Outline of Scientific Program and Its Results

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1. Planning of Scientific Program

The straight line drawn from Syowa Station to the South Pole, across the inland of Queen Maud Land, is adequate to grasp an entire picture of East Antarctica in location and length. In 1962, when the Japanese Antarctic Research Expedition (JARE) began to make a plan on the traverse along this line, the inland of Queen Maud Land was the largest and the last unexplored area of the Antarctica. Therefore, it was expected that this plan of traverse would be worth as much as the U.S.S.R. traverse along the Mirny—Vostok—South Pole route.

Shortly, the plan of traverse lost a little of its scientific and adventurous freshness, owing to the beginning of traverse activities on this area by U.S.S.R. and U.S.A. parties, but made it possible to study this area widely because of convergence of our and their routes. Therefore, our traverse route to the South Pole was carefully planned so as not to overlap and also to make a well-connected network with their routes.

Scientific program of our traverse, shown in Table 1, was drafted on the basis of the following aims.

1) Studies on the Antarctic ice sheet, and the subglacial relief and crustal structures. For these, there are necessity for working together with various kinds of geodetic and geophysical investigations, and for concerted analysis of their results synthetically.

2) Meteorological and glaciological studies on ice and snow. For studies on the ice-mass budget of Antarctica, it is necessary to investigate the detailed distribution of snow accumulation on the interior of the continent, and to study some factors contributing to snow accumulation, for example, the general atmospheric circulation transporting water-mass to the interior, the loss of water-mass by sublimation and abrasion, the formation process of ice from snow, and so on.

3) Observations on geomagnetism and VLF emissions for the studies of their latitudinal variations. At the early stage of planning, it had been expected that these observations would be made in the range between 69°S and 80°S in geomagnetic latitude along the geomagnetic meridian of the Syowa Station, but

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Table 1. The scientific program of the JARE South Pole Traverse 1968-69.

Item of observation	Interval	Time required (h-min)	Remarks
Navigation			
Orientation	At any time		Gyro-compass and sun compass
Position	Every noon	2-30	Solar observation
Elevation	4 km	5	Interval method
Meteorological	00, 06, 12 and 18GMT	10	Preference of observations taken at 00 and 12GMT
Geomorphologic and geologic	On occasion		Only in the ice-free areas
Glaciological			
Snow surface	4 to 16 km	30	Hardness, density, sastrugi, etc.
Pit of 2 m deep	Within 100 km	2-30	Annual snow accumulation
Hole of 20 m deep	〃	2-00	Snow temperature and snow sample
Snow stake	2 and 4 km	2	Snow accumulation
Strain gauge	At 4 stations	1-00	Ice flow
Ice thickness			
Seismic method	Within 100 km	2-30	Reflection and refraction methods
Radio echo method	8 or 16 km	1-00	
Gravity method	8 km	5	
Geomagnetic	24 km	45	Declination, inclination and total intensity
VLF emissions	Hourly	2	
Medical	On occasion		Combined with the health control of members
Snow vehicle	〃		

Collection of samples for studies of giant sea-salt particles and geochemistry were added to this program just before the beginning of the traverse.

this plan had been left as a subject for further research owing to a change of our traverse route.

4) Some medical studies on the traverse members, who are exposed to severe conditions of environment, for example, an extremely cold temperature and a low pressure, unstable conditions of life, and so on.

2. Progress of Investigations

The formation of traverse party and its daily operation was described by MURAYAMA (1971). Daily operation and the scientific work of the party are summarized in Table 2. Detailes of each observation will be described fully in respective report.

As a whole, the scientific program was carried out satisfactorily, although some were obliged to be modified or interrupted at the beginning of the traverse. Some observations changed are as follows:

Table 2. The schedule of observations during the traverse.

Observations on the way

1st group (vehicle Nos. 604, 603): Two vehicles, 4 km apart from each other, progress continuously

At intervals of 4 km	:	Elevation, snow surface
At 06, 12, and 18GMT	:	Meteorological observation
At 09GMT	:	Rdio communication to Syowa
On occasion	:	Medical study

2nd group (vehicle Nos. 605, 606): They move discontinuously after the first group, proceeding with the observation schedule.

At intervals of 2 km	: Snow stake
〃 8 km	: Gravity
〃 16 km	: Geomagnetism, surface snow, radio echo sounding
Hourly (evry 50 min)	: VLF emissions
At noon	: Astro-fix

Observations at camp stations at intervals of 100 km

Seismic sounding, glaciological studies by 2 m pit and 20 m hole

1) Field study on physics of snow and ice was removed from the scientific program because of the injury of Y. ENDO, the glaciologist. Other glaciological works were continuously carried out by other members of the party.

2) Since the earth auger had been left at St. 122, snow holes for measurements of temperature and for seismic shooting were dug by a hand auger. Their depth was about 10 m which is one-half of the planned depth. It is assumed that this is the reason for poor records of reflection.

3) The radio echo sounder set in the scientific caboose, which was damaged and left at St. 170, was not used during the way to the South Pole except at the beginning of the traverse. The sounder also developed a trouble by being exposed to an extremely low temperature.

4) At the early stage of the traverse, observation of VLF emissions was not necessarily satisfactory due to a trouble caused by rapid temperature variations inside the snow vehicle, and by disconnection of the antenna.

5) The radio communication between the leader vehicle 604 and the succeeding 603 was sometimes interrupted owing to a radio trouble by low temperature. On such occasion, measurement of elevation could not be made by the interval method, and it was carried out by the single point method.

Getting out of these difficulties at the early stage of the traverse, our party had gradually rearranged its setup and all observations was carried out favorably before the party reached 75°S, at which we were expected to succeed the scientific work of the JARE 1967-68 party. When our party started from the Plateau Station to the South Pole, it was getting to be such a mild weather that the vehicles could make better progress and all the scientific work proceeded very smoothly. We started the operation schedule as follows on the route south of the Plateau Station. A range of 1 degree in latitude, which is about 110 km distance, was covered in three days. On the first day, we went 24 km and on

the second and third, 48 km each. Pit study was made on the first and second nights, and seismic and astro-fix observations from the third night till the forenoon of the next day.

On the return trip from the South Pole, our party laid emphasis on completing some observations deficient on the outward trip, to solve few doubtful problems found on the outward course, and to compare the results of observations on the outward and return trips. For example, there are the relationship between undulation topography and conditions of snow surface, the distinct transformations of ice surface topography near the Fuji Divide (tentative) and St. 380, modifications of surface snow in summer, and so on. Gravity and geomagnetism were measured as often as on the outward trip. Further, pit studies of 0.5 m depth and collection of snow samples for the study of geochemistry were newly carried out during the return trip.

3. Summary of Results

The numbers of observations made during the traverse are given in Table 3. Data obtained are now being analysed and will soon been published in the form of a detailed article. In the next chapter and subsequent articles, it was mainly endeavored to present all the data.

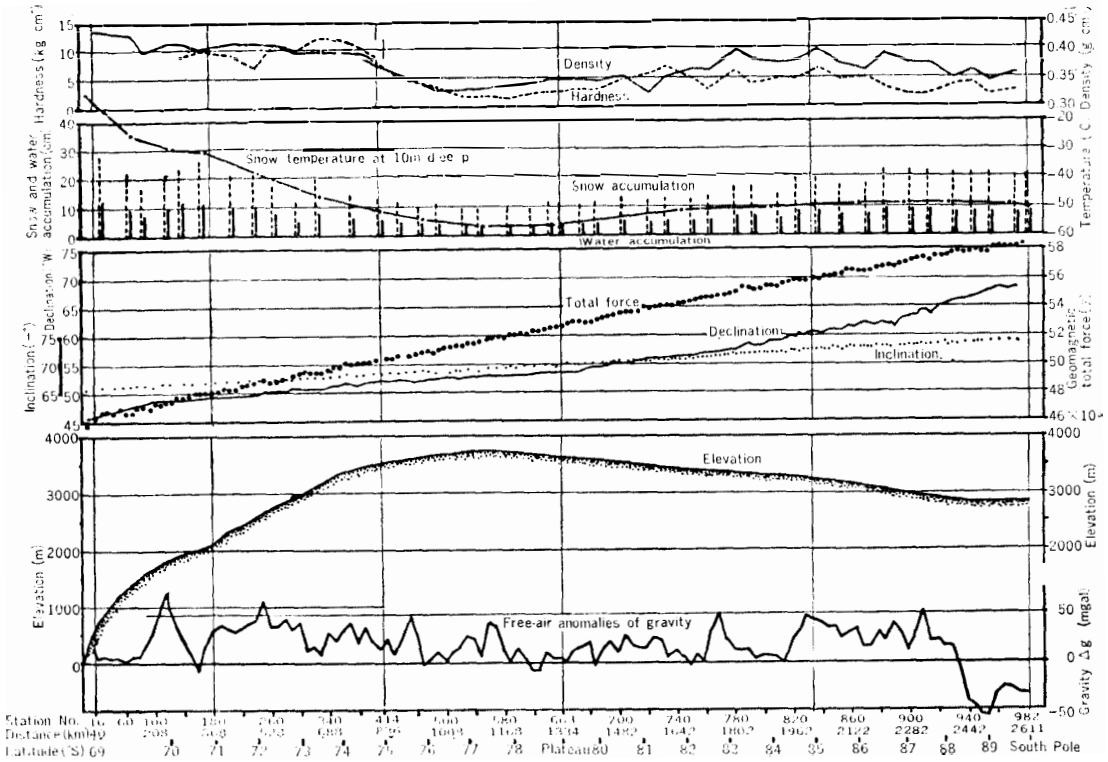

Fig. 1. The longitudinal variation of ice surface elevation, gravity, geomagnetism and surface conditions of snow along the traverse route.

Table 3. Results of observations.

Section		Way to the South Pole			Way from the South Pole	
		Syowa—75°S	75°S—Plateau	Plateau—South Pole	South Pole—Plateau	Plateau—St. 16
Distance (km)		836	498/1334	1277/2611	1277/3888	1294/5182
Days		30	19/49	39/88	26/114	27/141
Weather		Severe snow storm in the first half of October. Temperature dropped below −50°C late in October.	Weather was fine every day. The lowest temperature, −59.2°C, was recorded on November 8.	Temperature rose suddenly in mid-November, showing signs of summer.	Snow surface softened by sublimation. Occasional falls of ice crystals were observed.	Diurnal variation of temperature increased day by day. It snowed early in February.
Operation		ENDO, glaciologist, broke his left arm with the earth auger. This auger, scientific caboose, and all of steel sledges were left behind.	Vehicle 603 was abandoned because of the engine trouble. Progress of other vehicles was also obstructed by deep soft snow.	Sleds ran smoothly on the snow and the party reached the South Pole safely.	Parts of radio echo sounder could not be replaced. Vehicles had few troubles.	Some detailed observations were carried out at Fuji Divide, 75°S, and other spots. 6 tons of fuel were deposited for JARE 1969-70.
Number of observations	Position	1	6	29	0	0
	Elevation	199	124	319	319	353
	Weather	Routine	〃	〃	〃	〃
	Surface snow	56	30	150	79	81
	Pit of 2 m	5	8	21	0	10
	〃 0.5 m	0	0	0	189	81
	Hole of 10 m	4	5	11	0	6
	Snow stake	224	124	319	319	647
	Sea-salt particles	16	8	21	0	0
	Snow samples for geochemistry	4	0	0	21	22
	Strain gauge	0	0	0	0	4
	Seismic	6	5	11	0	8
	Radio echo	8	0	0	0	0
	Gravity	100	73	181	245	254
	Geomagnetics					
	3 components	2	7	42	44	52
	Total force only	39	58	2	282	613
	VLF emissions	44 days	13 days	30 days	90 hours	144 hours
	Medical	0	11 persons	11 persons	11 persons	11 persons

With reference to the General map inside of the back cover, and to Figs. 1 and 2, outline of regional and seasonal aspects in the traverse area will be described. The general map presents the topography of ice sheet and directions of prevailing wind on the traverse area. Fig. 1 shows the longitudinal variations on the values of ice surface elevation, gravity, geomagnetism and surface conditions of snow. Fig. 2 shows daily variations of weather and some phenomena relating to it. By looking at these map and graphs in relation to one another, it will probably be possible to understand the general aspects of this area.

Ice surface topography of the traverse area is divided into five areas on the borders of 71°S, 74°25'S, 81°S, and 87°S. That is, there are the marginal slope, katabatic slope, central core, interior slope, and interior basin. The marginal slope is a part of Enderby Land separated from East Antarctica proper by the subglacial through running east to west near 71°S. In this area, weather varies periodically and snow falls more than in the interior by the influence of coastal depressions. The surface temperatures from the start of traverse till the late October made such a periodic variation and at the same time steadily dropped to the level of −50°C because the party was progressing into the high land of the interior. Since the ice surface of the marginal and katabatic slopes is fairly steep, katabatic winds blow in the

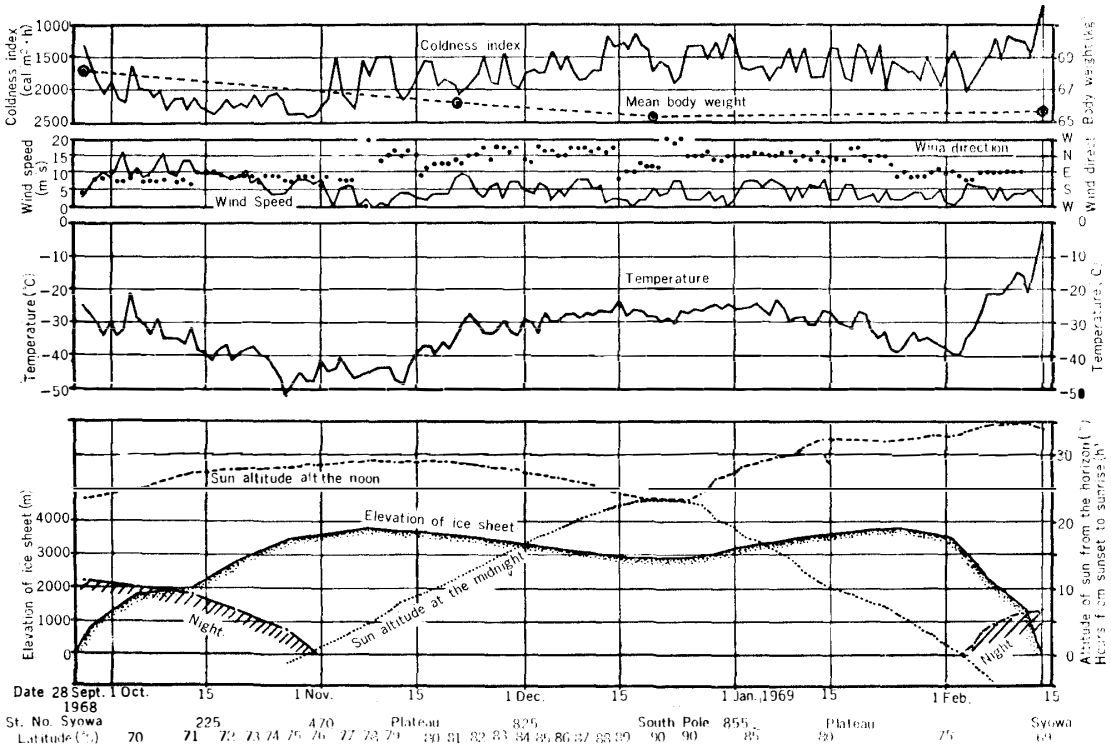

Fig. 2. Daily variations of weather and some phenomena concerning them.. Temperature and wind are values at 09 GMT.

speed of 7-15 m/s there. Such an extremely low temperature and high wind, which present coldness index in the ranges from 2,200 to 2,400 cal/m^2·h meant worst conditions for activities of our traverse members. In the katabatic slope, snow accumulation was distributed sporadically in accordance with ice surface showing a stair-like topography.

Ice surface topography transforms distinctly at the neighborhood of 74°25′S and of Fuji Divide. This transformation gives a conspicuous boundary on areal variation of meteorological and glaciological phenomena, for example, surface wind, snow accumulation, and snow hardness, but it is not clear whether the transformation is reflected from relief of subglacial topography or not. Fuji Divide is a broad divide of the East Antarctic ice sheet, located at 77°26′S and 41°32′E, and is 3717 m above sea level, and its annual mean temperature was −57.1°C by measurement of snow temperature at 10 m depth, and annual water accumulation in the ranges of 3.9 to 4.2 cm was measured by pit study. Since surface winds are very weak and show various directions near the divide, there are the softest area of snow and the originating area of katabatic winds. Surface temperature rose suddenly in the middle of November. Such a rise in temperature was recorded at the Plateau Station and also at the upper free atmosphere of Syowa Station, where the pressure is the same level as that of the traverse party.

In the interior slope, there is regular undulation of ice sheet. Though glaciological phenomena vary locally in accordance with regular undulation, there are no large variations over the whole area. For example, annual mean temperature is in the small range of −49.0° to −51.5°C, direction of the prevailing wind is concentrated in the narrow sector of NNW to NNE, and snow hardness show similar values of 3 or 4 kg/cm^2 over the whole area. The weather from the late November to the middle of January of the following year, when the party was operating in the area south of 81°S, showed a well-regulated variation having a cycle of 10 to 13 days and this variation became conspicuous as the party approached the South Pole. In the same period, the sun moved around a circle higher than 10° above the horizon all day, and the snow surface was remarkably modified by sublimation by solar radiation.

Getting into the interior basin, wind direction shifted to NNW only and snow hardness became very soft. These are clear differences to those of the interior slope, and, in this basin, there was no regularity on surface undulation such as seen in the interior slope. Therefore, it can be said that the interior basin is a definite unit of East Antactica.

Reference

MURAYAMA, M. (1971): General Statement: JARE South Pole Traverse 1968-69. JARE Scient. Rep., Special Issue, No. 2, 1-22.