-2.91	1486
067	71 54 46 .330	39 01 54 .172	151.18	71 54 43 .587	39 01 54 .261	147.34	85.01	0 35	-3.66	"
068	71 55 37 .331	39 05 59 .621	170.74	71 55 34 .633	39 05 59 .795	167.56	83.63	1 09	-3.97	"
069	71 54 31 .053	39 10 19 .029	154.68	71 54 28 .253	39 10 19 .090	151.09	86.78	0 23	-3.72	"
070	71 56 23 .174	39 12 37 .642	179.64	71 56 20 .516	39 12 37 .915	176.40	82.42	1 50	-3.86	"
071	71 55 22 .043	39 14 58 .951	165.51	71 55 19 .285	39 14 59 .158	161.80	85.50	1 20	-3.78	"
072	71 56 23 .656	39 17 01 .580	178.89	71 56 20 .979	39 17 01 .928	175.33	83.03	2 19	-4.06	"
073	71 55 13 .464	39 17 46 .062	162.45	71 55 10 .702	39 17 46 .287	158.96	85.63	1 27	-4.04	1487
074	71 56 24 .612	39 20 47 .208	169.04							
574				71 56 30 .905	39 21 43 .837	165.07				
075	71 55 20 .617	39 23 44 .743	160.52	71 55 17 .896	39 23 44 .747	157.23	84.33	0 02	-4.14	"
076	71 56 50 .221	39 27 46 .115	174.05	71 56 47 .614	39 27 46 .043	171.09	80.80	359 31	-4.06	1490
077	71 55 30 .402	39 28 29 .439	165.99	71 55 27 .726	39 28 29 .321	163.10	82.94	359 13	-3.68	"
078	71 56 53 .138	39 32 00 .362	181.75	71 56 50 .565	39 32 00 .209	178.28	79.75	358 57	-3.56	"
079	71 55 37 .228	39 31 26 .975	171.79	71 55 34 .568	39 31 26 .345	168.02	82.45	359 08	-3.57	"
080	71 57 04 .381	39 36 33 .854	188.05	71 57 01 .826	39 36 33 .696	184.99	79.20	358 54	-3.09	"
081	71 55 37 .488	39 36 28 .303	168.29	71 55 34 .816	39 36 28 .180	164.83	81.89	359 10	-4.03	"



Station	24 November-30 December 1969			20 December 1973-16 January 1974			Movement for 4 years			
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							displacement (m)	azimuth		
A082	71° 57' 28" .606	39° 41' 19" .370	192.94	71° 57' 26" .091	39° 41' 19" .266	189.68	77.95	359° 16'	-3.45	1490
083	71 56 02 .338	39 45 51 .326	178.39	71 55 59 .750	39 45 51 .199	175.44	80.21	359 08	-3.98	"
084	71 58 00 .144	39 47 52 .015	196.61	71 57 57 .665	39 47 51 .925	193.30	76.83	359 21	-4.32	1491
085	71 56 57 .853	39 51 53 .624	192.01	71 56 55 .313	39 51 53 .517	188.50	78.72	359 15	-3.51	"
086	71 58 13 .153	39 53 33 .440	198.55	71 58 10 .659	39 53 33 .295	195.48	77.30	358 58	-3.99	"
087	71 56 43 .700	39 56 53 .717	183.68	71 56 41 .126	39 56 53 .584	180.18	79.78	359 05	-4.51	"
088	71 58 25 .062	39 59 27 .009	198.05							
588				71 58 25 .036	39 59 42 .215	194.93				
089	71 56 38 .782	40 03 00 .503	175.85	71 56 36 .203	40 03 00 .154	172.21	80.00	357 36	-4.95	1494
090	71 58 19 .389	40 08 26 .161	193.99	71 58 16 .871	40 08 25 .644	190.09	78.19	356 22	-4.09	1495
091	71 56 46 .100	40 09 59 .617	174.22							
591				71 56 37 .701	40 09 47 .375	171.69				
092	71 58 15 .089	40 15 56 .038	208.22	71 58 12 .624	40 15 55 .300	204.17	76.72	354 42	-3.87	"
093	71 56 21 .480	40 15 00 .163	165.40							
593				71 56 00 .443	40 14 43 .764	164.47				
094	71 58 13 .258	40 20 02 .323	205.46	71 58 10 .832	40 20 01 .585	201.36	75.52	354 37	-4.53	1498
095	71 56 56 .577	40 25 54 .133	201.71	71 56 54 .139	40 25 53 .241	197.35	76.04	353 32	-4.24	"
096	71 58 29 .376	40 26 56 .136	214.41	71 58 27 .026	40 26 55 .457	211.20	73.12	354 53	-4.66	"
097	71 57 03 .031	40 31 02 .108	206.22	71 57 00 .635	40 31 01 .283	202.71	74.68	353 55	-4.66	"
098	71 59 10 .259	40 35 06 .598	228.04	71 59 07 .970	40 35 05 .909	223.78	71.25	354 41	-4.26	"
099	71 57 53 .107	40 38 29 .007	215.59	71 57 50 .745	40 38 28 .173	211.38	73.64	353 45	-4.72	"
100	71 59 20 .752	40 42 52 .804	231.98	71 59 18 .471	40 42 52 .010	228.18	71.10	353 51	-4.63	1499
101	71 58 08 .676	40 44 25 .567	221.64	71 58 06 .328	40 44 24 .677	217.38	73.27	353 18	-4.54	"
102	71 59 16 .371	40 49 26 .978	229.70	71 59 14 .080	40 49 26 .049	225.62	71.56	352 51	-4.80	"
103	71 58 23 .789	40 51 48 .190	225.62	71 58 21 .454	40 51 47 .193	221.62	72.99	352 28	-4.35	1500
104	71 59 19 .536	40 53 37 .267	234.72							
604				71 59 17 .318	40 53 36 .012	231.83				
105	71 58 17 .884	40 57 46 .629	231.72	71 58 15 .581	40 57 45 .617	227.56	72.03	352 15	-4.55	"
106	71 59 22 .473	41 00 44 .431	235.92							
606				71 59 20 .489	41 00 37 .729	232.92				

Station	24 November-30 December 1969			20 December 1973-16 January 1974			Movement for 4 years			
	Latitude (S)	Longitude (E)	Elevation (m)	Latitude (S)	Longitude (E)	Elevation (m)	Horizontal		Vertical displacement (m)	Period (days)
							displacement (m)	azimuth		
A107	71° 58' 42". 961	41° 04' 04". 051	233.57	71° 58' 40". 680	41° 04' 03". 002	230.46	71.40	351° 54'	-4.90	1500
108	71 59 39 .984	41 07 31 .098	245.06	71 59 37 .738	41 07 29 .995	240.74	70.41	351 22	-4.73	1501
109	71 58 43 .051	41 10 02 .742	238.09	71 58 40 .769	41 10 01 .630	234.22	71.52	351 25	-4.67	"
110	71 59 51 .973	41 12 33 .523	251.52	71 59 49 .740	41 12 32 .380	248.24	70.07	351 00	-4.48	"
111	71 59 21 .001	41 14 40 .804	251.65	71 59 18 .757	41 14 39 .663	247.78	70.40	351 04	-4.59	"
112	71 59 58 .454	41 15 05 .553	257.18	71 59 56 .230	41 15 04 .394	253.60	69.81	350 50	-4.90	"
113	71 59 29 .008	41 17 52 .351	250.74	71 59 26 .788	41 17 51 .181	246.90	69.71	350 44	-4.23	"
114	72 00 25 .541	41 20 38 .181	264.26	72 00 23 .358	41 20 36 .922	260.58	68.72	349 54	-4.15	"
115	72 00 01 .984	41 24 28 .814	259.82	71 59 59 .818	41 24 27 .584	255.66	68.16	350 02	-4.68	1502
116	72 00 46 .261	41 23 28 .868	273.62	72 00 44 .125	41 23 27 .635	269.86	67.24	349 53	-3.93	"
117	71 59 57 .504	41 27 03 .544	264.11	71 59 55 .374	41 27 02 .313	260.80	67.06	349 52	-5.28	"
118	72 01 02 .702	41 25 38 .763	280.50	72 01 00 .600	41 25 37 .549	277.06	66.17	349 53	-4.64	1503
119	72 00 03 .974	41 30 56 .185	256.60							
619				72 00 01 .543	41 30 55 .485	254.19				
120	72 01 30 .440	41 33 13 .549	289.44	72 01 28 .438	41 33 12 .267	285.57	63.25	348 49	-3.94	"
121	72 00 42 .771	41 36 26 .277	282.45	72 00 40 .778	41 36 25 .002	278.26	62.96	348 49	-4.13	"
122	72 01 33 .491	41 35 57 .353	294.46	72 01 31 .538	41 35 56 .165	290.82	61.58	349 22	-4.23	"
123	72 00 31 .892	41 38 46 .732	282.46	72 00 29 .938	41 38 45 .501	278.57	61.69	348 59	-4.04	"
124	72 01 24 .801	41 40 04 .231	285.97							
624				72 01 22 .059	41 39 39 .869	284.00				
125	71 59 53 .197	41 43 08 .495	285.54	71 59 51 .263	41 43 07 .304	281.97	61.02	349 13	-3.55	"
126	72 01 07 .166	41 46 57 .215	297.88	72 01 05 .309	41 46 56 .265	293.80	58.26	351 01	-4.37	"
127	71 59 56 .622	41 47 00 .964	288.24	71 59 54 .711	41 46 59 .910	284.59	60.08	350 19	-4.22	1505
128	72 00 53 .189	41 50 03 .876	296.84	72 00 51 .331	41 50 02 .979	293.24	58.22	351 31	-4.51	"
129	71 59 52 .240	41 53 00 .283	284.55	71 59 50 .346	41 52 59 .293	280.49	59.46	350 49	-4.44	"
130	72 00 55 .479	41 56 55 .324	290.34	72 00 53 .636	41 56 54 .435	286.95	57.75	351 31	-4.66	"
131	71 59 57 .125	41 59 57 .995	283.04	71 59 55 .257	41 59 56 .999	279.74	58.67	350 38	-3.59	"
132	72 00 46 .140	42 03 21 .632	281.74							
632				72 00 44 .878	42 03 23 .923	278.59				
133	71 59 32 .049	42 06 27 .116	277.16	71 59 30 .171	42 06 25 .967	274.28	59.24	349 17	-4.76	"

Station	24 November-30 December 1969			20 December 1973-16 January 1974			Movement for 4 years			
	Latitude (S)	Longitude (E)	Elevation (m)	Latitude (S)	Longitude (E)	Elevation (m)	Horizontal displacement (m)		Vertical displacement (m)	Period (days)
							displacement (m)	azimuth		
A134	72° 00' 27". 996	42° 07' 39". 976	273. 75							
634				72° 00' 29". 369	42° 07' 43". 192	271. 06				
135	71 59 45 . 009	42 10 35 . 417	272. 35	71 59 43 . 135	42 10 34 . 161	269. 28	59. 31	348° 17'	-4. 68	1505
136	72 00 17 . 664	42 13 01 . 546	272. 30							
636				72 00 14 . 974	42 12 37 . 603	269. 62				
137	71 59 43 . 071	42 13 20 . 256	272. 93							
637				71 59 39 . 359	42 13 02 . 012	270. 99				
138	72 00 28 . 713	42 15 25 . 941	262. 54	72 00 26 . 847	42 15 24 . 435	259. 27	59. 60	346 00	-3. 95	1507
638				72 00 09 . 327	42 18 23 . 555	260. 00				
139	71 59 15 . 390	42 15 29 . 355	266. 96							
639				71 59 13 . 694	42 15 26 . 869	265. 60				
140	71 59 58 . 813	42 21 22 . 378	283. 84	71 59 56 . 930	42 21 20 . 531	279. 39	60. 98	343 07	-4. 33	"
141	71 58 28 . 794	42 18 28 . 236	263. 28	71 58 26 . 907	42 18 26 . 521	261. 22	60. 75	344 17	-4. 34	"
142	71 59 15 . 803	42 25 40 . 484	297. 52	71 59 13 . 916	42 25 38 . 588	293. 26	61. 24	342 44	-4. 27	"
143	71 57 47 . 109	42 24 04 . 276	254. 66							
643				71 57 45 . 199	42 24 02 . 569	253. 50				
144	71 58 56 . 627	42 28 39 . 619	299. 02	71 58 54 . 750	42 28 37 . 749	295. 94	60. 88	342 51	-3. 64	1508
145	71 58 00 . 532	42 33 57 . 570	289. 89	71 57 58 . 666	42 33 55 . 696	286. 47	60. 57	342 43	-3. 83	"
146	71 58 57 . 974	42 33 52 . 337	308. 02	71 58 56 . 119	42 33 50 . 603	305. 00	59. 85	343 51	-3. 44	"
147	71 58 08 . 220	42 36 53 . 418	299. 14	71 58 06 . 362	42 36 51 . 615	295. 32	60. 12	343 17		1509
148	71 59 41 . 520	42 35 43 . 871	317. 35	71 59 39 . 700	42 35 42 . 305	313. 85	58. 37	345 06	-4. 13	1511
149	71 58 29 . 584	42 39 56 . 954	305. 34	71 58 27 . 752	42 39 55 . 270	302. 03	59. 03	344 07	-3. 98	"
150	71 59 28 . 429	42 40 33 . 569	313. 04							
650				71 59 26 . 309	42 40 31 . 830	310. 24				
151	71 58 30 . 072	42 43 33 . 538	298. 90	71 58 28 . 259	42 43 31 . 837	296. 10	58. 51	343 48	-3. 37	"
152	71 59 28 . 108	42 44 12 . 153	308. 04							
652				71 59 25 . 419	42 44 09 . 229	305. 01				
153	71 59 08 . 313	42 47 47 . 064	296. 66							
653				71 59 01 . 165	42 47 56 . 374	294. 00				
154	72 00 51 . 588	42 46 36 . 115	325. 16	72 00 49 . 839	42 46 34 . 381	322. 14	56. 69	342 58		1512

Station	24 November-30 December 1969			20 December 1973-16 January 1974			Movement for 4 years			
	Latitude (S)	Longitude (E)	Elevation (m)	Latitude (S)	Longitude (E)	Elevation (m)	Horizontal displacement		Vertical displacement (m)	Period (days)
							(m)	azimuth		
A155	72° 01' 25". 772	42° 52' 06". 218	337. 39	72° 01' 24". 102	42° 52' 04". 305	334. 11	54. 90	340° 31'	-3. 44	1512
156	72 00 03 . 697	42 52 39 . 689	307. 97							
656				72 00 04 . 843	42 52 29 . 897	306. 28				
157	72 01 28 . 631	42 55 22 . 521	331. 92	72 01 26 . 981	42 55 20 . 376	329. 24	55. 10	338 08		1513
158	71 59 50 . 198	42 58 23 . 668	304. 88							
658				71 59 54 . 075	42 58 12 . 848	302. 13				
159	72 01 27 . 904	43 00 32 . 150	350. 49	72 01 26 . 268	43 00 29 . 761	347. 10	55. 62	335 44	-3. 26	"
160	72 00 09 . 258	43 03 35 . 037	329. 15	72 00 07 . 607	43 03 32 . 506	326. 58	56. 62	334 39	-3. 27	"
161	72 01 34 . 104	43 03 57 . 492	363. 11	72 01 32 . 476	43 03 55 . 135	360. 08	55. 27	335 55	-3. 01	"
162	72 00 13 . 775	43 07 00 . 268	348. 90	72 00 12 . 121	43 06 57 . 843	345. 90	56. 28	335 37	-2. 90	1514
163	72 01 33 . 478	43 07 28 . 864	367. 67	72 01 31 . 851	43 07 26 . 567	364. 51	55. 01	336 27	-3. 20	"
164	72 00 08 . 285	43 09 50 . 306	354. 83	72 00 06 . 612	43 09 47 . 953	352. 20	56. 54	336 30	-2. 85	"

Table 2. Surface slope of the ice sheet at the stations of a triangulation chain in Mizuho Plateau, 1973-1974.

Station	Downhill slope		Uphill slope		Station	Downhill slope		Uphill slope	
	Direction (degrees true)	Inclination (angle)	Direction (degrees true)	Inclination (angle)		Direction (degrees true)	Inclination (angle)	Direction (degrees true)	Inclination (angle)
A001	45°	-36'	180°	+58'	A045	21°	-13'	187°	+18'
003	33	-33	188	+1° 52'	046	342	-13	142, 180	+18
004	3	-32	218	+1 47	047	0	-19	180	+18
005	314	-37	147	+53	048	38, 45	-29	156	+ 3
006	350	-40	180	+48	049	354	-24	188	+18
007	343	-35	101	+1 04	050	357	-23	180, 187	+16
008	315	-32	129, 135	+59	051	13	-13	182	+22
009	335	-36	174	+1 12	052	0, 16	-35	192	+10
010	348	-39	180	+42	053	16	-22	208	+21
011	350	-40	126	+1 08	054	6	-20	198	+20
012	313	-42	90	+24	055	0	-18	205	+29
014	37	-46	180, 186	+25	056	16	-40	165	+ 4
015	315	-18	137	+44	057	18	-29	182	+15
016	270	-32	180	+ 1	058	12	-17	167, 180	+20
017	296	-25	133	+1 20	059	14	-22	182	+20
018	348	-41	173	+19	060	0	-33	144	+ 7
019	270	-15	171	+23	061	42	-21	169	+21
020	4	-40	315	+38	062	7	-36	179	+33
021	0	-17	218	+11	063	0, 351	-21	182	+30
022	324	-30	202	+26	064	345	-39	178	+22
023	315	-12	144	+22	065	3	-21	147	+40
024	25	-28	210	+1 40	066	0	-29	182	+20
025	24	-22	190	+35	067	0	-24	181	+53
026	0	-27	180, 204	+1 06	068	352	-42	178	+ 3
027	358	-15	183	+34	069	348	-25	179	+23
028	337	-35	188	+21	070	0	-24	180	+20
029	318	-28	180, 204	+18	071	345	-21	157	+29
030	325	-31	186	+28	072	0, 335	-37	190	+ 6
031	309, 315	-19	148	+13	073	0, 10	-19	199	+25
032	11	-27	145	+ 6	074	359	-14	180, 192	+21
033	345	-14	170	+25	075	0, 348	-29	181	+ 4
034	4	-19	160	+25	076	342	-13	189	+22
035	10	-18	184	+40	077	325	-18	159	+17
036	0, 20	-35	176	- 2	078	322	-16	165, 180	+18
037	25	-22	228	+21	079	2	-33	167	+ 3
038	29, 45	-17	180, 192	+12	080	3	-22	180	+19
039	11	-18	188	+20	081	4	-20	164, 180	+25
040	0, 13	-32	180	- 1	082	0, 10	-23	182	+16
041	46	-15	176, 180	+12	083	334	-36	174, 180	+ 3
042	34	-12	164, 180	+18	084	359	-17	180	+21
043	0	-15	180	+17	085	324	-19	190	+17
044	5	-30	151	+ 5	086	28	-15	179	+29

Station	Downhill slope		Uphill slope		Station	Downhill slope		Uphill slope	
	Direction (degrees true)	Inclination (angle)	Direction (degrees true)	Inclination (angle)		Direction (degrees true)	Inclination (angle)	Direction (degrees true)	Inclination (angle)
A087	356°	-36'	168°	+ 4'	A131	331°	-31'	147°	+ 1'
588	0	-18	180	+22	632	45	- 7	180	+22
089	0	-14	170	+24	133	358	-10	153	+19
090	358	-19	175	+29	634	46	- 3	156	+24
591	358	-26	136	+10	135	1	-20	158	+ 9
092	358	-22	171	+27	636	36, 45	- 2	135	+30
593	331	- 4	167	+32	637	2	- 9	151	+24
094	1	-23	180	+32	138	34	- 3	135, 142	+43
095	345	-39	178	+ 3	638	28	-18	122	+1° 03'
096	335	-17	180	+20	639	30, 45	-18	152	+13
097	0, 9	-12	171, 180	+17	140	338	-12	145	+59
098	0	-18	162	+16	141	55	0	120	+28
099	0, 346	-30	186	+ 4	142	335	-19	143	+50
100	352	-17	173	+19	643	237	- 8	150	+33
101	358	-21	182	+18	144	334	-17	162	+38
102	0, 354	-15	164	+15	145	318	-16	168	+37
103	347	-32	143	+ 5	146	316	-25	171	+23
604	327	-16	159	+16	147	309	-33	180	+11
105	334	-20	167, 180	+14	148	346	-19	173, 180	+11
606	0, 350	- 9	172	+17	149	305	-18	189	+16
107	0, 6	-30	135, 161, 180	+ 2	650	346	-15	171, 180	+13
108	346	-17	158	+21	151	0, 351	-22	220	+ 8
109	45, 357	-18	155	+20	652	0	-11	197	+25
110	352	-21	157	+22	653	314	- 2	180	+31
111	346	-34	166, 180	+ 2	154	0, 346	-15	163	+22
112	0, 352	-18	180	+17	155	0, 343	-34	134	+ 2
113	345	-18	134	+21	656	357	- 7	193	+41
114	352	-21	137	+24	157	347	-16	205	+31
115	315, 325	-31	165	+28	658	296	- 2	146	+48
116	346	-23	141	+28	159	350	-36	121, 135	+14
117	6	-21	194	+24	160	315, 334	-16	165	+43
118	339	-34	135, 147	+ 3	161	346	-26	134	+24
619	315, 0, 45	- 9	151	+21	162	315	-19	183	+26
120	335	-22	144	+27	163	340	-37	176	+11
121	341	-21	134	+34	164	24	-17	180	+15
122	350	-23	135, 141	+15					
123	337	-35	155	+ 6					
624	359	-11	159	+28					
125	353	-22	180	+16					
126	313	-16	143	+12					
127	338	-38	171	+ 5					
128	2	-20	153	+12					
129	0, 343	-20	195	+18					
130	6	-15	198	+17					