IX. MOVEMENT OF ICE SHEET AND GLACIERS IN SÔYA COAST IN 1969 - 1972

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1. Introduction

The movement of the ice-sheet and glaciers in the Sôya Coast, was measured by JARE-10(1969-1970), -11(1970-1971), -12(1971-1972), and -13(1972-1973), during a period of 1969 - 1972.

The measurement of the flow of the Heitô Glacier, Langhovde, was started on February 9, 1970, by the collaboration of JARE-10 and -11, and was continued until February 10, 1972, by JARE-12 and -13. The flow of the Langhovde Glacier was measured during a period of September 15, 1970 - March 11, 1971, by JARE-11 and -12. The movement of the coastal ice sheet of the Sôya Coast was measured during a period of August 23, 1969 - February 2, 1971, by JARE-10 and -11. Areas and locations of the measurements are illustrated in Fig.1.

2. Heitô Glacier, Langhovde

2.1. Method

Three rows of markers (bamboo poles), A, B and C, were set up at the surface of the Heitô Glacier: upstream row A with two markers A1 and A2; midstream row B with six markers B1 to B6; downstream row C with three markers C1, C2, and C3, as shown in Figs. 1b and 2. The position and elevation of each marker were surveyed by triangulation with the base line X-Y set up on the left bank of the glacier; the angle was measured by Wild T-2 theodolite, and the distance by electrotapes, Cubic DM-20.

Limits of error allowed for the survey were:

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

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2.2. Position and elevation (coordinates system)

The position and elevation of a marker were tentatively calculated as follows:

The International Ellipsoid (old type) was applied to the Sôya Coast area, and was projected to a plane by the Gauss-Krüger projection. The positive direction of the X-coordinate axis was taken in the geographical north, and that of the Y-coordinate axis in the geographical east with the origin of the coordinates at (69°00'00"S, 39°30'00"E). The elevation was referred to the mean sea level.

The positions (X, Y) and elevations (H) of the survey stations X and Y were:

Survey station	Position		Elevation
	X	Y	H
X	-30634.008m	12328.346m	447.61m
Y	-29899.634	11812.863	324.21

The limit of error for measurement of a glacier movement: It was presumed that the position of a marker on the glacier would be changed by 5-6cm at most during six months as a result of the slanting of the marker (pole) itself and the resetting of it. The total error for the measurement of glacier movement would amount to 8 - 10cm, if an error of 3 - 4cm accompanied by surveying is taken into consideration in addition to the foregoing errors.

2.3. Measurements

Surveys of the position and elevation of each marker were carried out in 1970 - 1972 as follows:

Initial survey: February 9, 1970 (by JARE-10 and -11),
2nd survey: September 10, 1970 (by JARE-11),
3rd survey*: March 10, 1971 (by JARE-11 and -12),
4th survey**: February 10, 1972 (by JARE-12 and -13).

* Marker B6 was reset.

** Marker B2, B3, C1 and C2 were found missing.

The results are given in Tables 1 and 4, Figs.2a, 2b and 2c (They failed in measuring the elevation H of the markers)

3. Langhovde Glacier, Langhovde

3.1. Method

Seven markers (bamboo poles), L1 to L7, were set up on a line across the Langhovde Glacier, as shown in Fig.1. The position and elevation of each marker were surveyed by triangulation with the base line R(5) - Z.

Surveying instruments and limits of error allowed for the survey were the same as those for the Heitô Glacier. The positions (X, Y) and elevations (H) of the survey stations R(5), a triangulation point of Langhovde area, and Z were:

Survey station	Position		Elevation
	X	Y	H
R(5)	-29104.654m	12849.171m	496.62m
Z	-31133.184	12674.318	461.42

3.2. Measurements

Surveys of the position and elevation of each marker were carried out in 1970 - 1971 as follows:

Initial survey: September 15, 1970 (by JARE-11),

2nd Survey: March 11, 1971 (by JARE-11 and -12).

On the occasion of the second survey was made on March 11, 1971, three markers, L3, L5 and L6 were found slanting downstream-ward by 40 - 50°, and four markers, L1, L2, L4 and L7 were found missing. The results are given in Tables 2 and 4, and Fig.3 (They failed in measuring the elevation H of the markers).

4. Coastal Ice Sheet of Sôya Coast

4.1. General

Two kinds of methods were applied to the measurement of the movement of the ice sheet in the Sôya Coast in 1969 - 1971.

4.2. Triangulation chain

A triangulation chain (Naruse et al., 1972) "East Ongul Island - S16" was established in a period of August 23 - 30, 1969, by JARE-10. The base line was set up by connecting two triangulation points, No.4 and No.5 in East Ongul Island; S16 was connected with East Ongul Island by ten triangles, as shown in Figs.1 and 4; markers were denominated G(0), G(1) to G(9), where G(0) coincided with Mukai Rocks, and G(9) with S16.

Surveying instruments and limits of error allowed for the survey were the same as those for the Heitô Glacier. The positions (X, Y) and elevations (H) of No.4 and No.5, that is, the ends of the base line in East Ongul Island, were:

Survey station	Position		Elevation
	X	Y	H
No.4	-1961.130m	3720.855m	35.38m
No.5	- 782.153	4561.615	41.20

All the markers except G(7) and G(9), however, were found missing when a resurvey of the markers was carried out by JARE-11 in August - September 1970, whereby G(7) and G(9) coincided with G5 and G6(=S16) of JARE-11's survey, respectively. The results are given in Tables 3 and 4, and Fig.4.

4.3. By a traverse survey (Naruse et al., 1972) "East Ongul Island - Langhovde", 18 markers (bamboo poles), G1 to G18, were set up between the triangulation points, No.5, East Ongul Island, and R(5), Langhovde, as shown in Figs. 1 and 5, in August - September 1970.

Surveying instruments and limits of error allowed for the survey were the same as those for Heitô Glacier. The positions (X, Y) and elevations (H) of the terminal points, No.5 and R(5), were given in sections 4.2. and 3.1.of this report. The Astronomic Control Point of East Ongul Island and triangulation point R(2), Langhovde, were used respectively as the bench marks for both the terminal parts of the traverse survey.

Surveys of the position and elevation of each marker were carried out in 1970 - 1971 as follows:

Initial survey: August 31 - September 16, 1970 (by JARE-11),
2nd survey: January 30 - February 2, 1971 (by JARE-11).

The second survey for markers No.11 to No.18 was abandoned because of difficulties caused by an exposed crevasse field. The results are given in Tables 3 and 4, and Fig.5 (They failed in measuring the elevation H of the markers).

Reference

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. JARE Data Rep., 17 (Glaciology), 111-131.

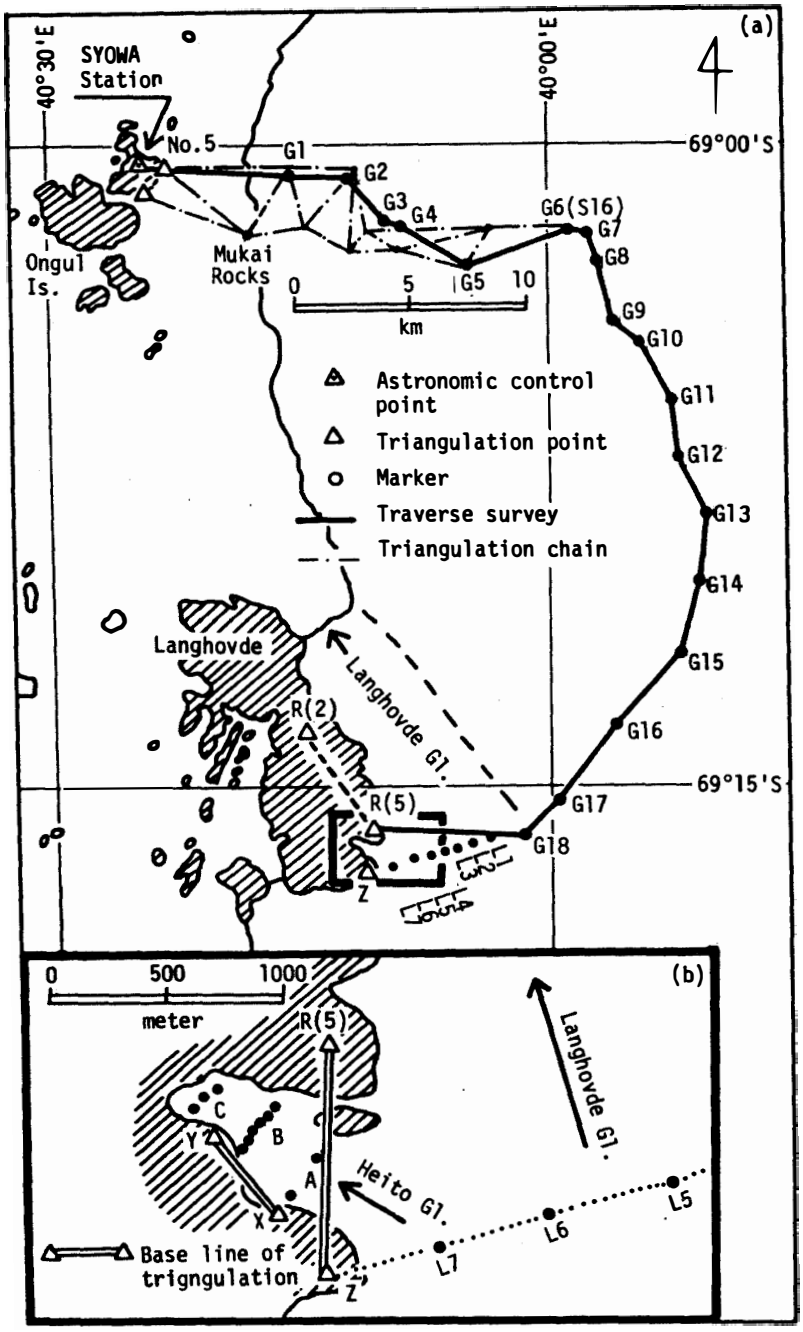

Fig.1. Measurements of movement of the ice-sheet and glaciers in Sôya Coast in 1969 - 1972.

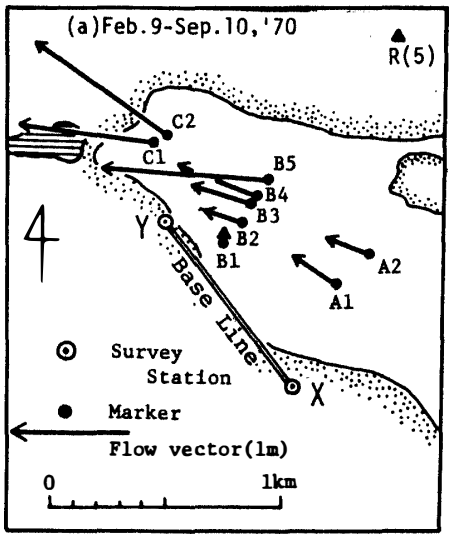

Fig. 2a

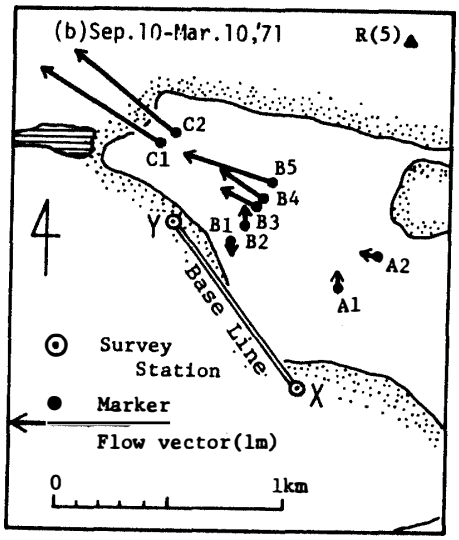

Fig. 2b

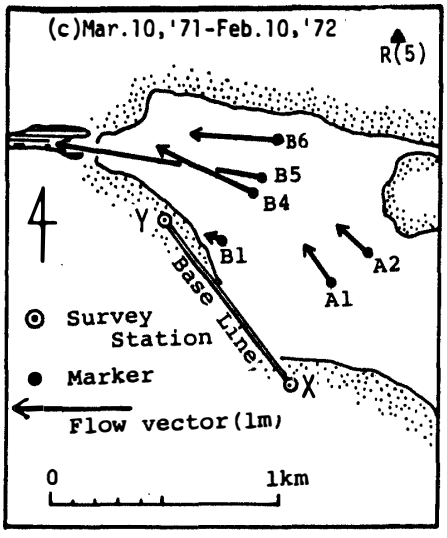

Fig. 2c

Fig.2. Movement (horizontal component) of the Heitô Glacier, Langhovde in 1970 - 1972.

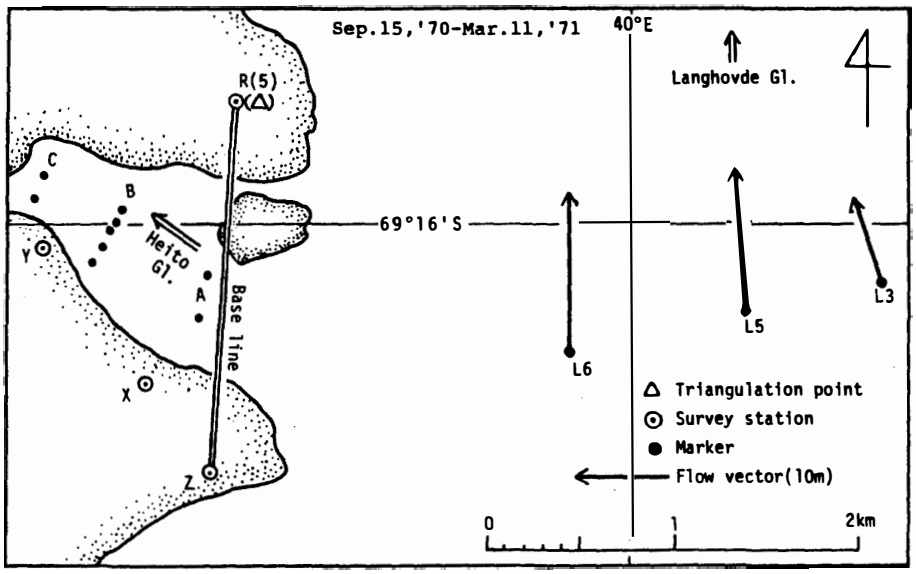

Fig.3. Movement (horizontal component) of the Langhovde Glacier, during a period of September 15, 1970 - March 11, 1971.

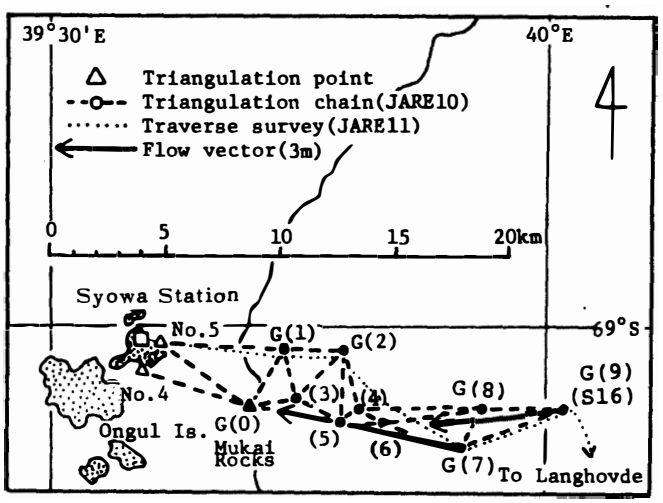

Fig.4. Triangulation chain connected S16 with East Ongul Island, and movement (horizontal component) of the ice sheet during a period between August 23, 1969 and September 5, 1970.

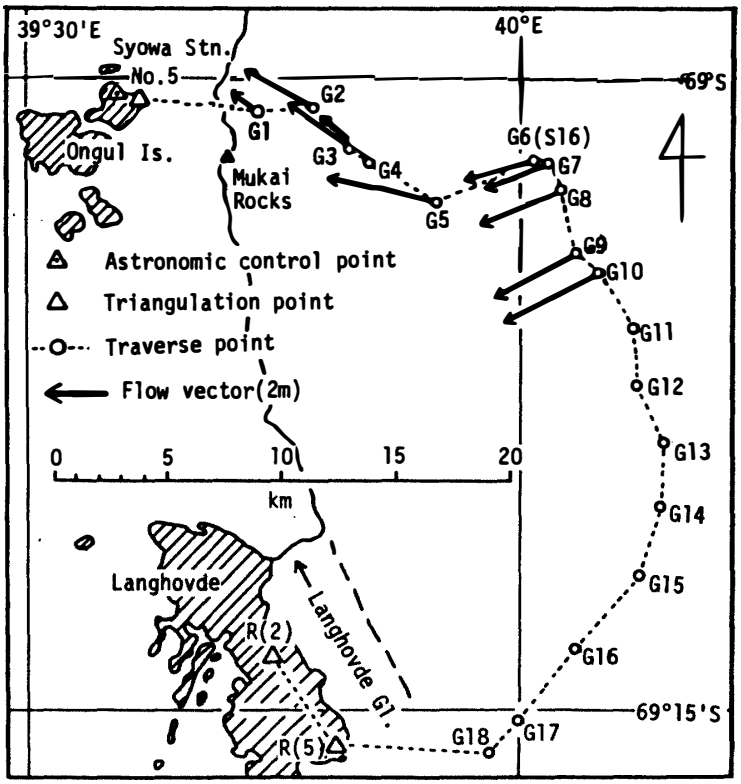

Fig.5. Traverse survey line connected R(5), Langhovde, with No.5, East Ongul Island, and movement (horizontal component) of the coastal ice sheet during a period of August 31, 1970 and February 2, 1971.

Table 1. Position (X, Y) of markers set up on the Heitô Glacier, Langhovde, 1970 - 1972.

Date	Marker	X (m)	Y (m)
Feb. 9, 1970	A1	- 30,184.24	12,528.27
	2	- 30,062.18	12,675.35
	B1	- 29,981.14	12,067.90
	2	- 29,897.82	12,122.06
	3	- 29,817.89	12,173.11
	4	- 29,777.24	12,198.97
	5	- 29,716.27	12,239.18
	C1	- 29,543.25	11,757.33
	2	- 29,511.73	11,817.94
Sep. 10, 1970	A1	- 30,184.00	12,527.95
	2	- 30,062.03	12,675.02
	B1	- 29,981.03	12,067.90
	2	- 29,897.74	12,121.78
	3	- 29,817.72	12,172.61
	4	- 29,777.00	12,198.32
	5	- 29,716.17	12,237.75
	C1	- 29,543.10	11,756.17
	2	- 29,510.91	11,816.80
Mar. 10, 1971	A1	- 30,183.90	12,527.95
	2	- 30,062.01	12,674.94
	B1	- 29,981.16	12,067.94
	2	- 29,897.62	12,121.76
	3	- 29,817.56	12,172.32
	4	- 29,776.76	12,197.96
	5	- 29,715.96	12,236.98
	6	- 29,538.33	12,298.59
	C1	- 29,542.44	11,755.13
	2	- 29,510.17	11,815.95
Feb. 10, 1972	A1	- 30,183.59	12,527.75
	2	- 30,061.78	12,674.69
	B1	- 29,981.12	12,067.83
	4	- 29,776.35	12,197.11
	5	- 29,715.66	12,235.20
	6	- 29,538.29	12,297.86

Table 2. Position (X,Y) of markers set up on the Langhovde Glacier, 1970 - 1971.

Date	Marker	X (m)	Y (m)
Sep. 15, 1970	L3	- 30,136.62	16,275.84
	L5	- 30,294.62	15,552.59
	L6	- 30,498.13	14,616.01
Mar. 11, 1971	L3	- 30,127.79	16,272.80
	L5	- 30,279.46	15,551.30
	L6	- 30,480.81	14,615.73

Table 3. Position (X,Y) of markers set up on the coastal ice sheet of the Sôya Coast, 1969 - 1971.

Date	Marker	X (m)	Y (m)
Aug. 23, 1969	G(0)	- 3,767.07	8,086.93
"	(1)	- 1,293.12	9,768.80
"	(2)	- 1,055.69	12,119.68
Aug. 25, 1969	(3)	- 2,776.92	10,402.11
"	(4)	- 3,142.59	12,935.66
"	(5)	- 3,879.91	12,661.20
"	(6)	- 4,142.85	14,378.76
Aug. 26, 1969	(7)	- 5,434.70	17,644.55
"	(8)	- 3,680.30	18,584.34
"	(9)	- 3,714.72	21,865.34
Sep. 1, 1970	G 1	- 1,291.75	9,759.13
"	2	- 1,178.79	12,106.41
Sep. 4, 1970	3	- 3,216.55	13,934.09
"	4	- 3,754.72	14,683.83
Sep. 5, 1970	G5/G(7)	- 5,433.48	17,638.08
"	G6/G(9)	- 3,715.28	21,860.75
"	G 7	- 3,779.21	22,482.87
"	8	- 5,016.19	23,072.51
Sep. 6, 1970	9	- 7,789.75	23,629.60
"	10	- 8,591.85	24,740.51
"	11	- 10,586.61	25,840.02

Date	Marker	X (m)	Y (m)
Sep. 7, 1970	12	- 13,055.71	26,091.80
"	13	- 15,587.53	27,296.53
Sep. 8, 1970	14	- 18,385.22	27,103.90
Sep. 9, 1970	15	- 21,341.41	26,189.32
"	16	- 24,577.40	23,326.63
"	17	- 27,767.82	20,855.48
"	18	- 29,211.98	19,561.01
Jan. 30, 1971	G1	- 1,291.23	9,758.27
"	2	- 1,177.39	12,103.95
Jan. 31, 1971	3	- 3,215.06	13,932.04
"	4	- 3,753.23	14,681.96
"	5	- 5,432.75	17,634.36
Feb. 1, 1971	6	- 3,716.02	21,858.27
"	7	- 3,780.10	22,480.75
"	8	- 5,017.46	23,069.66
Feb. 2, 1971	9	- 7,791.32	23,626.89
"	10	- 8,593.64	24,737.14

Table 4. Horizontal displacements of markers set up on glaciers and ice-sheet, in 1969 - 1972: (dx and dy are horizontal components of the displacement in the geographical north and east, respectively, during a period given in the table, calculated from Tables 1, 2 and 3; $ds = \sqrt{(dx)^2 + (dy)^2}$; α is the geographical direction of the displacement, as 0° : north, 90° : east, 180° : south, and 270° : west.)

(a) Heitô Glacier, Langhovde, 1970 - 1972.

Period	Marker	dx (cm)	dy (cm)	ds (cm)	α (deg.)
Feb.9 - Sep. 10, 1970 (214 days): Winter	A1	24	-32	40	307
	2	15	-33	36	294
	B1	11	0	11	0
	2	8	-28	29	286
	3	17	-50	53	289
	4	24	-65	69	290
	5	10	-143	143	274
	C1	15	-116	117	277
	2	82	-114	140	306

Period	Marker	dx (cm)	dy (cm)	ds (cm)	α (deg.)
Sep.10, 1970 - Mar.10, 1971 (182 days): Summer	A1	10	0	10	0
	2	2	- 8	8	284
	B1	-13	+ 4	14	163
	2	12	- 2	12	351
	3	16	-29	33	299
	4	24	-36	43	304
	5	21	-77	80	285
	C1	66	-104	123	302
	2	74	-85	113	311
Mar.10, 1971 - Feb.10, 1972 (338 days): 11 months	A1	31	-20	37	327
	2	23	-25	34	313
	B1	4	-11	12	290
	4	41	-85	94	296
	5	30	-178	181	280
	6	4	-73	73	273
Feb.9, 1970 - Mar.10, 1971 (395 days): 13 months	A1	34	-32	47	317
	2	17	-41	44	293
	B1	- 2	+ 4	5	117
	2	20	-30	36	304
	3	33	-79	86	293
	4	48	-101	112	295
	5	31	-220	222	278
	C1	81	-220	234	290
	2	156	-199	253	308
Feb.9, 1970 - Feb.10, 1972 (732 days): 2 years	A1	65	-52	83	321
	2	40	-66	77	301
	B1	2	- 7	7	286
	4	89	-186	206	296
	5	61	-398	403	279

(b) Langhovde Glacier, 1970 - 1971.

Period	Marker	dx (cm)	dy (cm)	ds (cm)	α (deg.)
Sep. 15, 1970 - Mar. 11, 1971 (158 days)	L3	883	-304	934	341
	L5	1516	-129	1522	355
	L6	1732	- 28	1732	359

(c) Sôya Coast, 1969 - 1971.

Period	Marker	dx (cm)	dy (cm)	ds (cm)	α (deg.)
Aug. 26, 1969 - Sep. 5, 1970 (376 days)	G5/G(7)	122	-647	658	280
	G6/G(9)	-56	-459	462	263
Sep. 1, 1970 - Jan. 30, 1971 (151 days)	G1	52	- 86	101	301
Sep. 1, 1970 - Jan. 30, 1971 (151 days)	2	140	-246	283	300
Sep. 4, 1970 - Jan. 31, 1971 (149 days)	3	149	-205	253	306
Sep. 4, 1970 - Jan. 31, 1971 (149 days)	4	149	-187	239	309
Sep. 5, 1970 - Jan. 31, 1971 (148 days)	5	73	-372	379	281
Sep. 5, 1970 - Feb. 1, 1971 (149 days)	6	- 74	-248	259	253
Sep. 5, 1970 - Feb. 1, 1971 (149 days)	7	- 89	-212	230	247
Sep. 5, 1970 - Feb. 1, 1971 (149 days)	8	-127	-285	312	246
Sep. 6, 1970 - Feb. 2, 1971 (149 days)	9	-157	-271	313	240
Sep. 6, 1971 - Feb. 2, 1971 (149 days)	10	-179	-337	382	242