II. STRATIGRAPHY OF SNOW COVER IN MIZUHO PLATEAU IN 1971 - 1972

Tomomi YAMADA*

1. Introduction

A stratigraphic study of the polar snow cover in Mizuho Plateau, shown in Fig.A (folded map), was carried out on snow pit wall and snow cores in 1971 - 1972(JARE-12). International Classification of Snow is not sufficiently applicable to a snow cover in the polar region. The fundamental concept of the classification is based on the premise that a snow cover is composed of "snow grains". In the case of polar snow, except for surface snow, it is difficult to define "snow grains" in a layer, as an ice-bridge connecting original snow grains has grown so thick that such a bridge gets together to form a dense network of ice-bridges as a whole. Therefore, a trial was made to describe the texture of snow layer: visual observation was mainly applied, and a new concept of "compactness" was introduced, as an approach to an advanced stratigraphic study of the polar snow cover.

2. Description of Stratigraphy of Snow Cover

Stratigraphic elements of a snow cover were defined as follows (see Table 1):

1. Snow surface.
2. Ice crust.
3. Multiple ice crust: A group of fine ice sheets overlaid closely as shown in Fig.1.
4. Layer boundary.

Filling up the air void of a snow block, e.g., with ice-saturated aniline, one can easily make a flat section of the block by the use of a planner or microtome, and observe the 2-dimensional texture of the snow block microscopically. Then, the following three snow layers 5, 6 and 7 were defined.

5. Round-snow layer: round-shaped snow grains are separately observed,
6. Angular-snow layer: angular-shaped snow grains are separately observed (mainly depth hoar),

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

7. Network-snow layer: isolated snow grains are scarcely observed; the texture of snow appears as a network of ice at the section.

8. Iced firn layer: Formed as a result of the violent percolation of melt water and subsequent refreezing; contains air voids, and is air- and water-permeable (density $<0.82\,g/cm^3$).

9. Ice: A thick ice layer, an ice wedge or an ice lens. (Since a sample is taken from a boring core, 7.5 cm in diameter, it is difficult to tell the body of ice to which the sample belongs.)

10. Thermal crack: Crack formed in surface layers of a snow cover by thermal contraction (Watanabe and Yoshimura, 1972; Yamada, 1975).

Regarding the round- and angular-snow layers (layer 5 and 6), the grain shape, grain size and compactness (to be mentioned later) were described by the use of specific symbols and their combinations, as shown in Table 2.

*1 Grain size: The grain size was observed by absolute measurement and/or comparative observation. In the absolute measurement, the standard of the International Classification of Snow was applied, namely:

Symbol	Grain diameter (mm)
a	0.5 or less
b	0.5 - 1.0
c	1.0 - 2.0
d	2.0 - 4.0
e	4.0 or more

When the comparative observation was made, the grain size was defined by three grades: coarse, medium and fine, as shown in Table 2; the grain size of an observed layer was defined by comparing it with those of several neighboring layers.

*2 Compactness: "Compactness" was newly defined to express the texture of snow. The higher the snow density and the smaller the grain size or the pore size, the greater the "Compactness". The compactness of a snow layer was defined in relative terms in the same way as the grain size, and was expressed in three grades: loose, medium and compact. The grade of compactness was expressed by the density of the grain size symbols, in a diagram.

Snow density: Volume of snow samples were 100 - 200 cm^3.

Hardness of snow: Samples No.4 and 9 were measured by Canadian hardness gauges, and others by Kinosita's gauge.

An outline of stratigraphic observations carried out in 1971 - 1972 is given in Table 3, and the results in Figs.2 to 16, and Tables 4 to 9.

References

Watanabe, O. and A. Yoshimura (1972): Glaciological observations in the vicinity of Mizuho Camp, Enderby Land, East Antarctica, 1970. Antarctic Rec., 45, 20-32 (in Japanese).

Yamada, T. (1975): Thermal cracks in snow cover at Mizuho Camp in 1971. JARE Data Rep., 27, 177.

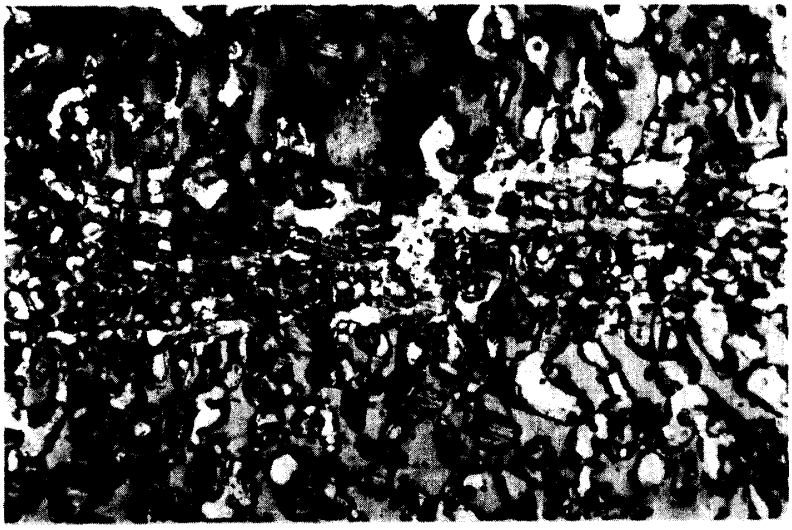

Fig. 1. Multiple ice crust.

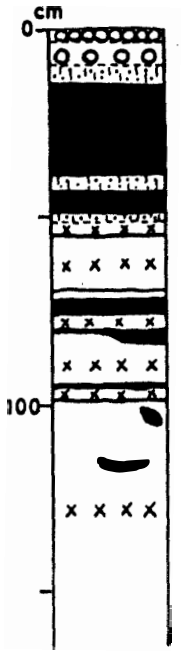

Fig.2. Snow cover, slightly below the firn-line in Sôya Coast, 390 m above sea level (Sample No.1).

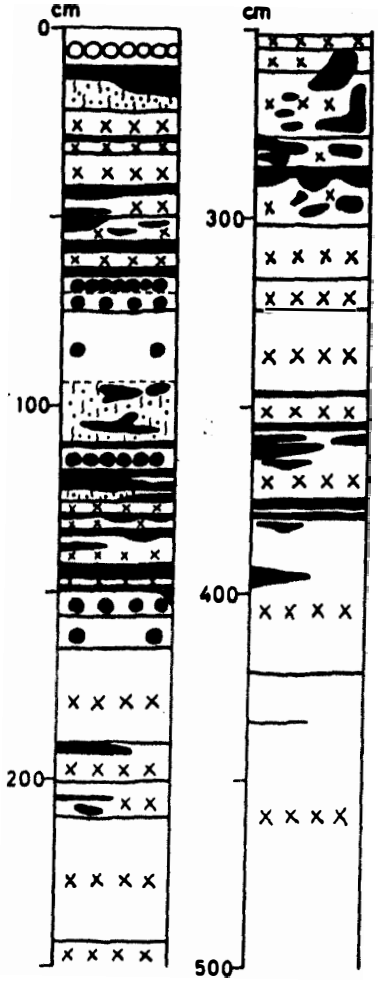

Fig.3. Snow cover, firn-line area in Sôya Coast, 404 m above sea level (Sample No.2).

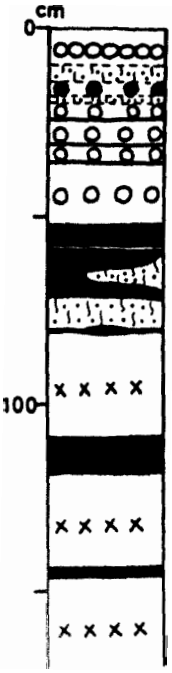

Fig.4. Snow cover, soaked zone in Sôya Coast, 454m above sea level (Sample No.3).

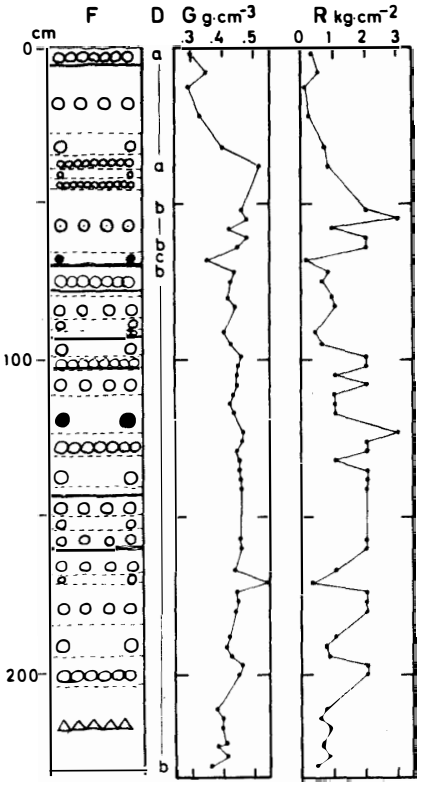

Fig. 5. Snow core at S30 (Sample No.4)

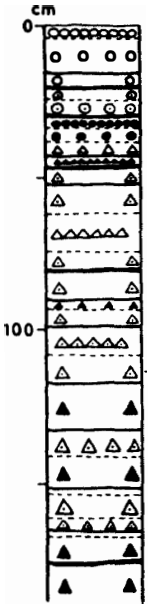

Fig. 6. Snow core at H180 (Sample No.5).

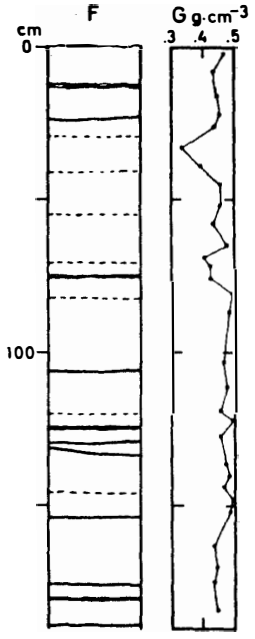

Fig. 7. Snow core at S169 (Sample No.6-1).

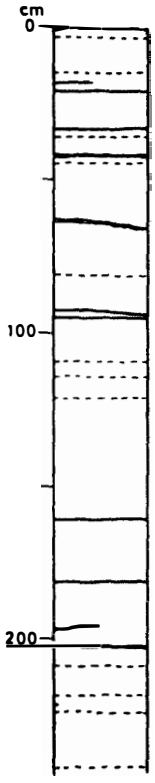

Fig. 8. Snow core at S169 (Sample No.6-2: 20m leeward of No.6-1)

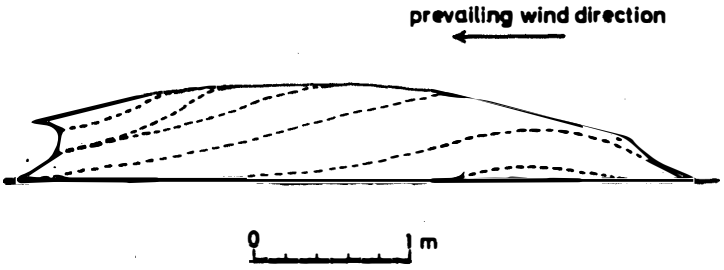

Fig. 9. Stratification of sastrugi, parallel to the prevailing wind direction, Mizuho Camp (Sample No.7).

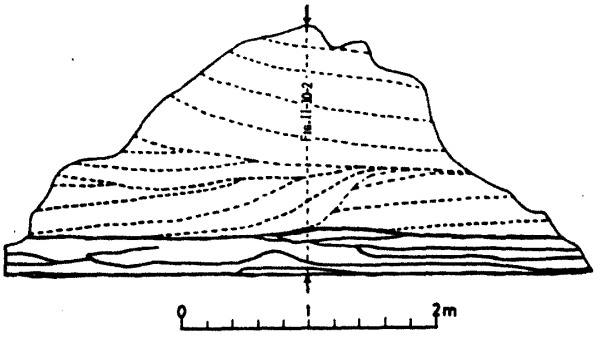

Fig.10a. Stratification of sastrugi, normal to the prevailing wind direction, Mizuho Camp (Sample No.8).

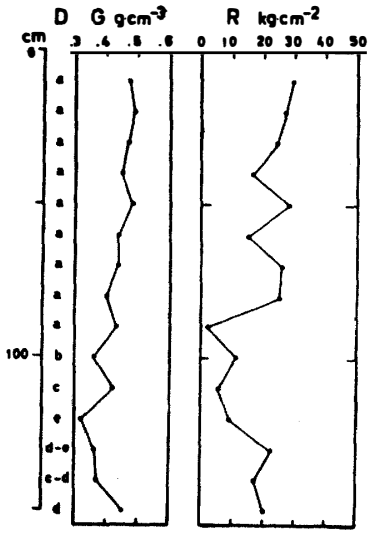

Fig.10b. Vertical distribution of grain size, density and Kinosita's hardness at the position indicated in Fig. 10a.

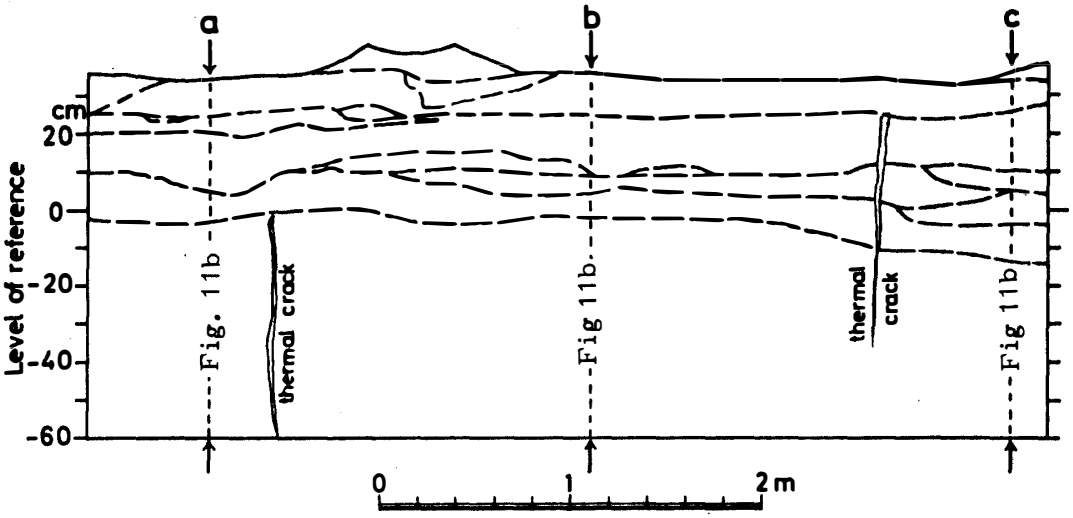

Fig.11a. Trench wall at Mizuho Camp (Sample No.9) (broken line: ice crust, multiple ice crust or layer boundary).

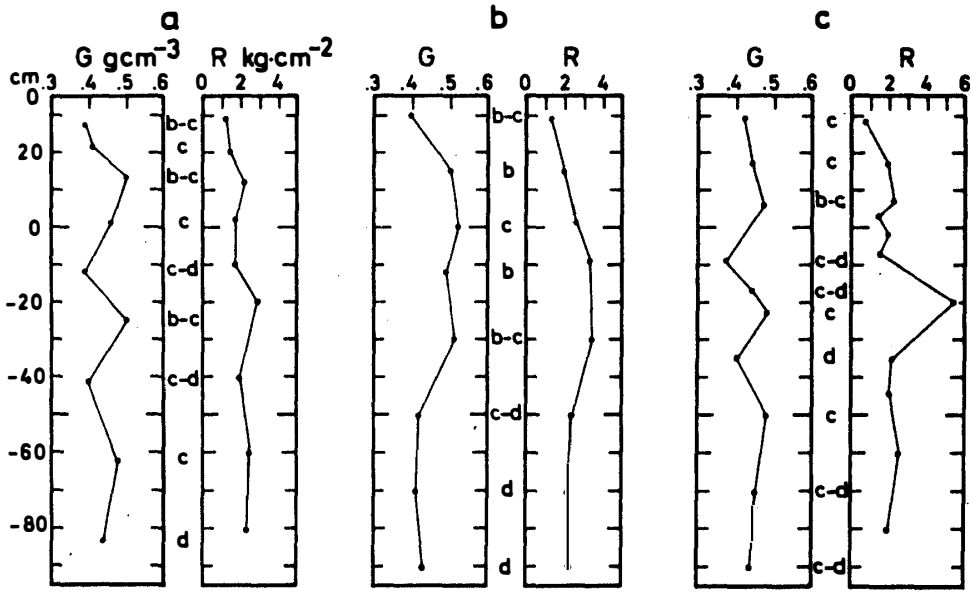

Fig.11b. Vertical distribution of grain size, density and Canadian hardness at the positions indicated in Fig.11a.

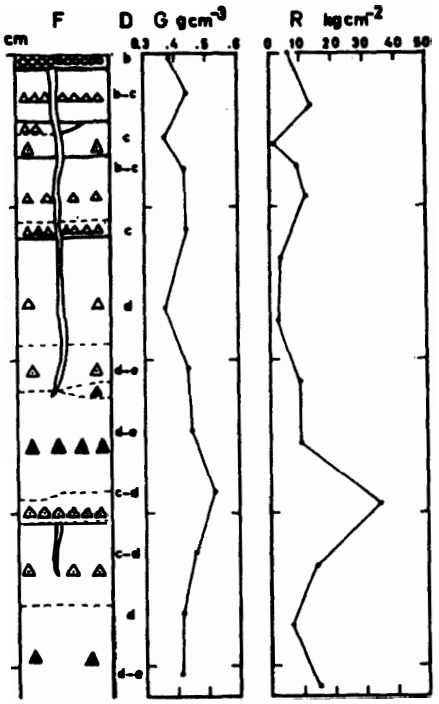

Fig. 12. South wall of a pit in a glazed surface area, Mizuho Camp; well developed thermal cracks were observed (Sample No.10-1).

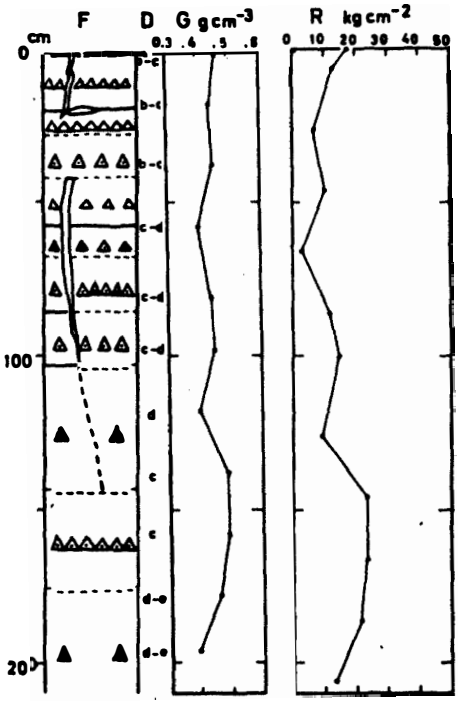

Fig. 13. East wall of the same pit as Fig.12 (Sample No.10-2).

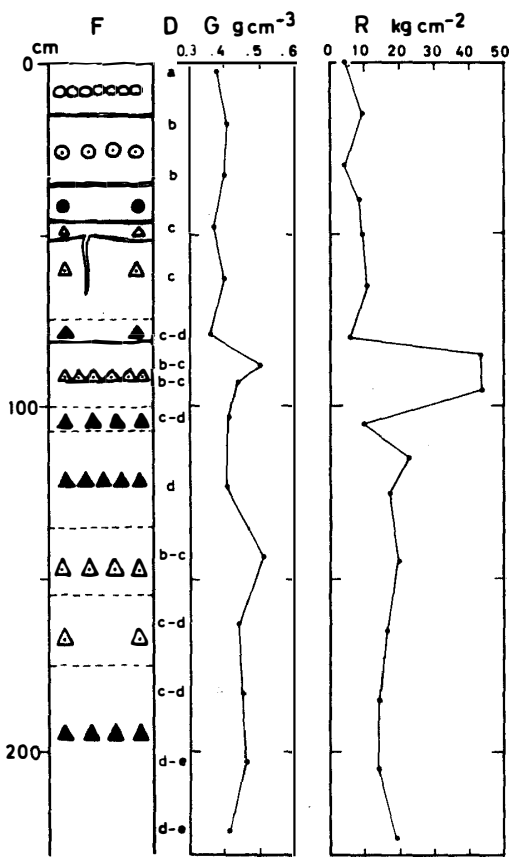

Fig.14. South wall of a pit in a drifted snow area, Mizuho Camp (Sample No.11-1).

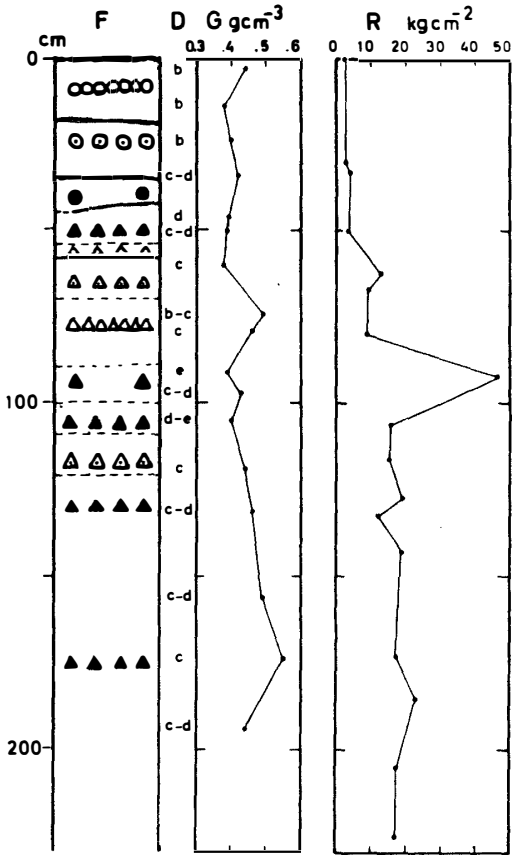

Fig.15. East wall of the same pit as Fig.14 (Sample No. 11-2).

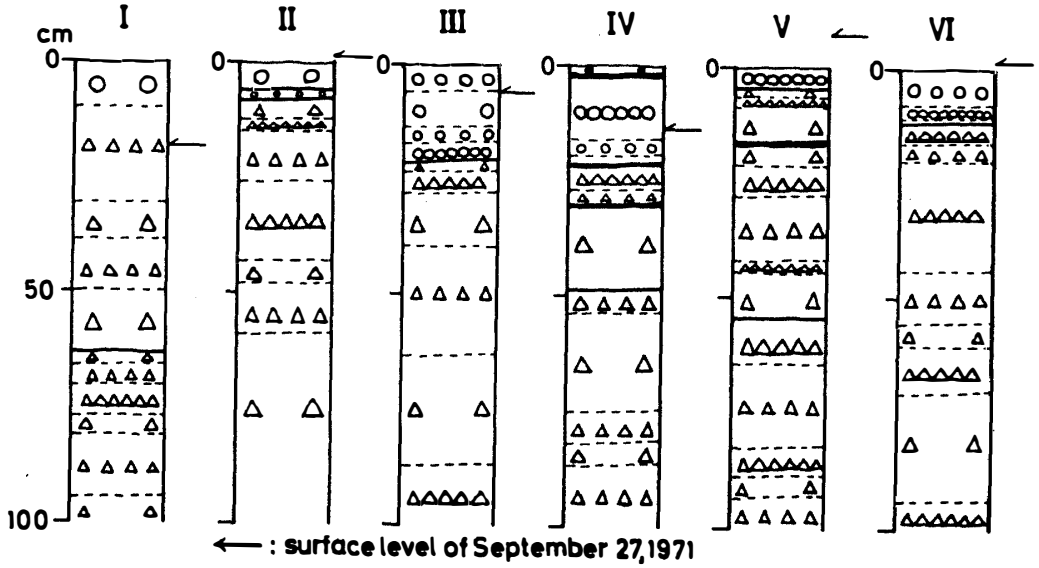

Fig.16. Snow core from a 36-stake farm at Mizuho Camp; the location of sampling is given in Fig.B (Sample No.12). The grain size is not measured.

Table 1. Stratigraphic elements of a polar snow cover.

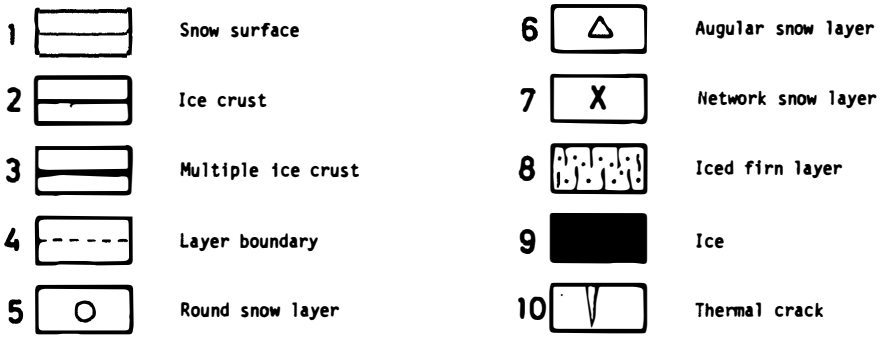

Table 2. Detailed description of layers 5 and 6 in Table 1.

Grain shape	Grain size *1	Compactness *2
○ Round-snow	○ Fine	○ Loose
		○ Medium
		○ Compact
	⊙ Medium	⊙ Loose
		⊙ Medium
		⊙ Compact
	● Coarse	● Loose
		● Medium
		● Compact
△ Angular-snow	△ Fine	△ Loose
		△ Medium
		△ Compact
	◬ Medium	◬ Loose
		◬ Medium
		◬ Compact
	▲ Coarse	▲ Loose
		▲ Medium
		▲ Compact

Table 3. Outline of stratigraphic observations, 1971 - 1972.

Sample No.		Location		Date of observation	Remarks	Fig.	Table
1		Sôya Coast	390m*	Sep.15,1971	firn line area (sampling: Aug.21, 1971)	2	
2			404m*	Sep.15,1971		3	
3			454m*	Sep.15,1971	soaked zone (sampling: Aug.27)	4	
4	core	Mizuho Plateau	S30	Dec. 8,1971	(sampling: Sep.23)	5	4
5			H180	Oct. 22,1971	(sampling: Sep.25)	6	
6-1			S169-1	Dec.31,1971	(sampling: Dec.24)	7	5
6-2			S169-2			8	
7		Mizuho Camp	Sastrugi-1	Jan. 5,1972	section of sastrugi	9	
8			Sastrugi-2	Dec.13,1971	section of sastrugi	10a,b	6
9	section		glazed surface	Dec.18,1971	trench wall	11a,b	7
10-1	or			Dec.15,1971	south wall	12	8
10-2	pit				east wall	13	
11-1			drifted snow	Dec.17,1971	south wall	14	9
11-2					east wall	15	
12-I~VI	core		stake-farm	Jan. 9,1972	1m core x 6 (sampling: Jan.5, 1972)	16	

* Elevation above sea level. Observation sites of samples Nos. 9 - 12 are shown by ◎ in Fig.B (folded map).

Table 4. Grain size, density and Canadian hardness of snow at S30, December 8, 1971.

Depth (cm)	Grain size	Density (g/cm^3)	Canadian hardness (kg/cm^2)	Depth (cm)	Grain size	Desnity (g/cm^3)	Canadian hardness (kg/cm^2)
2	a	0.295	0.3	126	b	0.457	2.0
8	a	0.346	0.5	129	b	0.444	2.0
13	a	0.290	0.1	132	b	0.450	1.0
22	a	0.325	0.2	135	b	0.450	2.0
32	a	0.401	0.7	138	b	0.453	2.0
38	a	0.513	0.8	141	b	0.459	2.0
52	b	0.456	2.0	157	b	0.454	2.0
55	b	0.473	3.0	160	b	0.457	2.0
58	b	0.418	0.9	167	b	0.432	1.0
61	b	0.437	2.0	171	b	0.540	0.3
64	b	0.443	2.0	174	b	0.441	2.0
68	c	0.349	0.1	177	b	0.445	2.0
72	b	0.434	0.8	180	b	0.441	2.0
75	b	0.424	0.6	188	c	0.415	1.0
80	b	0.414	0.9	191	c	0.406	0.7
83	b	0.438	1.0	194	c	0.425	0.8
91	b	0.401	0.4	197	b	0.457	2.0
95	b	0.424	0.6	200	c	0.450	2.0
99	b	0.458	2.0	211	c	0.378	0.7
102	b	0.446	2.0	214	c	0.395	0.5
105	b	0.441	1.0	217	c	0.396	0.8
108	b	0.444	2.0	220	c	0.412	0.6
111	b	0.432	1.0	223	c	0.433	0.6
114	b	0.422	1.0	226	c	0.412	0.8
117	b	0.433	1.0	229	c	0.358	0.4
123	b	0.464	3.0				

Table 5. Density of snow at S169-1, December 31, 1971.

Depth (cm)	Density (g/cm^3)	Depth (cm)	Density (g/cm^3)
2	0.46	87	0.48
8	0.43	103	0.46
16	0.44	111	0.47
22	0.45	119	0.45
26	0.43	122	0.49
33	0.33	127	0.45
39	0.39	136	0.47
45	0.45	140	0.48
52	0.45	144	0.46
58	0.43	148	0.49
65	0.47	152	0.48
69	0.40	163	0.43
72	0.42	170	0.44
76	0.42	175	0.43
81	0.49	184	0.44

Table 6. Grain size, density and Kinosita's hardness of sastrugi-2, Mizuho Camp, December 13, 1971.

Depth (cm)	Grain size	Density (g/cm^3)	Kinosita's hardness (kg/cm^2)
10	a	0.47	29
20	a	0.49	27
30	a	0.47	24
40	a	0.45	16
50	a	0.48	28
60	a	0.44	15
70	a	0.44	26
80	a	0.40	25
90	a	0.43	2
100	b	0.36	11
110	c	0.42	5.8
120	e	0.32	6.6
130	d-e	0.36	22
140	c-d	0.37	17
150	d	0.45	20

Table 7. Grain size, density and Canadian hardness of snow at the trench wall, Mizuho Camp, December 18, 1971.

	Depth (cm)	Grain size	Density (g/cm^3)	Depth(cm)	Canadian hardness (kg/cm^2)
a	+40	a-b	0.53	+40	4.5
	+27	b-c	0.39	+29	1.3
	+21	c	0.41	+20	1.4
	+13	b-c	0.50	+12	2.2
	+1	c	0.46	+2	1.7
	-12	c-d	0.39	-10	1.7
	-25	b-c	0.50	-20	2.9
	-41	c-d	0.40	-40	2.0
	-62	c	0.47	-60	2.5
	-83	d	0.44	-80	2.2
b	+42	a-b	0.51	+42	3.1
	+30	b-c	0.40	+29	1.1
	+15	b	0.50	+15	2.0
	0	c	0.52	+1	2.6
	-12	b	0.49	-9	3.3
	-30	b-c	0.51	-30	3.4
	-50	c-d	0.42	-50	2.4
	-70	d	0.41	-70	2.2
	-90	d	0.43	-90	2.3
c	+39	b-c	0.47	+39	2.0
	+29	c	0.42	+28	0.7
	+17	c	0.44	+17	1.9
	+6	b-c	0.47	+7	2.2
	-9	c-d	0.37	+3	1.4
	-17	c-d	0.44	-2	1.9
	-23	c	0.48	-7	1.5
	-35	d	0.40	-20	5.4
	-50	c	0.48	-35	2.2
	-70	c-d	0.45	-44	2.0
	-90	c-d	0.44	-60	2.5
				-80	1.9

Table 8. Grain size, density and Kinosita's hardness of snow at a glazed surface area, Mizuho Camp, December 15, 1971.

South wall

Depth (cm)	Grain size	Density (g/cm^3)	Depth (cm)	Kinosita's hardness (kg/cm^2)
3	b	0.39	0	6.6
13	b-c	0.44	17	13.7
28	c	0.37	30	1.6
38	b-c	0.43	37	8.5
58	c	0.44	47	11.5
83	d	0.37	67	3.5
103	d-e	0.44	87	2.6
123	d-e	0.45	107	9.4
143	c-d	0.52	127	9.6
163	c-d	0.46	147	35
183	d	0.42	167	14.5
203	d-e	0.41	187	7.6
			207	15

East wall

Depth (cm)	Grain size	Density (g/cm^3)	Depth (cm)	Kinosita's hardness (kg/cm^2)
3	b-c	0.46	0	17.5
18	b-c	0.44	6	12.5
38	b-c	0.45	26	6.2
58	c-d	0.40	46	10.5
81	c-d	0.44	66	2.7
98	c-d	0.45	86	11.5
118	d	0.40	100	14.7
138	c	0.49	126	9.1
158	c	0.49	146	23
178	d-e	0.46	166	23
196	d-e	0.39	186	21
			206	13.3

Table 9. Grain size, density and Kinosita's hardness of snow in a drift snow area, Mizuho Camp, December 17, 1971.

South wall

Depth (cm)	Grain size	Density (g/cm³)	Depth (cm)	Kinosita's hardness (kg/cm²)
2	a	0.38	0	4.6
18	b	0.41	15	9.7
33	b	0.40	30	4.2
48	c	0.37	40	8.5
63	c	0.40	50	9.2
79	c-d	0.36	65	10.5
88	b-c	0.50	80	5.4
93	b-c	0.44	85	43
103	c-d	0.41	95	43
123	d	0.41	105	9.5
143	b-c	0.51	115	22.5
163	c-d	0.44	125	17
183	c-d	0.45	145	19.5
203	d-e	0.46	165	16
223	d-e	0.41	185	14
			205	14
			225	19

East wall

Depth (cm)	Grain size	Density (g/cm³)	Depth (cm)	Kinosita's hardness (kg/cm²)
2	b	0.44	2	2.4
14	b	0.38	30	2.7
24	b	0.40	33	3.8
34	c-d	0.42	50	3.2
46	d	0.39	62	12.5
50	c-d	0.39	67	9.1
60	c	0.38	80	8.7
74	b-c	0.49	92	46
79	c	0.46	106	15.5
91	e	0.39	116	15
97	c-d	0.43	127	19
105	d-e	0.40	132	12
119	c	0.44	143	19
131	c-d	0.46	173	17
156	c-d	0.49	185	22
174	c	0.55	205	17
194	c-d	0.44	225	17