VI. 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

Renji NARUSE*, Aiichiro YOSHIMURA** and Hiromu SHIMIZU*

With the purpose of conducting researches on the ice sheet flow, a triangulation chain and a traverse survey line, 250 and 200 km in total length respectively, were installed in the Mizuho Plateau - West Enderby Land area in 1969 and 1970 by JARE 10 and JARE 11 (see Fig. A attached to the end of this volume).

1. Triangulation Chain

1.1. Outline

A triangulation chain was set along the parallel of 72°S (S240 - A001, as shown in Fig. A) during a period from November 24 to December 30, 1969, by the traverse party of JARE 10.

The chain which tied S240 (A164) to the Yamato Mountains is composed of 162 triangles and 164 stations.

1) Datum point

A001: Adopted position 71°47'28.06"S, 36°12'12.24"E.

2) Angle measurements

Horizontal angle: all the interior angles of 162 triangles.

Vertical angle: from each of 164 stations to the four neighboring stations.

3) Distance measurements

On the following 12 sides of triangles:

A001-A002, A001-A004, A005-A006, A031-A032, A048-A049, A064-A065, A088-A089, A099-A100, A116-A117, A134-A135, A152-A153, A163-A164.

(A001-A002: this line served as a base line with a length of about 850 m on the bare rocks of two nunataks near the southern end of the Yamato Mountains.)

* The Institute of Low Temperature Science, Hokkaido University, Sapporo.

**Geographical Survey Institute, Ministry of Construction, Azabu Iikura-cho, Minato-ku, Tokyo.

4) Azimuth observations

At the following 9 stations by solar observation:
A001 (to A002), A025 (to A024), A049 (to A048), A065 (to A064), A089 (to A088), A117 (to A116), A135 (to A134), A153 (to A154), A164 (to A163).

1.2. Method of survey

The method of survey is based on the standard operation procedure for the fourth order triangulation of Japan.

1) Observers

Hisao Ando, Masaru Yoshida, Kunio Omoto, Renji Naruse and Yutaka Ageta.

2) Observations

(a) Angle measurements with a Wild T2 theodolite:
Horizontal angle ... two pairs of observations at the graduated circle of 0° and 90°.
Vertical angle ..... one pair of observations.

(b) Distance measurements with an Electrotape instrument (Cubic DM-20): one pair of measurements alternating the Interrogater and the Responder.

(c) Measurements of air temperature and air pressure: (for the correction of Electrotape data).

3) Limits of error allowed

(a) Observed differential: 15"
(b) Double angle difference: 25"
(c) Vertical angle constant difference: 20"
(d) Closure error of a triangle: 20"
(e) Distance difference between two measurements:
about $2 + D/(2 \times 10^5)$ cm,
where D = observed distance (cm).

4) Procedure of survey

The field party was split into four groups, each with a theodolite and a tripod target about 3 m in height. Each group carried out operations at each station by the following procedure:

(a) Selecting a station.
(b) Setting the tripod target.
(c) Plumbing a point on the snow surface from the center of the target.
(d) Setting a theodolite exactly on the center point.

(e) Measuring the horizontal and the vertical angles of neighboring targets.

(f) Setting a metal pole (3 m in length) or a bamboo stake (about 2.5 m in length) exactly at the center point.

(g) Moving to the next new station, where the same procedure is repeated (see Fig. VI-1).

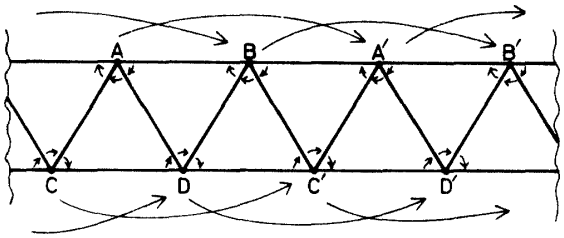

Fig. VI-1. Procedures of the triangulation survey. Subsequently to angle measurements each group moves from A to A', B to B', C to C' and D to D'.

Distance measurements and azimuth observations were made for every 10 to 15 triangles to correct the accumulation of errors. The length of every side of triangles was approximately calculated during the survey to find any sizable error.

1.3. Computation of elevation and location

1) General

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

Projection: Gauss-Krüger projection.

Computer: NEAC-2206 located at the Geographical Survey Institute.

2) Computation of elevation

The elevation of each station was calculated by the following equation:

$$\Delta h = S \cdot \tan \tfrac{1}{2}(\alpha_1 - \alpha_2) + \tfrac{1}{2}(i_1 + f_1) - \tfrac{1}{2}(i_2 + f_2),$$

where, Δh is the relative elevation between two stations, S the distance between two stations, α the altitude angle, i the height of the instrument, and f the height of the tripod target. Suffix 1 or 2 denotes that of station 1 or 2 (see Fig. VI-2).

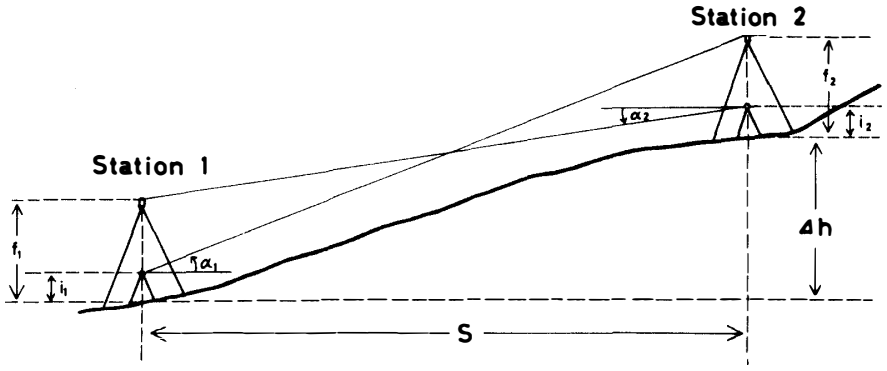

Fig. VI-2. A schema indicating the way of measuring the altitude angle.

Possible errors resulting from refraction by air or the curvature of the earth can be counterbalanced, as a measurement is made from one station to the next station and another measurement in the opposite direction between the two stations.

3) Correction of Electrotape data

(a) Meteorological correction.

$$D = D_o + D_o(320 - \Delta) \times 10^{-6},$$

where, $\Delta = (n - 1)\cdot 10^6 \simeq \frac{103.49}{T} \cdot P$,

where, D_o is observed distance, n the index of refraction by air, T the air temperature (^oK), and P the air pressure (mmHg).

The effect of vapour pressure on the measurement is considered to be negligible as the vapour pressure is low due to low temperature.

(b) Slope correction.

$$d = D\cdot\cos\alpha,$$

where, d is the horizontal distance, D the slope distance, and α the altitude angle (see Fig. VI-3).

(c) Sea level correction.

$$S = d\cdot(1 - h/R),$$

where, S is the distance on the sea level, $h = (h_1 + h_2)/2$ (mean elevation above the sea level of two stations), and R the radius of curvature of the earth (see Fig. VI-4).

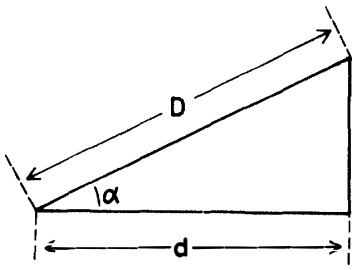

Fig. VI-3. Slope correction in the measured distance.

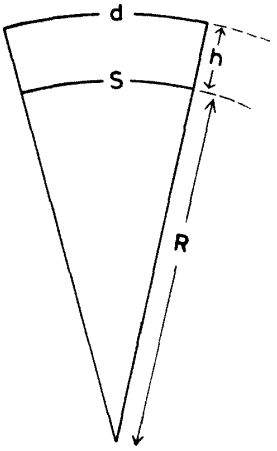

Fig. VI-4. Sea level correction in the measured distance.

4) Computation of net adjustment

The triangulation chain (as shown in Fig. VI-5) was divided into five blocks (see Table VI-2). In each block, computation of net adjustment was made by the least squares method from the observation equation, whose unknown factor was the correction term to approximate values of (X, Y) coordinates of an unknown station.

At the first block, calculations were made from the following input data:

(a) (X, Y) coordinates of the datum point A001 as (0.000 m, 0.000 m).
(b) Approximate (X, Y) coordinates of unknown stations as (X_i', Y_i').
(c) Distances S_1, S_2 of the beginning and the final side of the block.
(d) Direction angles T_1, T_2 at the beginning and the final side of the block.
(e) Observed horizontal angles at each station (see Fig. VI-6).

At the second block, the same calculations were made on the condition that the last stations C and D in the first block were the given points. On the third to the fifth blocks, calculations were made in the same way.

1.4. Results of computation

Elevation H and coordinates (X, Y) of all stations are tabulated in Table VI-1, where it is supposed H = 0.00 m, X = 0.000 m, Y = 0.000 m at the datum point A001. The direction of X coordinate is geographical north and that of Y is east.

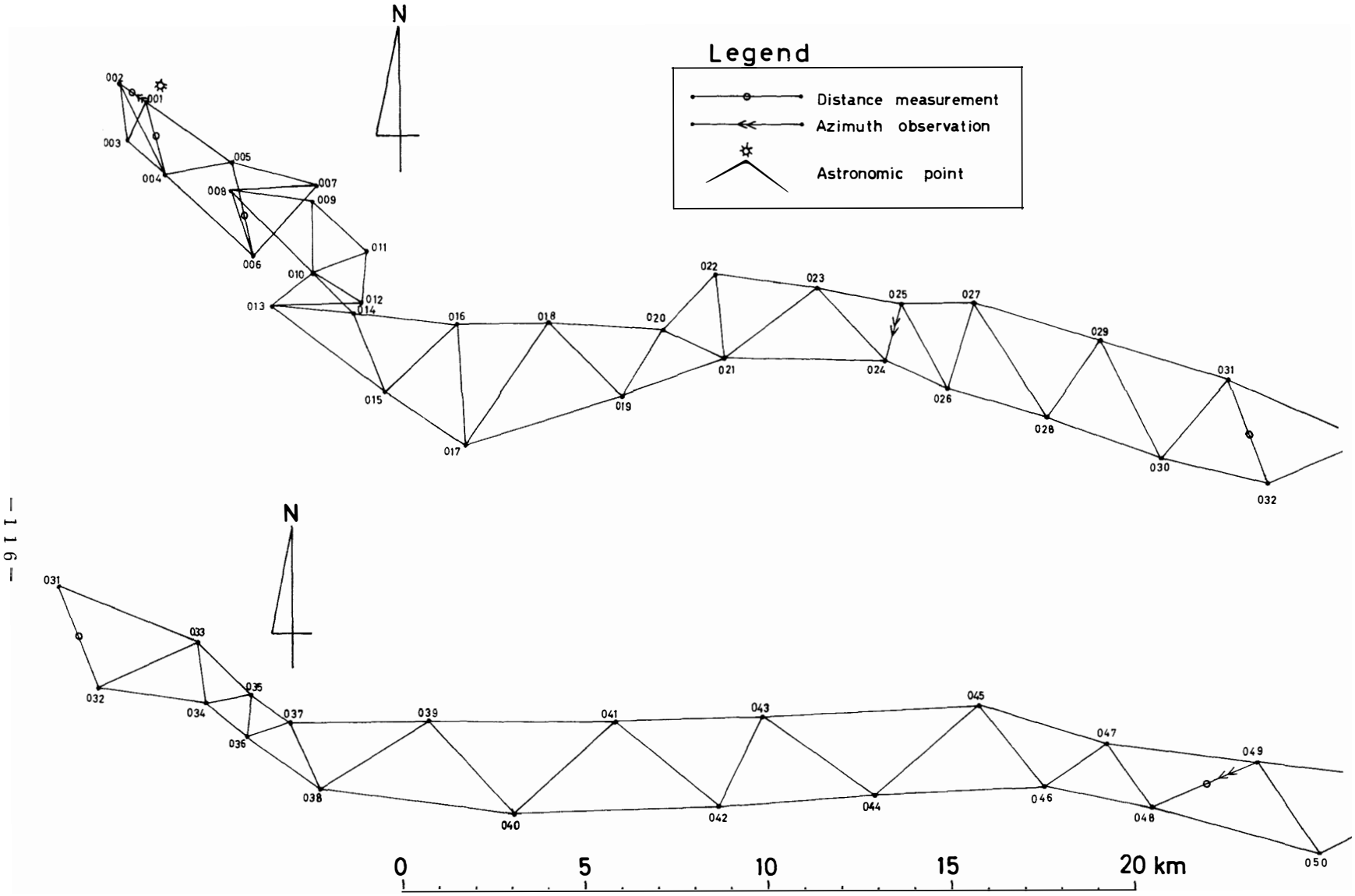

Fig. VI-5-1. The triangulation chain installed from S240 ($72^{\circ}00'08"S$, $43^{\circ}09'51"E$) to A001 ($71^{\circ}47'28.06"S$, $36^{\circ}12'12.24"E$).

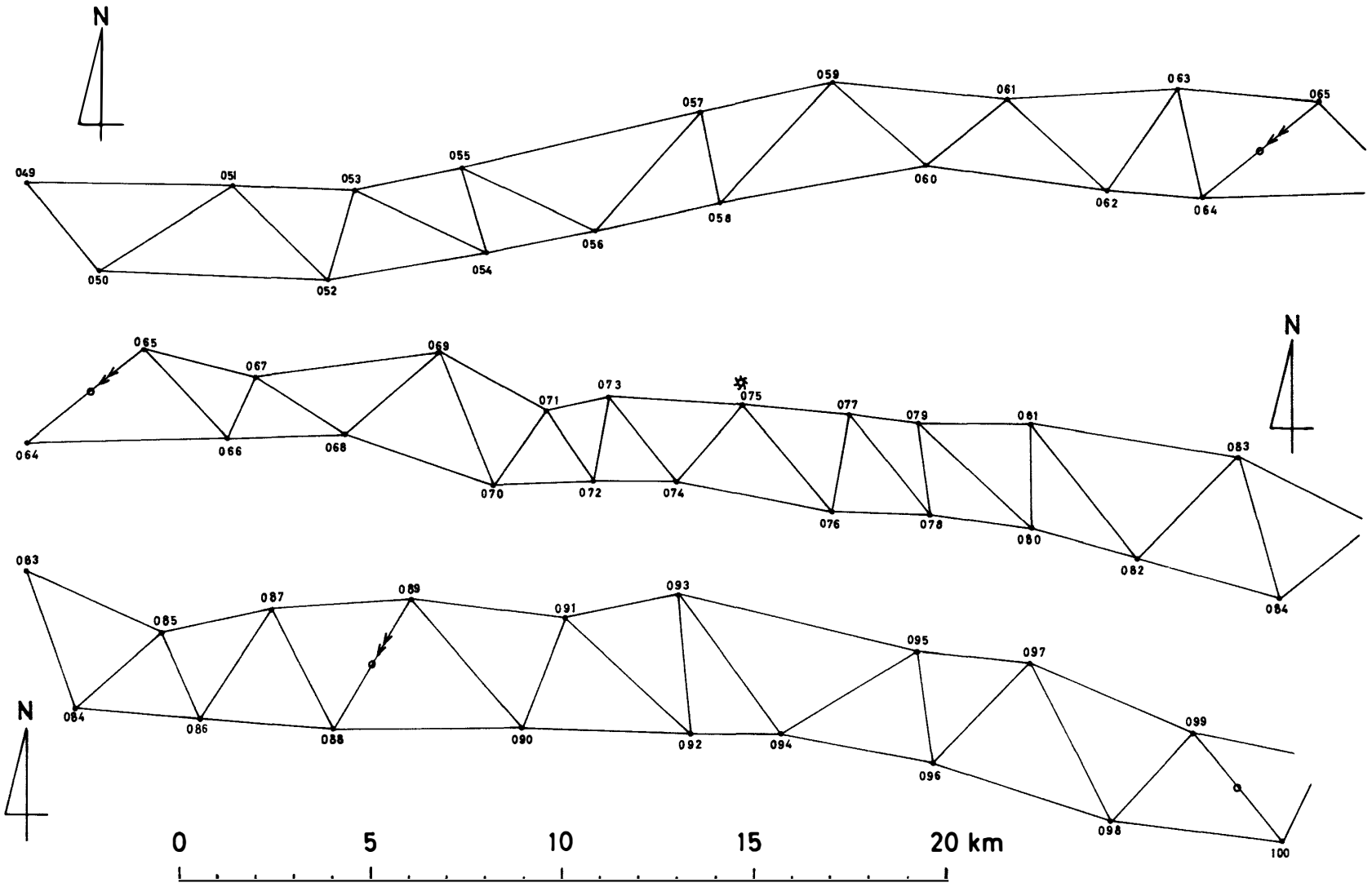

Fig. VI-5-2. The triangulation chain installed from S240 ($72^{\circ}00'08"S$, $43^{\circ}09'51"E$) to A001 ($71^{\circ}47'28.06"S$, $36^{\circ}12'12.24"E$).

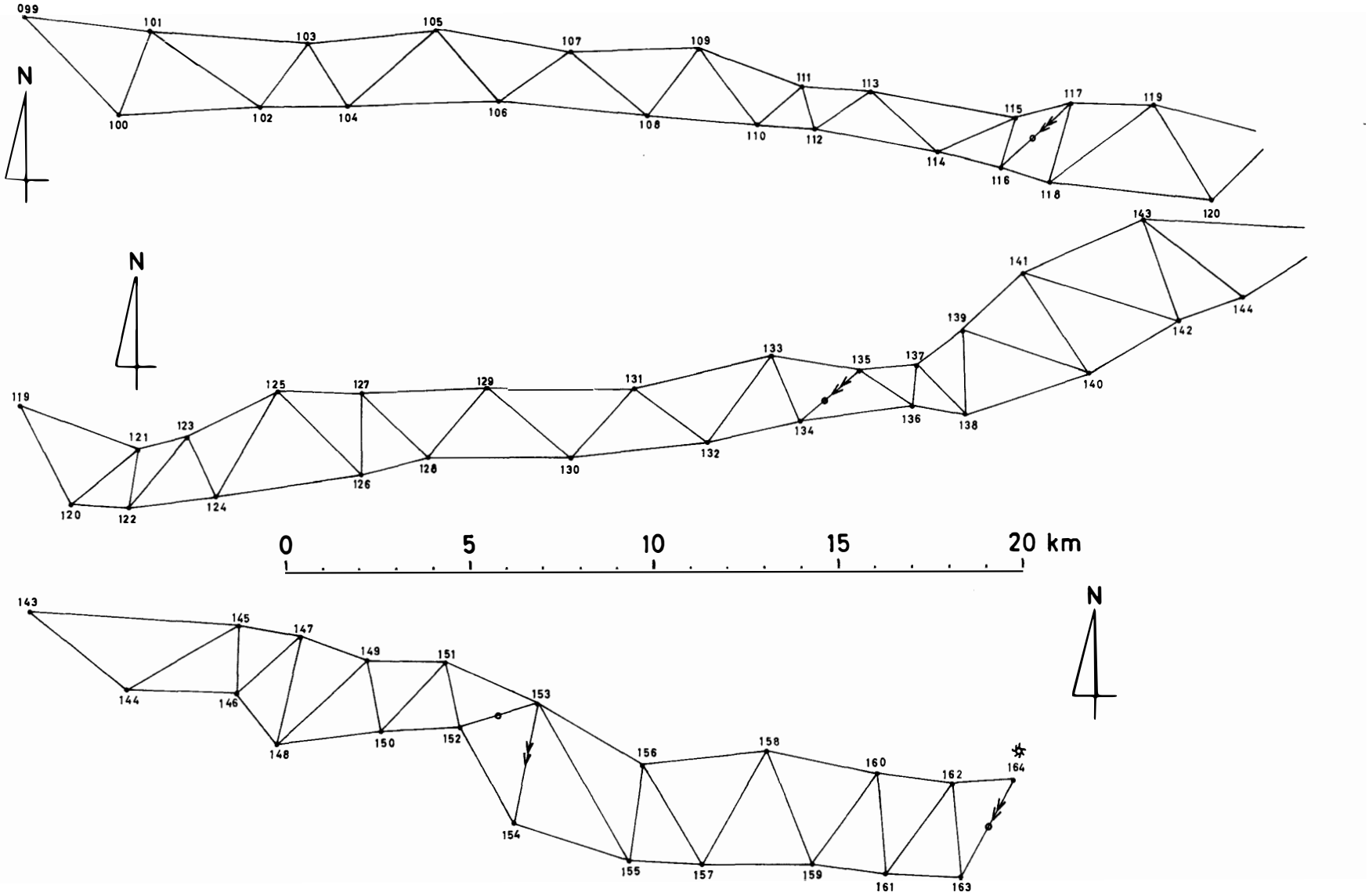

Fig VI-5-3. The triangulation chain installed from S240 ($72^{\circ}00'08"S$, $43^{\circ}09'51"E$) to A001 ($71^{\circ}47'28.06'S$, $36^{\circ}12'12.24"E$).

Table VI-1. (X, Y) coordinates and relative elevations of all stations in the Triangulation Chain.

Station	H	X	Y	M_x	M_y
	m	m	m	m	m
A001	0.00	0.000	0.000		
002	25.43	+ 503.358	- 681.665	0.034	0.046
003	- 3.46	- 1068.955	- 530.229	0.042	0.029
004	14.88	- 2035.431	+ 532.506	0.013	0.048
005	27.33	- 1728.916	2327.617	0.055	0.080
006	63.70	- 4289.829	2922.476	0.171	0.148
007	40.06	- 2364.402	4668.187	0.119	0.233
008	32.27	- 2448.305	2292.892	0.093	0.115
009	41.85	- 2762.023	4472.764	0.131	0.225
010	84.19	- 4714.187	4484.859	0.222	0.239
011	79.83	- 4182.489	5983.933	0.216	0.332
012	96.76	- 5535.015	5788.389	0.292	0.329
013	82.23	- 5578.184	3323.016	0.271	0.229
014	96.46	- 5840.213	5635.192	0.312	0.322
015	99.15	- 7963.741	6429.728	0.467	0.393
016	116.12	- 6178.690	8414.401	0.377	0.519
017	121.79	- 9505.427	8558.369	0.605	0.556
018	122.73	- 6218.426	10894.832	0.425	0.735
019	133.37	- 8235.434	12893.962	0.555	0.906
020	133.90	- 6407.225	14036.497	0.492	0.992
021	137.59	- 7212.292	15708.881	0.540	1.103
022	121.16	- 4936.172	15497.034	0.508	1.086
023	127.92	- 5298.035	18291.348	0.544	1.264
024	128.40	- 7304.559	20177.365	0.579	1.369
025	123.21	- 5792.569	20585.292	0.562	1.387
026	140.73	- 8094.175	21891.593	0.597	1.432
027	121.90	- 5822.683	22545.534	0.576	1.459
028	143.23	- 8891.166	24589.800	0.627	1.525
029	140.45	- 6866.809	25968.118	0.622	1.565
030	160.18	-10017.985	27613.775	0.667	1.585
031	156.24	- 7879.812	29429.613	0.688	1.608
032	159.57	-10670.176	30503.254	0.710	1.595
033	155.06	- 9497.972	33256.439	0.075	0.112
034	168.48	-11182.445	33462.558	0.073	0.130
035	167.21	-10973.776	34662.975	0.091	0.175

Station	H	X	Y	M_x	M_y
	m	m	m	m	m
A036	176.91	-12078.602	34524.659	0.127	0.178
037	171.70	-11719.017	35672.948	0.128	0.235
038	175.97	-13528.496	36446.364	0.236	0.294
039	164.50	-11769.501	39432.954	0.214	0.506
040	171.47	-14336.380	41657.630	0.360	0.685
041	156.83	-11932.376	44441.651	0.338	0.899
042	159.45	-14268.590	47196.389	0.457	1.109
043	149.87	-11881.809	48401.482	0.427	1.197
044	156.87	-14114.405	51411.749	0.529	1.404
045	144.11	-11737.317	54256.788	0.540	1.579
046	154.30	-13947.024	55991.087	0.596	1.668
047	155.17	-12837.757	57666.107	0.599	1.733
048	160.29	-14633.189	58877.107	0.639	1.755
049	157.56	-13491.231	61794.252	0.639	1.755
050	168.09	-15989.208	63438.094	0.677	1.749
051	160.26	-14192.377	67092.434	0.682	1.774
052	171.41	-16891.053	69327.093	0.743	1.791
053	155.37	-14644.946	70233.317	0.715	1.812
054	162.34	-16607.887	73468.521	0.778	1.873
055	150.50	-14362.249	73037.079	0.741	1.871
056	159.07	-16328.612	76263.743	0.803	1.953
057	144.58	-13575.649	79329.252	0.818	2.059
058	153.77	-16004.732	79544.843	0.835	2.059
059	138.05	-13242.395	82758.194	0.863	2.174
060	150.33	-15565.927	84918.140	0.893	2.239
061	143.18	-14065.657	87196.459	0.913	2.298
062	151.77	-16653.079	89573.978	0.953	2.325
063	133.22	-14165.927	91550.938	0.955	2.347
064	154.44	-17063.781	91934.287	0.974	2.344
065	129.82	-14903.097	95169.320	0.974	2.344
066	169.38	-17378.463	97195.298	0.103	0.093
067	149.81	-15881.028	97994.825	0.079	0.119
068	168.28	-17572.235	100279.645	0.154	0.224
069	152.28	-15641.836	102873.804	0.183	0.362
070	177.09	-19178.873	104033.796	0.280	0.436
071	163.01	-17354.733	105486.547	0.251	0.516
072	176.42	-19321.943	106567.600	0.324	0.580
073	159.92	-17171.100	107106.361	0.284	0.608

Station	H	X	Y	M_x	M_y
	m	m	m	m	m
A074	166.51	-19463.526	108732.605	0.365	0.704
075	158.09	-17572.460	110542.313	0.364	0.800
076	171.79	-20470.104	112711.824	0.466	0.919
077	163.82	-18022.230	113261.900	0.429	0.943
078	179.49	-20693.979	115146.852	0.516	1.043
079	169.52	-18326.920	114956.093	0.468	1.033
080	185.86	-21188.813	117751.593	0.576	1.164
081	166.00	-18496.733	117850.478	0.528	1.169
082	190.63	-22095.295	120447.319	0.644	1.273
083	176.10	-19578.744	123213.304	0.647	1.374
084	194.26	-23292.706	124154.265	0.724	1.403
085	189.81	-21505.132	126587.246	0.730	1.471
086	196.39	-23893.346	127401.842	0.769	1.479
087	181.45	-21244.524	129493.162	0.768	1.503
088	195.58	-24472.368	130766.327	0.796	1.503
089	173.38	-21314.532	133021.725	0.796	1.503
090	191.52	-24628.629	135942.134	0.825	1.498
091	171.74	-21801.983	137027.533	0.820	1.504
092	205.65	-24782.403	140260.115	0.856	1.508
093	162.86	-21232.578	139961.455	0.842	1.515
094	202.95	-24886.554	142622.856	0.879	1.524
095	199.20	-22749.756	146159.059	0.914	1.553
096	207.55	-25661.147	146550.786	0.929	1.554
097	199.39	-23159.151	149097.413	0.960	1.577
098	221.12	-27262.291	151154.091	1.010	1.596
099	208.58	-25019.281	153266.743	1.046	1.608
100	225.27	-27916.820	155589.659	1.100	1.607
101	214.99	-25755.600	156645.165	0.085	0.057
102	222.89	-28068.001	159369.940	0.102	0.203
103	218.89	-26547.078	160846.558	0.154	0.263
104	227.87	-28351.366	161755.991	0.160	0.330
105	224.90	-26633.542	164291.473	0.234	0.492
106	229.09	-28765.092	165833.333	0.273	0.615
107	226.71	-27697.786	167840.762	0.309	0.754
108	238.21	-29621.106	169676.963	0.399	0.888
109	231.32	-27981.271	171271.626	0.399	0.996
110	244.69	-30230.368	172536.315	0.490	1.091

Station	H	X	Y	M_x	M_y
	m	m	m	m	m
A111	244.76	-29375.205	173832.703	0.487	1.173
112	250.31	-30552.146	173972.016	0.530	1.181
113	243.80	-29777.018	175642.586	0.534	1.271
114	257.46	-31658.351	177077.857	0.614	1.327
115	252.89	-31120.378	179342.928	0.632	1.364
116	266.77	-32438.492	178652.247	0.648	1.350
117	257.15	-31110.586	180832.661	0.648	1.350
118	273.54	-33053.759	179847.769	0.651	1.346
119	249.67	-31505.737	183036.737	0.664	1.356
120	282.58	-34292.327	184110.435	0.695	1.354
121	275.54	-32984.953	186080.672	0.701	1.369
122	287.59	-34526.291	185663.944	0.713	1.363
123	275.44	-32770.120	187451.306	0.714	1.385
124	278.93	-34470.914	188042.192	0.735	1.388
125	278.57	-31803.365	190058.975	0.745	1.430
126	290.78	-34288.674	192030.451	0.781	1.468
127	281.15	-32114.136	192268.604	0.770	1.482
128	279.30	-34023.416	193850.945	0.801	1.520
129	267.00	-32300.565	195711.428	0.812	1.580
130	272.81	-34465.886	197768.128	0.856	1.636
131	265.54	-32832.410	199683.872	0.864	1.694
132	264.13	-34533.571	201479.703	0.898	1.725
133	259.60	-32420.546	203473.243	0.902	1.761
134	256.16	-34215.398	203998.318	0.914	1.762
135	254.72	-33054.934	205803.493	0.914	1.762
136	254.71	-34201.683	207096.993	0.060	0.057
137	255.34	-33152.277	207382.466	0.046	0.068
138	244.95	-34681.000	208439.753	0.101	0.110
139	249.43	-32422.190	208700.502	0.090	0.130
140	266.32	-34104.351	211932.856	0.164	0.276
141	245.80	-31157.735	210554.185	0.163	0.228
142	280.29	-33031.673	214532.188	0.218	0.412
143	237.44	-30200.941	213896.516	0.246	0.399
144	281.81	-32618.314	216303.484	0.256	0.502
145	272.68	-31208.123	219521.625	0.328	0.627
146	290.74	-32974.078	219283.853	0.320	0.616
147	281.80	-31623.930	221175.916	0.355	0.670
148	299.50	-34429.926	220205.224	0.355	0.638

Station	H	X	Y	M_x	M_y
	m	m	m	m	m
A149	287.48	-32470.653	222857.665	0.380	0.718
150	295.12	-34322.547	223011.469	0.389	0.721
151	280.96	-32709.410	224923.488	0.405	0.755
152	290.09	-34538.637	225097.222	0.409	0.760
153	278.72	-34152.722	227213.761	0.421	0.759
154	307.07	-37261.887	226188.082	0.442	0.760
155	318.92	-38662.454	229214.759	0.462	0.762
156	289.60	-36168.331	229814.860	0.452	0.760
157	313.55	-38959.092	231073.200	0.472	0.763
158	286.39	-36119.744	233139.533	0.472	0.768
159	332.02	-39269.006	234022.180	0.488	0.772
160	310.74	-37044.140	236039.483	0.491	0.778
161	344.75	-39682.786	235954.130	0.499	0.779
162	331.31	-37407.786	237978.351	0.501	0.784
163	350.16	-39894.685	237967.173	0.507	0.784
164	337.20	-37426.102	239617.415	0.507	0.784

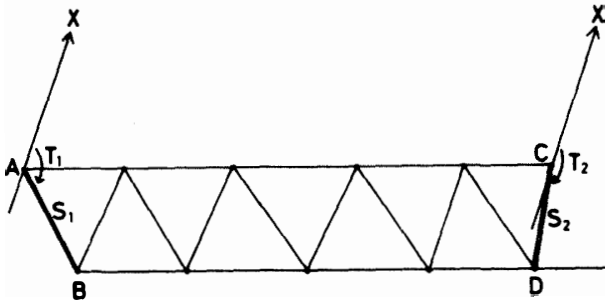

Fig. VI-6. Computation of a net adjustment in each block.

1.5. Accuracy

Standard errors of (X, Y) coordinates, M_x and M_y (see Fig. VI-7), were calculated in each block separately. They are tabulated also in Table VI-1. The maximum standard error in each block is shown in Table VI-2.

The error in position of the farthest station from the datum point is estimated to be within 10 m.

Errors in elevation were calculated in accordance with the law of propagation of error.

The standard error of unit weight in the angle measurement is 4.68".

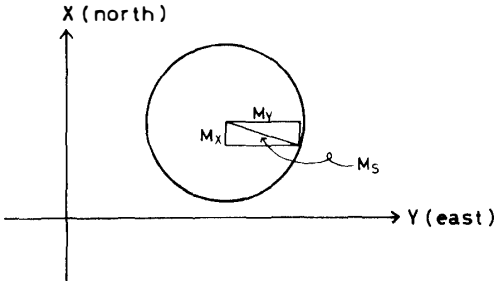

Fig. VI-7. A schema showing an error in position.

Table VI-2. Standard error M_x, M_y in each block.

Block number	Station	M_x	M_y
I	A001 - A032	0.7 m	1.6 m
II	A033 - A065	1.0	2.3
III	A066 - A100	1.1	1.6
IV	A101 - A135	0.9	1.8
V	A136 - A164	0.5	0.8
	A001 - A164	1.94m	3.78m

2. Traverse Survey Line

2.1. Outline

A traverse survey was carried out from a south peak of the Sandercock Nunataks to the southwestward (W00 - W55, as shown in Fig. A), during a period from December 17 to 30, 1970, by the traverse party of JARE 11.

The survey was an open traverse, starting at the datum point located on the bare rock and covering 55 stations on the ice sheet (see Fig. VI-8).

1) Datum point

W00: After 19 sets of solar observation, the position was adopted as 68°36'41.000"S, 52°06'02.000"E.

Adopted azimuth of C4: 135°11'31.8" (after 6 sets of solar observation.) (see Fig. VI-8).

2) Azimuth observations

W19 (to W18), W33 (to W32), W55 (to W54). (after 6 sets of solar observation.)

2.2. Method of survey

1) Observers

All members of the field party (Hiromu Shimizu, Okitsugu Wata-

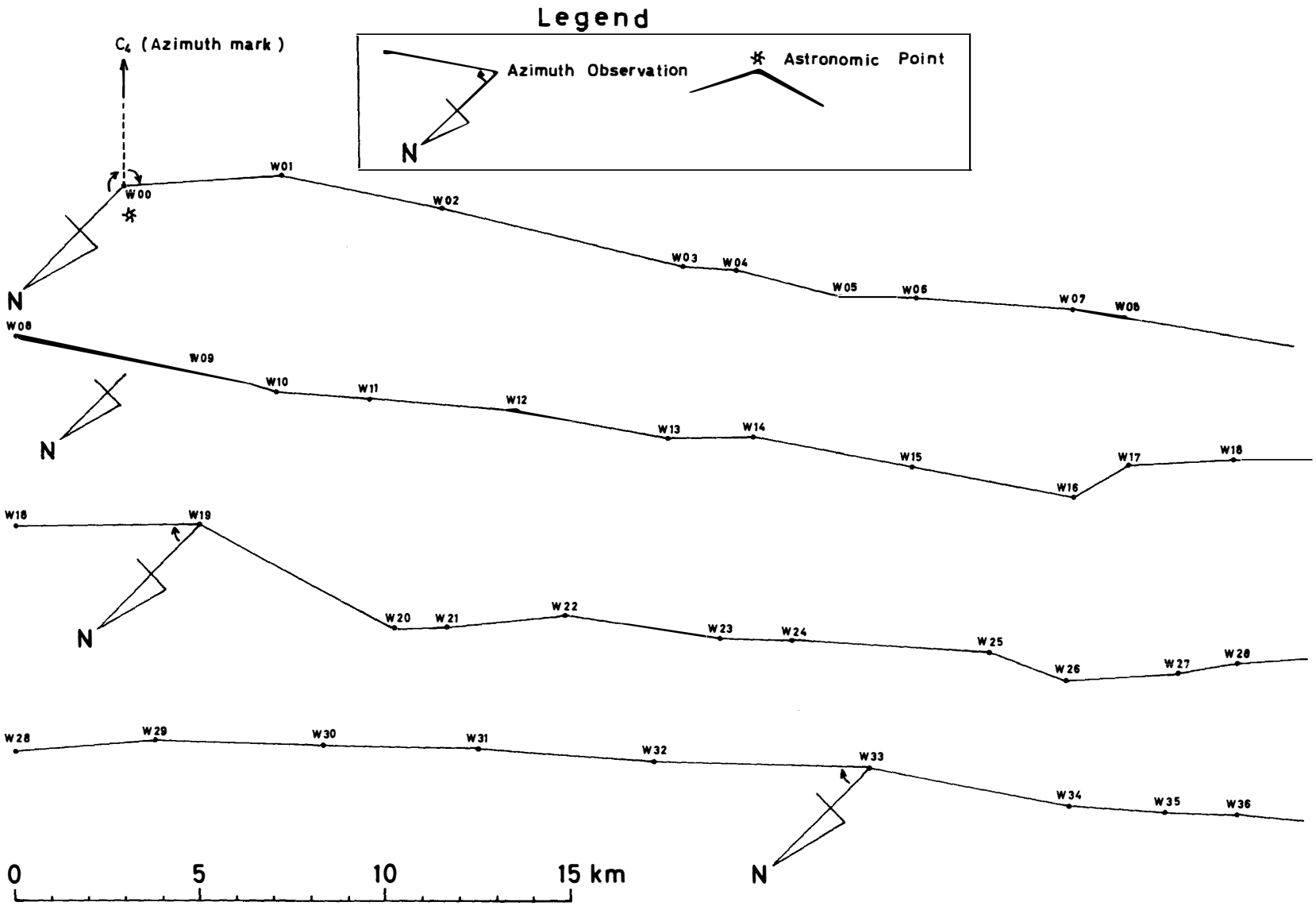

Fig. VI-8-1. The traverse survey line installed from W00 ($68^{\circ}36'41"S$, $52^{\circ}06'02"E$) to W55 ($69^{\circ}41'23"S$, $48^{\circ}10'15"E$).

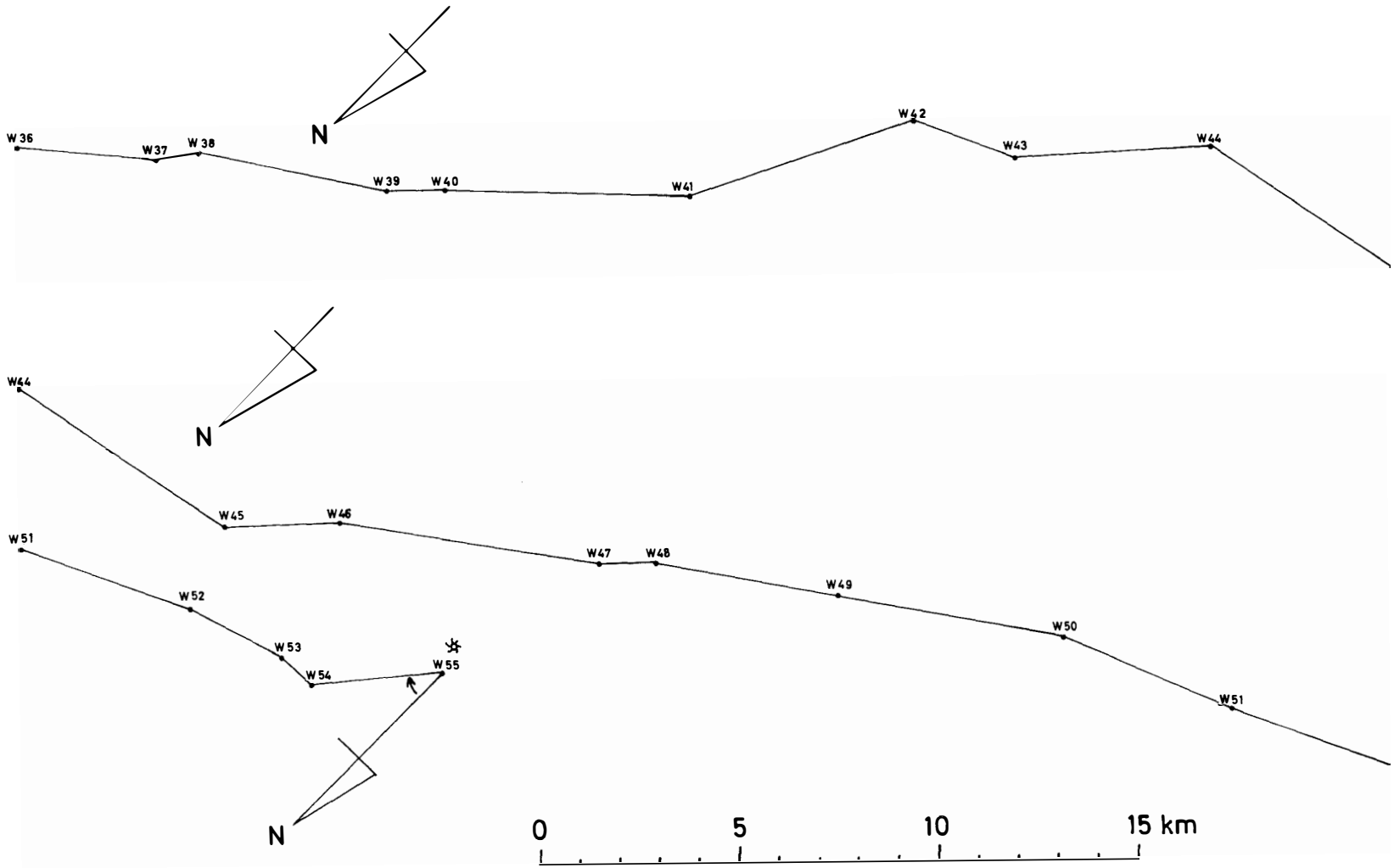

Fig. VI-8-2. The traverse survey line installed from W00 (68°36'41"S, 52°06'02"E) to W55 (69°41'23"S, 48°10'15"E).

nabe, Aiichiro Yoshimura and 5 other men) were engaged in the observations.

2) Observations

Same as those of "Triangulation Chain".

3) Limits of error allowed

(a) Observed differential: 15"

(b) Double angle difference: 25"

(c) Vertical angle constant difference: 20"

4) Procedure of survey

The field party was split into four groups: one of them carried out reconnaissance and selection of a station; three other groups, each with a theodolite and an Electrotape instrument, carried out angle and distance measurements.

The procedure of survey is the same way as that of the standard traverse survey.

2.3. Computation of elevation and location

1) General

Reference ellipsoid: International Ellipsoid. (Radius of equator: 6378388 m, flattening: 1/297.0)

Computer: Same as that of "Triangulation Chain".

2) Computation of elevation

The tripod target was not used in this survey. However, the way in which the elevation was computed was nearly the same as that of "Triangulation Chain".

3) Correction of Electrotape data

Same as that of "Triangulation Chain".

4) Computation of latitude and longitude

The latitude and longitude of each station was calculated from the following input data:

(a) Latitude and longitude of datum point W00.

(b) Adopted azimuth of C4.

(c) Observed azimuth (astronomic azimuth) at three stations (W19, W33 and W55).

(d) Observed distances at each span.

(e) Observed angles at each station.

The weight of astronomic azimuth was the same value as that of the included angles, namely 1.000.

2.4. Results of computation

The latitude, longitude and elevation of all stations are tabulated

Table VI-3. Locations and relative elevations of all stations in the traverse survey.

Station	Elevation H	Latitude	Longitude	M.F (Lat.)	M.F (long.)
	m			m	m
W00	0.0	68°36' 41".000S	52°06' 02".000E		
01	- 40.4	68 38 23.327	52 01 53.846	0.15	0.15
02	- 32.7	68 39 41.892	51 56 28.728	0.31	0.27
03	- 39.7	68 41 33.547	51 48 11.344	0.60	0.45
04	- 34.2	68 42 03.829	51 46 35.503	0.67	0.51
05	- 37.2	68 42 52.909	51 42 52.188	0.82	0.60
06	- 38.4	68 43 38.685	51 40 41.168	0.91	0.69
07	- 50.0	68 45 07.077	51 35 58.155	1.11	0.86
08	- 55.7	68 45 33.042	51 34 21.019	1.18	0.92
09	- 69.3	68 47 08.552	51 28 18.951	1.44	1.10
10	- 82.2	68 47 42.241	51 25 29.097	1.57	1.17
11	- 89.9	68 48 35.015	51 22 42.052	1.68	1.27
12	-119.5	68 49 59.151	51 18 11.057	1.87	1.43
13	-139.4	68 51 14.017	51 13 08.046	2.07	1.56
14	-142.5	68 52 06.692	51 10 46.705	2.15	1.65
15	-151.7	68 53 25.344	51 05 28.093	2.32	1.76
16	-169.5	68 54 46.750	50 59 59.867	2.48	1.87
17	-162.0	68 55 41.109	50 59 19.791	2.50	1.92
18	-164.6	68 56 47.859	50 56 32.495	2.54	1.97
19	-158.3	68 58 42.601	50 51 20.768	2.60	2.02
20	-194.2	68 59 37.791	50 42 59.559	2.67	2.04
21	-195.0	69 00 10.089	50 41 34.714	2.69	2.05
22	-192.3	69 01 29.808	50 38 32.214	2.73	2.09
23	-211.4	69 02 50.930	50 33 25.341	2.80	2.14
24	-215.6	69 03 33.579	50 31 18.510	2.83	2.17
25	-217.9	69 05 26.226	50 25 20.121	2.93	2.26
26	-220.5	69 05 56.518	50 22 21.005	2.98	2.29
27	-224.2	69 07 08.452	50 19 25.540	3.04	2.34
28	-230.0	69 07 51.289	50 18 00.743	3.06	2.38
29	-245.4	69 09 24.860	50 14 13.206	3.12	2.45
30	-254.4	69 11 04.880	50 09 13.682	3.20	2.53
31	-243.3	69 12 39.258	50 04 33.830	3.26	2.59
32	-242.4	69 14 16.882	49 59 11.671	3.32	2.63
33	-249.8	69 16 27.197	49 52 46.541	3.35	2.67
34	-236.7	69 18 05.552	49 46 00.383	3.40	2.70

Station	Elevation H	Latitude	Longitude	M.F (Lat.)	M.F (Long.)
	m			m	m
W35	-228.6	69°19'00".182S	49°43'01".354E	3.43	2.72
36	-229.5	69 19 42.070	49 40 53.700	3.45	2.74
37	-233.1	69 20 54.193	49 36 47.857	3.50	2.77
38	-237.0	69 21 23.564	49 35 47.529	3.51	2.79
39	-266.0	69 22 46.202	49 29 40.072	3.60	2.84
40	-261.0	69 23 19.747	49 28 04.829	3.63	2.87
41	-268.2	69 25 31.572	49 21 13.573	3.76	2.99
42	-214.4	69 28 19.597	49 17 00.373	3.86	3.18
43	-215.6	69 28 53.451	49 13 16.268	3.95	3.23
44	-221.2	69 30 47.909	49 08 08.578	4.08	3.38
45	-221.9	69 31 20.736	48 58 46.907	4.35	3.42
46	-204.2	69 32 27.596	48 55 37.520	4.45	3.50
47	-142.0	69 34 26.941	48 47 14.138	4.70	3.66
48	-134.2	69 34 55.608	48 45 48.342	4.74	3.69
49	-133.6	69 36 17.138	48 39 39.455	4.91	3.79
50	-101.9	69 37 55.873	48 32 10.765	5.11	3.89
51	- 82.0	69 38 44.854	48 25 27.067	5.28	3.93
52	- 41.3	69 39 41.391	48 18 58.112	5.42	3.98
53	- 19.6	69 40 01.835	48 14 59.992	5.49	3.99
54	- 17.7	69 40 01.095	48 13 31.452	5.50	3.99
55	+ 6.0	69 41 23.293	48 10 14.531	5.53	4.00

in Table VI-3, where it is supposed H = 0.0 m at datum point W00.

2.5. Accuracy

Errors (M. F.) in latitude and longitude of each station are tabulated also in Table VI-3.

Because of the open traverse, the accumulation of errors in the angle measurement increased remarkably at stations remote from the datum point.

The error in position of the farthest station (W55) from the datum point is ±5.53 m in latitude and ±4.00 m in longitude. Gewichtseinheitsfehler is 7.98". The error in elevation is about ±4 m.

3. Strain Grid

3.1. Outline

Surveys for the strain grid of 1 km x 1 km square were carried out in 1969, 1970 and 1971 by the traverse parties of JARE 10 and JARE

11, at the stations noted in Table VI-4. The strain grids at S40, S100 and S160 were surveyed twice in different years. Results of calculation of strain rate will be reported in a separate article.

3.2. Method

The distance of the diagonal of the square was measured by an Electrotape instrument, and the interior angles of the two triangles were measured by theodolites (see Fig. VI-9).

Table VI-4. Locations of Strain Grid surveyed in 1969 - 1971.

Station	Location		Date
	Latitude	Longitude	
S 40	69°04.7' S	41°07' E	Nov. 5, 1969; Jan. 22, 1971
100	69 38.1'	42 50'	Nov. 10, 1969; Nov. 10, 1970
160	70 40.2'	43 06'	Nov. 14, 1969; Jan. 16, 1971
200	71 19.4'	43 00'	Nov. 18, 1969
C 37	71 07' 53"	37 27.5'	Jan. 16, 1970
80	71 05' 40"	39 43' 53"	Jan. 19, 1970
Mizuho Camp	70 42.1'	44 17.5'	Nov. 18, 1970
Y200	71 46' 13"	48 55' 58"	Nov. 27, 1970
W 55	69 41' 23"	48 10' 15"	Dec. 30, 1970

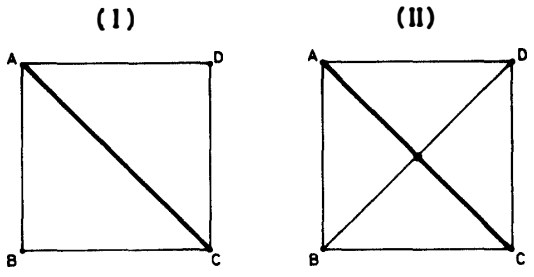

Fig. VI-9. The configuration of square strain grids.
(I) JARE 10.
(II) JARE 11.

The method of the survey is the same as that of "Triangulation Chain".

3.3. Computation

Procedures of correction and computation are the same as those of "Triangulation Chain".

Acknowledgments

We are indebted to Messrs. H. Ando, M. Yoshida, K. Omoto, Y. Ageta, O. Watanabe, and many other members of the 10th and the 11th Japanese Antarctic Research Expeditions for their co-operation with us in the surveys. We are grateful to Mr. M. Ichihara of the Geographical Survey Institute, who has evinced genuine enthusiasm in undertaking computer programing and operating for the research. We also wish to thank Dr. M. Tazima, Messrs. H. Haruyama, S. Kakinuma and M. Masuda of Geographical Survey Institute for their valuable advice.