

5. Stratigraphic Observations of Surface Snow Cover

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5.1. Introduction

Stratigraphic observations of the surface snow cover of Mizuho Plateau were carried out in 1974 - 1975.

The objects of the observations were as follows:

- 1) Estimation of snow accumulation where direct measurement is not feasible.
- 2) Investigation on interaction between the air and the snow cover in connection with process of snow surface formation, metamorphosis of snow layers, and transitional sequences of their regional characteristics.
- 3) Glacial zoning of dry snow area; detailed investigations on oxygen isotope and fission products over a snow profile together with physical properties of a firn layer.

Seven 1-m pits and nine 2-m pits were dug in 1974 - 1975 for snow stratigraphy. Sampling of 10-m snow cores was made at 15 stations including some stations where 2-m pits were excavated. These cores were carried back to Japan for precise analyses. Ram sonde profiles from the surface to a depth of 2 meters were also obtained at 53 stations. Results of studies of six 2-m pits dug and four 10-m core collected during the period of 1971 - 1973 were included in this Chapter.

5.2. Methods and results of observation

5.2.1. Pit studies

Studies of pits including six 2-m pits dug in 1969 - 1970 summer are listed in Table 1. Station numbers, date of observation and observed items are summarized in Table 1. Two-meter pits were dug at every 100 km approximately along the traverse routes.

The dimension of the wall of a 2-m deep pit was 2.2 m in depth \times 2.5 m in width. Stratigraphy of the surface snow cover was investigated by a brush-up method on the wall of each 2-m pit. At each observable layer density measurements were made with a density tube. Oxygen isotope samples were collected at a few points from each layer. Grain size was determined at a few points within one observable layer by identifying grains on a millimeter grid card under polarized light. Hardness of snow was measured with Canadian hardness gauge on the same surface wall. Also a Swiss Ram sonde was used to make a hardness profile in the proximity of a pit parallel to the wall and 30 cm from the edge of

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the pit. Samples for fission products analysis (gross β -activity) were collected from each annual layer identified in situ. The results of 2-m pit observation in 1974 - 1975 summer are shown in Fig. 1 with legend.

The dimension of the wall of an 1-m pit was 1.2 m in depth and 0.5 m in width; the stratigraphy, density, grain size and hardness by Canadian gauge were recorded. Studies of 1-m pits which were made to complement the 2-m pit observation in the 1974 - 1975 summer, are shown in Fig. 2. Numerical data of density and oxygen isotope ratio (analyzed by Kikuo Kato, refer to Chapter IV in this volume) of 2-m pit are given in Table 2-1. The results of 2-m pit observation in the 1969 - 1970 summer are shown in Fig. 3. The numerical data of density are tabulated in Table 2-2.

5.2.2. 2 m depth Ram hardness profiling

The purposes of Ram hardness profiling are as follows:

1) Tracing of snow stratigraphy under the similar environmental conditions: it is considered that Ram hardness profiles and existence of key layer (bed) are largely dependent on environmental conditions.

2) Determination of regional characteristics of depth hoar formation deduced from Ram hardness profiles.

Vertical profiling of Ram hardness with about 5 cm step to a depth of 2 m was made at every 20 km along the Route Y' and 40 km along the Routes I and J, while the results along Routes S, Z, Y and W in 1970 - 1971 have been reported by Watanabe and Ageta (1972). All the results of Ram hardness profiles from the surface to a depth of 2 m along the route of traverses in 1974 - 1975 are given in Figs. 4 A, B and C. Numerals in diagrams of Fig. 4 indicate the "Key bed", whose definition was given in Watanabe and Ageta (1972). Ram hardness numbers are tabulated in Table 3 with integrated values from the surface to 100 cm in depth and to 180 - 200 cm.

Ram hardness of surface snow suddenly decreased when the elevation reached 2,900 m, and remained considerably low in value for higher elevation than that along Routes I and J.

5.2.3. 10-m core studies

Snow cores 10 m in length were obtained at 19 stations in 1969 - 1975 by the use of a SIPRE type 3-inch corer. Core catalogue is given in Table 4. These cores were wrapped with an aluminum foil and kept in corrugated cardboard boxes stuffed with snow for keeping ice saturated vapor. Cores, transported by ship from Antarctica to the cold laboratory of the Institute of Low Temperature Science, Hokkaido University, Sapporo, has been stored there at an average temperature of -20°C . Previous to investigation, the core was divided by the following procedure; First a core was cut into two equal halves along the long axis. Then, a slab 1 cm thick for stratigraphic analysis was

sliced from one of the halves along its long axis. The rest of this half-cut core was used for geochemical and texture analyses, after the density measurement was done. The other half was preserved for other purposes. The following examinations were made on each core:

1) Stratigraphy of a core

The snow slab for stratigraphic analysis was examined on light table. Such remarkable textures as well-developed depth hoar layers (meta-layer) and lamina-forming layers (paleo-layer), which retained their original textures during a process of accumulation, and such sheet structures as ice crust and layer boundary were described. The formative process of depth hoar was described in terms of the level defined in the legend. Numbers of ice crusts in multi-layered ice crusts were also recorded.

2) Analysis of physical properties

The density was measured by volume and weight technique. Usually one sample was taken for density measurement from each homogeneous part of a layer, but two or three samples were taken from a thick part.

The grain size (diameter) was measured continuously from surface to 10 m depth with a scale graduated in 0.1 mm.

3) Collection of snow samples for chemical analyses

At least one sample for analysis of oxygen isotope content was collected from each observable layer, but when the layer was thick two or three samples were collected. Samples from those observable layers belonging to an annual layer were used as a whole for gross β -activity.

Stratigraphic profiles of 10 cores out of 19 cores obtained are given in Fig. 5, which consists of two parts: (1) a stratigraphic columnar section with remarks at the left; (2) a combination diagram of depth hoar leveling (DHL) by a black histogram, grain size by a white histogram and profile of density at the right side. Profiles of oxygen isotope content and gross β -activity are given of only two stations (H 128 and S 97). Numeral data of density and oxygen isotope content were tabulated in Tables 5 and 6 respectively. Detailed stratigraphic analysis of the 10-m long cores obtained at 19 stations are still under way.

References

- Watanabe, O. and Ageta, Y. (1972): Surface condition of the ice sheet in Mizuho Plateau-West Enderby Land area, East Antarctica, 1969 - 1971. JARE Data Rep., 17 (Glaciol.), 48 - 76.
- Watanabe, O. (1972): Stratigraphic observation of the surface snow cover in West Enderby Land, East Antarctica, 1970 - 1971. JARE Data Rep., 17 (Glaciol.), 88 - 110.

Table 1. Catalogue of pit studies in 1969-1975.

Station No.	Elevation (m)	Date of Observation	Observation
(2m Deep Pit-Study 1969 - 1970)			
S 16	554	27 Jan. 1970	St. Temp.
S 122	1910	18 Jan. 1970	St.
W 55	2168	31 Dec. 1969	St.
Y 100	2606	22 Nov. 1969	St. Temp.
Y 200	2880	27 Nov. 1969	St.
Y 370	2564	4 Dec. 1969	St.
(2m Deep Pit-Study 1974 - 1975)			
Mizuho Camp	2230	16-19 May. 1974	St. $\delta^{18}O$ β
Y'100	2596	17 Oct. 1974	St. $\delta^{18}O$ β
Y'200	2880	25 Oct. 1974	St. $\delta^{18}O$ β
I 235	3199	2 Nov. 1974	St. $\delta^{18}O$ β
I 365	3310	16 Nov. 1974	St. $\delta^{18}O$ β
I 485	3388	9 Nov. 1974	St. $\delta^{18}O$ β
I 600	3408	12 Nov. 1974	St.
J 225	3039	22 Nov. 1974	St. $\delta^{18}O$ β
J 364	2613	26 Nov. 1974	St. $\delta^{18}O$ β
W 280	2405	5 Jan. 1975	St. $\delta^{18}O$ β
W 46	1958	31 Dec. 1974	St. $\delta^{18}O$ β
(1m Deep Pit-Study 1974)			
I 540	3404	13 Nov. 1974	St.
I 425	3359	15 Nov. 1974	St.
J 45	3253	18 Nov. 1974	St.
J 145	3179	19 Nov. 1974	St.
J 270	2886	23 Nov. 1974	St.
J 318	2799	24 Nov. 1974	St.
J 408	2504	27 Nov. 1974	St.

St.: Stratigraphic observation
Temp.: Snow temperature measurement
 $\delta^{18}O$: Oxygen isotope ratio analysis
 β : Fission products analysis (Gross β activity)

Table 2-1 Snow density and oxygen isotope content
of 2-m pit studies in 1974 - 1975

$\bar{\rho}$: mean of density

$\bar{\delta}^{18}\text{O}$: mean of oxygen isotope ratio

Y' 100 2596 m				Y' 210 2880 m			
No.	depth	ρ	$\delta^{18}\text{O}$	No.	depth	ρ	$\delta^{18}\text{O}$
1	12	0.35	-45.5	1	8	0.42	-47.7
2	12	0.44	-44.9	2	17	0.35	-40.3
3	32	0.41	-40.8	3	21	0.43	-46.5
4	35	0.43	-42.6	4	27	0.43	-40.5
5	42	0.43	-44.3	5	41	0.54	-46.2
6	45	0.44	-43.5	6	45	0.40	-46.4
7	52	0.39	-43.1	7	35	0.33	-45.6
8	54	0.31	-38.6	8	52	0.41	-50.3
9	67	0.35	-40.2	9	56	0.37	-50.2
10	72	0.41	-43.0	10	67	0.46	-46.4
11	90	0.36	-36.5	11	62	0.43	-45.0
12	92	0.31	-45.4	12	68	0.38	-42.0
13	104	0.43	-46.4	13	78	0.39	-47.4
14	120	0.46	-40.1	14	91	0.46	-44.7
15	125	0.39	-47.4	15	93	0.38	-42.7
16	147	0.37	-48.3	16	104	0.48	-41.6
17	175	0.43	-37.8	17	114	0.38	-45.7
18	197	0.46	-42.6	18	120	0.44	-48.8
19	205	0.43	-39.2	19	113	0.39	-43.7
20	210	0.43	-37.2	20	130	0.46	-40.7
				21	143	0.48	-42.5
				22	160	0.38	-45.0
				23	164	0.43	-48.1
				24	170	0.37	-40.6
				25	181	0.47	-40.1
				26	190	0.41	-42.5
				27	185	0.43	-44.8
				28	200	0.39	-47.2

$\bar{\rho}$	0.40	g/cm ³
range	0.31~0.44	g/cm ³
$\bar{\delta}^{18}\text{O}$	-42.4	‰
range	-48.3~-36.5	‰

$\bar{\rho}$	0.42	g/cm ³
range	0.33~0.54	g/cm ³
$\bar{\delta}^{18}\text{O}$	-44.8	‰
range	-50.3~-40.1	‰

I 235 3200 m

No.	depth	ρ	$\delta^{18}\text{O}$
1	5	0.30	-54.5
2	20	0.36	-51.2
3	32	0.40	-53.6
4	44	0.41	-42.9
5	43	0.33	-37.6
6	49	0.45	-43.8
7	59	0.36	-49.6
8	66	0.36	-54.8
9	75	0.37	-53.8
10	93	0.35	-52.3
11	97	0.34	-50.1
12	102	0.40	-47.5
13	117	0.34	-47.1
14	120	0.43	-56.4
15	142	0.40	-52.4
16	147	0.36	-51.6
17	153	0.36	-50.8
18	158	0.31	-48.8
19	162	0.31	-49.0
20	167	0.40	-54.3
21	165	0.36	-50.3
22	176	0.37	-50.9
23	191	0.51	-48.7
24	195	0.40	-48.7
25	180	0.30	-48.1
26	207	0.40	-54.8
27	204	0.37	-55.3

$\bar{\rho}$ 0.37 g/cm³
 range 0.30~0.51 g/cm³
 $\bar{\delta}^{18}\text{O}$ -50.4 ‰
 range -56.4~-37.6 ‰

I 365 3310 m

No.	depth	ρ	$\delta^{18}\text{O}$
1	5	0.26	-44.7
2	10	0.41	-39.5
3	11	0.34	-57.5
4	20	0.35	-54.9
5	26	0.36	-52.9
6	30	0.31	-45.6
7	32	0.35	-48.5
8	38	0.33	-50.8
9	40	0.33	-54.8
10	48	0.33	-53.0
11	50	0.31	-55.8
12	64	0.39	-52.1
13	73	0.39	-53.1
14	80	0.40	-52.4
15	87	0.35	-46.0
16	90	0.34	-49.6
17	100	0.36	-51.9
18	100	0.35	-53.1
19	113	0.31	-52.7
20	122	0.34	-51.4
21	128	0.41	-49.4
22	132	0.33	-48.8
23	139	0.36	-57.4
24	149	0.39	-58.3
25	157	0.37	-55.0
26	163	0.32	-49.0
27	174	0.31	-48.2
28	180	0.36	-51.2
29	192	0.40	-50.4
30	200	0.35	-52.4

$\bar{\rho}$ 0.35 g/cm³
 range 0.26~0.41 g/cm³
 $\bar{\delta}^{18}\text{O}$ -51.3 ‰
 range -58.3~-39.5 ‰

I 485 3383 m

No.	depth	ρ	$\delta^{18}\text{O}$
1	↑20	0.28	-53.8
2	↑3	0.31	-54.5
3	7	0.37	-52.9
4	13	0.32	-53.5
5	27	0.36	-48.7
6	32	0.33	-44.6
7	34	0.32	-54.4
8	38	0.36	-58.1
9	43	0.32	-39.9
10	46	0.36	-52.8
11	44	0.36	-53.8
12	51	0.35	-53.1
13	58	0.37	-53.3
14	61	0.26	-52.8
15	66	0.36	-51.8
16	71	0.33	-51.1
17	79	0.32	-51.8
18	88	0.32	-49.8
19	96	0.39	-49.5
20	103	0.34	-52.8
21	110	0.35	-53.5
22	117	0.33	-49.7
23	118	0.31	-54.4
24	145	0.38	-53.3
25	156	0.37	-54.5
26	166	0.38	-55.4
27	181	0.38	-55.4
28	190	0.35	-55.8
29	197	0.36	-57.8
30	209	0.32	

↑ : Height from the surface

$\bar{\rho}$ 0.34 g/cm³
 range 0.28~0.39 g/cm³
 $\bar{\delta}^{18}\text{O}$ -52.5 ‰
 range -58.1~-39.9 ‰

I 600 3408 m

No.	depth	ρ
1	↑5	0.32
2	5	0.37
3	9	0.33
4	23	0.32
5	32	0.32
6	37	0.29
7	43	0.36
8	42	0.32
9	43	0.34
10	56	0.35
11	66	0.30
12	62	0.31
13	66	0.31
14	71	0.36
15	78	0.33
16	85	0.34
17	96	0.37
18	105	0.41
19	114	0.34
20	123	0.35
21	131	0.37
22	133	0.37
23	142	0.47
24	145	0.36
25	151	0.30
26	153	0.42
27	161	0.37
28	169	0.31
29	178	0.33
30	192	0.44
31	201	0.36

↑ : Height from the surface

$\bar{\rho}$ 0.35 g/cm³
 range 0.29~0.47 g/cm³

J 225 3039 m

No.	depth	ρ	$\delta^{18}\text{O}$
1	5	0.40	-52.9
2	10	0.35	—
3	20	0.33	—
4	27	0.42	-52.6
5	35	0.37	—
6	41	0.41	-47.6
7	57	0.38	-45.0
8	60	0.36	-51.6
9	67	0.38	-51.6
10	70	0.38	-51.3
11	75	0.43	—
12	69	0.43	—
13	73	0.34	—
14	74	0.45	-48.8
15	80	0.39	-46.0
16	80	0.36	-39.4
17	96	0.36	-48.6
18	93	0.43	-49.2
19	112	0.41	—
20	139	0.45	-49.2
21	128	0.41	-50.4
22	135	0.36	-50.5
23	144	0.40	-43.3
24	150	0.40	-51.6
25	163	0.39	-44.3
26	167	0.40	—
27	168	0.45	-43.9
28	177	0.43	-47.8
29	179	0.44	-46.6
30	183	0.38	-44.0
31	190	0.38	-35.8
32	195	0.44	-51.3
33	207	0.39	-52.2
34	215	0.41	-51.5
35	224	0.40	-46.4

$\bar{\rho}$ 0.40 g/cm³
 range 0.33~0.45 g/cm³
 $\bar{\delta}^{18}\text{O}$ -47.9 ‰
 range -52.9~-35.8 ‰

J 364 2613 m

No.	depth	ρ	$\delta^{18}\text{O}$
1	2	0.42	-45.4
2	12	0.43	-44.7
3	17	0.44	-42.5
4	26	0.44	-45.6
5	29	0.44	-45.4
6	33	0.37	—
7-1	35	0.33	-46.6
7-2	44	0.35	-48.5
8	52	0.36	-48.1
9	60	0.42	—
10	61	0.35	-44.6
11	76	0.45	-45.1
12	91	0.43	-41.3
13	91	0.43	-45.3
14	112	0.44	-43.1
15	122	0.46	-42.8
16	127	0.43	-36.0
17	135	0.45	-44.6
18	143	0.48	—
19	150	0.44	-39.7
20	152	0.39	—
21	160	0.49	-46.5
22	178	0.34	—
23	173	0.50	—
24	183	0.35	—
25	186	0.48	-45.9
26	195	0.37	-44.8
27	202	0.39	—
28	213	0.49	-48.3

$\bar{\rho}$ 0.42 g/cm³
 range 0.33~0.50 g/cm³
 $\bar{\delta}^{18}\text{O}$ -44.5 ‰
 range -48.5~-36.0 ‰

W 280 2405 m

No.	depth	ρ	δ^{18}
1	3	0.50	-42.5
2	7	0.41	-41.4
3	17	0.46	-37.5
4	23	0.43	-34.9
5	33	0.40	-35.1
6	50	0.46	-35.9
7	62	0.45	-37.6
8	88	0.45	-42.4
9	85	0.43	-40.8
10	97	0.38	-36.4
11	103	0.47	-41.1
12	122	0.49	-41.9
13	133	0.48	-38.1
14	141	0.44	-37.7
15	139	0.45	-34.9
16	142	0.36	-35.2
17	151	0.47	-39.0
18	157	0.48	-39.7
19	159	0.47	-36.4
20	167	0.45	-38.4
21	176	0.47	-37.0
22	179	0.43	-38.3
23	180	0.43	-37.6
24	188	0.35	-36.7
25	196	0.48	-39.6
26	197	0.48	-40.9
27	205	0.46	-40.7
28	210	0.39	-38.0
29	218	0.36	-36.4

$\bar{\rho}$ 0.44 g/cm³
 range 0.35~0.48 g/cm³
 $\bar{\delta}^{18} \text{O}$ -38.3 ‰
 range -42.5~-34.9 ‰

W 46 1958 m

No.	depth	ρ	$\delta^{18} \text{O}$
1	3	0.36	-31.2
2	12	0.38	-38.6
3	21	0.37	-39.0
4	26	0.44	-41.6
5	33	0.42	-41.3
6	39	0.42	-41.1
7	23	0.49	-35.9
8	34	0.51	-34.5
9	47	0.51	-33.9
10	48	0.46	-34.6
11	72	0.47	-34.5
12	76	0.40	-30.4
13	83	0.41	-31.0
14	86	0.37	-34.6
15	92	0.39	-34.8
16	93	0.40	-32.8
17	98	0.39	-33.4
18	105	0.33	-32.6
19	107	0.39	-34.5
20	124	0.38	-37.5
21	127	0.43	-37.8
22	137	0.43	-35.9
23	146	0.43	-35.9
24	144	0.45	-35.1
25	162	0.44	-32.4
26	164	0.41	-32.7
27	172	0.44	-32.4
28	181	0.43	-32.5
29	193	0.36	-30.4
30	203	0.35	-35.1

$\bar{\rho}$ 0.42 g/cm³
 range 0.33~0.51 g/cm³
 $\bar{\delta}^{18} \text{O}$ -34.9 ‰
 range -41.6~-30.4 ‰

Table 2-2. Snow density of 2-m pit studies in 1969 – 1970.

S 16 554 m			S 122 1910 m			W 55 2168 m		
No.	Depth (cm)	Density (g/cm ³)	No.	Depth (cm)	Density (g/cm ³)	No.	Depth (cm)	Density (g/cm ³)
1	20	0.39	1	4	0.34	1	10	0.35
2	38	0.45	2	9	0.35	2	26	0.38
3	50	0.45	3	16	0.43	3	41	0.37
4	60	0.57	4	25	0.42	4	57	0.35
5	73	0.45	5	31	0.43	5	73	0.37
6	87	0.38	6	34	0.45	6	85	0.43
7	95	0.41	7	41	0.34	7	97	0.38
8	104	0.42	8	48	0.37	8	102	0.41
9	112	0.45	9	58	0.31	9	129	0.39
10	125	0.39	10	68	0.28	10	141	0.44
11	137	0.47	11	74	0.37	11	150	0.46
12	165	0.44	12	88	0.39	12	157	0.45
13	178	0.45	13	104	0.37	13	170	0.43
14	181	0.45	14	113	0.44	14	188	0.38
15	187	0.38	15	119	0.45	15	190	0.41
16	197	0.47	16	126	0.46	16	202	0.42
17	207	0.45	17	140	0.37	17	212	0.46
<hr/>			18	144	0.44	18	223	0.45
<hr/>			19	156	0.44	<hr/>		
Y 100 2606 m			20	171	0.45	Y 370 2564 m		
No.	Depth (cm)	Density (g/cm ³)	21	176	0.85	No.	Depth (cm)	Density (g/cm ³)
1	4	0.42	22	184	0.45	1	12	0.46
2	13	0.30	23	196	0.39	2	38	0.37
3	23	0.42	<hr/>			3	47	0.41
4	34	0.45	Y 200 2880 m			4	66	0.47
5	45	0.44	No.	Depth (cm)	Density (g/cm ³)	5	78	0.42
6	60	0.39	1	6	0.43	6	100	0.46
7	74	0.49	2	13	0.44	7	108	0.47
8	83	0.41	3	25	0.36	8	122	0.40
9	92	0.42	4	35	0.37	9	130	0.38
10	101	0.37	5	47	0.40	10	145	0.51
11	134	0.45	6	64	0.47	11	155	0.38
12	146	0.40	7	83	0.38	12	170	0.45
13	160	0.41	8	97	0.43	13	186	0.51
14	167	0.40	9	110	0.37	14	193	0.44
15	180	0.43	10	118	0.37	15	198	0.39
16	188	0.42	11	146	0.45	<hr/>		
17	197	0.41	12	160	0.38			
<hr/>			13	175	0.39			
			14	200	0.43			

Table 3. Ram hardness number along the Routes of Y'-I-J.

	R 100	R 101-200	R 200	
<u>Route J</u>				
J 20	4942	4084	9026	
J 40	3746	5449	9195	
J 60	3038	4598	7636	
J 80	7647	5496	13143	
J 100	4059	5622	9681	
J 120	4973	12160	17133	
J 140	3900	4941	8841	
J 160	4612	9060	13672	
J 180	7480	4565	12045	
J 200	6481	18080	24561	
J 220	5120	9407	14527	
J 225	5980	14528	20508	
J 250	8328	6391	14719	
J 270	7886	—	—	
J 290	12380	5767	18147	
J 310	21441	—	—	
J 330	13685	17836	31521	
J 350	12569	9592	22161	
J 370	4758	9605	14363	
J 390	10361	28260*	38621*	* 180 cm
J 408	9665	26569	35934	
J 430	10837	28280*	39117*	* 190 cm
J 450	15202	22477*	37679*	* 180 cm
<u>Route I</u>				
I 20	10635	13760*	24395*	* 190 cm
I 60	12801	9679*	22480*	* 190 cm
I 100	10405	6959*	17364*	* 190 cm
I 140	14642	10722*	25364*	* 190 cm
I 160	14800	20960*	35760*	* 190 cm
I 220	6351	8236*	14581*	* 190 cm
I 260	3741	3929	7670	
I 300	2647	5922	8569	
I 328	6797	3939	10736	
I 365	2408	2682	5090	
I 380	2071	4421	6492	
I 400	3397	3149	6546	
I 420	3599	4158	7757	
I 440 (1)	1515	2337	3852	
I 440 (2)	2595	4630	7225	
I 460	2581	2832	5350	
I 485	1993	2515	4508	
I 515	1558	2154	3712	
I 570	3983	3716	7699	
<u>Route H</u>				
H 250	14460*	—	—	* 93 cm
<u>Route Y'</u>				
Y' 20	22481	—	—	
Y' 40	15120	—	—	
Y' 60	20592	17718	38310	
Y' 80	21597	65118	86715	
Y' 100	20140	—	—	
Y' 120	8484	9634	18118	
Y' 140	7437	22082*	29519*	* 190 cm
Y' 160	6958	8965*	15923*	* 190 cm
Y' 190	14652	11600*	26252*	* 190 cm

Integrated value of Ram hardness number
R100: from surface to 100 cm depth
R101-200: from 100 cm depth to 200 cm depth
R200: from surface to 200 cm depth
*: in case read indicated figures for 200 cm

Depth (cm)	Ram hardness (kg)	Depth (cm)	Ram hardness	Depth (cm)	Ram hardness
<u>J 20</u>		150-155	60	77- 80	120
0- 10	8	155-160	52	80- 85	24
10- 13	27	160-165	48	85- 90	20
13- 15	70	165-170	52	90- 93	120
15- 20	152	170-175	40	93-100	143
20- 23	107	175-180	44		
23- 28	40	180-185	52	100-104	90
28- 30	80	185-190	32	104-107	20
30- 35	72	190-195	28	107-114	9
35- 40	68	195-200	56	114-120	23
40- 45	32			120-125	32
45- 50	32	200-205	56	125-130	24
50- 55	24	205-208	73	130-135	44
55- 60	16	208-217	89	135-140	20
60- 65	28	217-225	100	140-145	24
65- 70	40	225-235	32	145-150	40
70- 75	64			150-155	44
75- 79	85			155-160	28
79- 85	100	<u>J 40</u>		160-165	32
85- 90	32	0- 11	9	165-170	40
90- 95	32	11- 21	10	170-175	52
95- 99	15	21- 25	20	175-180	44
		25- 30	20	180-182	60
99-108	18	30- 38	23	182-184	120
108-110	60	38- 42	50	184-186	210
110-115	56	42- 45	47	186-190	188
115-120	32	45- 50	32	190-195	88
120-125	16	50- 55	12	195-205	36
125-129	25	55- 58	7		
129-135	47	58- 65	40	205-210	40
135-140	48	65- 70	28	210-215	64
140-145	36	70- 75	24	215-225	52
145-150	32	75- 77	60	225-230	40

Depth (cm)	Ram hardness (kg)	Depth (cm)	Ram hardness	Depth (cm)	Ram hardness
<u>J 60</u>		160-165	28	106-112	100
0- 10	14	165-170	32	112-119	26
10- 15	28	170-175	36	119-127	53
15- 21	20	175-180	36	127-135	28
21- 25	15	180-183	60	135-140	20
25- 31	10	183-186	133	140-145	96
31- 35	10	186-195	76	145-150	96
35- 40	16	195-200	56	150-155	64
40- 45	32			155-160	24
45- 47	10	200-205	80	160-168	35
47- 51	5	205-219	77	168-175	109
51- 55	20	219-222	440	175-180	80
55- 60	36			180-185	56
60- 65	36			185-191	67
65- 70	24	<u>J 80</u>		191-200	27
70- 75	44	0- 10	30	200-205	72
75- 78	53	10- 15	40	205-211	20
78- 80	70	15- 20	36	211-218	37
80- 85	88	20- 25	32	218-222	90
85- 90	32	25- 28	33	222-230	75
90- 95	20	28- 32	45		
95- 98	73	32- 37	16		
98-100	100	37- 40	60	<u>J100</u>	
		40- 45	60	0- 10	34
100-105	28	45- 50	68	10- 16	17
105-111	37	50- 55	80	16- 20	40
111-115	30	55- 60	224	20- 25	56
115-120	88	60- 65	200	25- 30	40
120-125	64	65- 70	264	30- 35	20
125-130	44	70- 75	160	35- 41	13
130-135	28	75- 86	44	41- 44	27
135-140	20	86- 90	45	44- 50	50
140-145	28	90- 96	24	50- 56	17
145-150	40	96-100	20	56- 60	20
150-155	48			60- 65	20
155-160	28	100-106	33	65- 68	53

Depth (cm)	Ram hardness (kg)	Depth (cm)	Ram hardness	Depth (cm)	Ram hardness
68- 71	67	<u>J120</u>		175-180	240
71- 75	60	0- 11	13	180-185	184
75- 81	33	11- 20	16	185-190	144
81- 84	40	20- 25	16	190-195	176
84- 90	93	25- 31	20	195-200	104
90- 95	96	31- 35	25		
95-100	56	35- 40	32		
		40- 45	32	<u>J140</u>	
100-105	48	45- 48	53	0- 10	16
105-110	48	48- 55	11	10- 17	51
110-115	48	55- 60	20	17- 25	45
115-120	32	60- 65	28	25- 32	17
120-125	40	65- 70	64	32-37	12
125-130	40	70- 72	90	37- 45	33
130-135	56	72- 75	120	45- 50	48
135-140	64	75- 80	120	50- 55	40
140-145	112	80- 85	90	55- 60	60
145-150	48	85- 90	28	60- 65	48
150-160	44	90- 95	24	65- 70	40
160-165	80	95-100	28	70- 75	72
165-170	152			75- 85	36
170-175	64	100-105	60	85- 90	40
175-180	48	105-110	64	90-100	48
180-185	96	110-115	76		
185-190	40	115-117	160	100-105	80
190-196	27	117-120	200	105-115	68
196-200	40	120-125	240	115-130	35
		125-130	96	130-135	32
200-206	53	130-140	68	135-140	56
206-210	50	140-145	120	140-145	120
210-215	80	145-150	120	145-150	112
215-220	104	150-160	84	150-155	96
220-230	40	160-165	120	155-159	40
		165-170	80	159-165	40
		170-175	120	165-172	51

Depth (cm)	Ram hardness (kg)	Depth (cm)	Ram hardness	Depth (cm)	Ram hardness
172-181	53	145-150	40	68- 71	40
181-189	15	150-155	96	71- 76	36
189-200	22	155-160	120	76- 81	40
		160-165	128	81- 84	80
200-205	56	165-171	40	84- 88	135
205-210	64	171-175	25	88- 92	135
210-215	104	175-177	100	92- 95	60
215-220	80	177-180	320	95-100	72
		180-185	192		
		185-190	96	100-105	72
		190-200	64	105-109	30
<u>J160</u>		200-205	64	109-116	17
0- 11	25	205-215	26	116-121	24
11- 19	10	215-220	64	121-129	30
19- 24	24	220-225	64	129-135	60
24- 30	27	225-230	72	135-140	84
30- 35	20			140-146	60
25- 40	28			146-152	20
40- 45	44			152-156	45
45- 50	44	<u>J180</u>		156-161	36
50- 60	56	0- 10	32	161-168	40
60- 65	64	10- 14	30	168-178	24
65- 70	32	14- 20	30	178-184	20
70- 72	90	20- 23	73	184-190	120
72- 75	200	23- 25	120	190-198	38
75- 81	73	25- 30	96	198-205	43
81- 90	53	30- 33	107		
90-100	56	33- 35	120		
		35- 38	160	205-207	60
100-105	64	38- 40	180	207-210	140
105-110	72	40- 45	108	210-214	60
110-115	120	45- 50	108	214-221	34
115-120	80	50- 53	60	221-230	87
120-125	160	53- 56	80		
125-130	96	56- 61	60		
130-140	36	61- 66	48	<u>J200</u>	
140-145	48	66- 68	60	0- 10	40

Depth (cm)	Ram hardness (kg)	Depth (cm)	Ram hardness	Depth (cm)	Ram hardness
10- 15	104	<u>J220</u>		180-185	144
15- 20	96	0- 10	52	185-190	32
20- 25	128	10- 15	88	190-200	36
25- 35	48	15- 20	88		
35- 41	93	20- 25	72	200-205	56
41- 50	27	25- 29	50	205-210	184
50- 60	20	29- 38	13	210-215	80
60- 65	16	38- 43	32	215-220	120
65- 75	44	43- 48	16		
75- 80	112	48- 55	23		
80- 85	80	55- 60	24	<u>J225</u>	
85- 90	56	60- 65	40	0- 10	56
90- 95	80	65- 70	64	10- 16	40
95-100	160	70- 76	27	16- 19	13
		76- 80	70	19- 25	67
100-105	128	80- 85	48	25- 30	32
105-110	96	85- 90	48	30- 35	40
110-115	48	90- 95	88	35- 41	53
115-125	120	95- 96	200	41- 45	70
125-130	176	96-100	110	45- 50	80
130-135	240			50- 56	33
135-140	192	100-107	29	56- 60	40
140-145	192	107-110	80	60- 64	70
145-150	256	110-115	192	64- 69	144
150-155	208	115-122	46	69- 72	200
155-160	400	122-125	93	72- 75	107
165-170	320	125-130	240	75- 80	56
170-180	128	130-135	192	80- 86	27
180-185	144	135-141	120	86- 94	30
185-190	272	141-147	27	94-100	80
190-195	176	147-150	13		
195-205	56	150-154	160	100-105	80
		154-160	107	105-110	120
205-210	144	160-170	44	110-115	96
		170-175	128	115-120	128
		175-180	144	120-125	104

Depth (cm)	Ram hardness (kg)	Depth (cm)	Ram hardness	Depth (cm)	Ram hardness
125-130	120	107-115	50	75- 80	136
130-140	208	115-130	48	80- 85	128
140-145	224	130-140	76	85- 90	192
145-150	304	140-150	56	90- 93	213
150-154	140	150-160	44	93-100	137
154-160	93	160-170	60		
160-165	80	170-175	64	100-105	88
165-170	224	175-180	72	105-110	80
170-175	240	180-185	88	110-115	80
175-179	340	185-190	56	115-120	176
179-188	124	190-197	69	120-125	176
188-200	127	197-202	168	125-130	80
200-205	128			130-133	147
205-207	120	202-205	267	133-137	560
207-213	67	205-210	224	137-140	800
213-220	137	210-215	368	140-145	520
		215-220	272	145-148	533
		220-225	240	148-155	206
		225-230	192	155-160	592
				160-161	2000
<u>J250</u>					
0- 10	96				
10- 15	144				
15- 20	104	<u>J270</u>			
20- 25	80	0- 10	52	<u>J290</u>	
25- 29	140	10- 15	28	0- 10	68
29- 35	133	15- 18	40	10- 15	56
35- 45	80	18- 25	11	15- 20	64
45- 50	120	25- 29	10	20- 26	53
50- 55	168	29- 36	17	26- 30	90
55- 58	93	36- 40	40	30- 35	184
58- 70	40	40- 45	40	35- 40	224
70- 80	28	45- 50	56	40- 45	240
80- 87	63	50- 55	96	45- 50	256
87- 92	90	55- 60	80	50- 55	160
92-100	25	60- 65	48	55- 66	116
		65- 70	112	66- 73	29
100-107	34	70- 75	104	73- 76	227

Depth (cm)	Ram hardness (kg)	Depth (cm)	Ram hardness	Depth (cm)	Ram hardness
76- 80	340	46- 50	110	95-100	176
80- 84	180	50- 55	176		
84- 90	67	55- 60	144	100-105	160
90-100	80	60- 65	192	105-110	320
		65- 70	208	110-120	304
100-105	32	70- 75	272	120-125	304
105-110	48	75- 80	480	125-130	352
110-120	40	80- 83	613	130-135	160
120-131	25	83- 85	550	135-140	168
131-138	29	85- 90	440	140-145	160
138-145	69	90- 95	480	145-150	128
145-152	29	95-100	660	150-160	88
152-157	24			160-165	192
157-161	50	100-105	540	165-170	288
161-170	31	105-108	1067	170-173	293
170-176	47	108-109	3500	173-180	131
176-180	70			180-185	112
180-186	67			185-190	104
186-192	60	<u>J330</u>		190-200	32
192-195	120	0- 10	36		
195-205	152	10- 15	48		
		15- 20	48	<u>J350</u>	
205-213	100	20- 25	104	0- 11	29
213-217	240	25- 30	72	11- 16	24
217-222	112	30- 35	104	16- 23	29
222-228	53	35- 38	80	23- 30	57
		38- 40	40	30- 33	53
		40- 47	23	33- 36	27
		47- 55	55	36- 40	190
<u>J310</u>		55- 60	40	40- 45	224
0- 10	92	60- 69	31	45- 52	86
10- 15	48	69- 76	80	52- 60	210
15- 20	56	76- 79	120	60- 65	288
20- 30	60	79- 85	140	65- 70	192
30- 35	32	85- 90	272	70- 75	224
35- 40	40	90- 95	240	75- 80	176
40- 46	67				

Depth (cm)	Ram hardness (kg)	Depth (cm)	Ram hardness	Depth (cm)	Ram hardness
80- 85	304	81- 84	13	45- 50	80
85- 90	176	84- 89	64	50- 54	40
90-101	66	89- 95	27	54- 60	67
		95-100	240	60- 65	144
101-108	46			65- 70	112
108-120	73	100-105	288	70- 75	112
120-127	57	105-111	80	75- 80	240
127-133	40	111-120	27	80- 85	192
133-141	130	120-125	40	85- 90	144
141-147	93	125-130	120	90- 95	240
147-160	129	130-135	208	95-100	208
160-165	224	135-140	48		
165-180	128	140-149	27	100-105	128
180-185	176	149-155	107	105-110	48
185-190	208	155-165	148	110-120	120
190-200	80	165-170	88	120-125	160
		170-175	88	125-130	32
200-210	96	175-180	48	130-135	336
210-215	256	180-186	73	135-140	288
215-220	400	186-195	111	140-145	320
220-225	176	195-200	88	145-150	144
				150-155	160
		200-204	110	155-160	368
<u>J370</u>		204-209	80	160-165	848
0- 10	32	209-211	340	165-170	960
10- 15	8	211-215	660	170-175	720
15- 25	64			175-180	900
25- 30	56				
30- 35	40	<u>J390</u>			
35- 41	47	0- 11	40	<u>J408</u>	
41- 49	30	11- 15	100	0- 10	36
49- 54	56	15- 20	112	10- 17	40
54- 58	80	20- 26	40	17- 20	160
58- 68	16	26- 31	32	20- 22	220
68- 74	33	31- 40	31	22- 25	213
74- 81	11	40- 45	72	25- 30	128

Depth (cm)	Ram hardness (kg)	Depth (cm)	Ram hardness	Depth (cm)	Ram hardness
30- 35	96	10- 15	192	14- 20	227
35- 40	112	15- 20	176	20- 25	128
40- 45	96	20- 25	128	25- 30	144
45- 50	128	25- 30	160	30- 35	208
50- 55	136	30- 35	72	35- 40	208
55- 60	96	35- 45	24	40- 45	176
60- 65	40	45- 55	36	45- 50	144
65- 75	96	55- 60	184	50- 55	144
75- 80	128	60- 65	224	55- 65	96
80- 85	160	65- 75	84	65- 70	400
85- 91	93	75- 81	53	70- 75	304
91-100	49	81- 90	71	75- 80	176
		90- 95	200	80- 85	112
100-105	160	95-100	208	85- 95	80
105-110	160			95-103	80
110-115	128	100-105	144		
115-121	120	105-115	96	103-110	171
121-130	53	115-120	88	110-115	224
130-135	128	120-130	128	115-120	240
135-140	112	130-135	152	120-130	128
140-145	72	135-140	232	130-135	256
145-150	72	140-145	464	135-140	272
150-155	32	145-150	288	140-145	128
155-160	160	150-155	544	145-150	480
160-165	544	155-160	640	150-160	272
165-170	800	160-165	640	160-165	320
170-175	1300	165-167	400	165-170	512
175-179	429	167-170	400	170-175	608
179-185	246	170-175	544	175-180	416
185-187	280	175-185	384		
187-195	300	185-190	304		
195-200	176				
				<u>I 20</u>	
				0- 10	72
				10- 15	80
<u>J430</u>		<u>J450</u>		15- 20	128
0- 10	60	0- 10	20	20- 25	96
		10- 14	130		

Depth (cm)	Ram hardness (kg)	Depth (cm)	Ram hardness	Depth (cm)	Ram hardness
25- 30	96	10- 15	64	<u>I 100</u>	
30- 35	112	15- 20	256	0- 10	48
35- 40	96	20- 25	240	10- 20	24
40- 45	48	25- 30	224	20- 27	46
45- 49	60	30- 33	267	27- 32	160
49- 55	240	33- 40	160	32- 35	267
55- 60	224	40- 45	80	35- 40	192
60- 63	346	45- 50	128	40- 45	80
63- 68	112	50- 55	64	45- 50	64
68- 76	70	55- 60	64	50- 55	80
76- 79	27	60- 65	64	55- 60	112
79- 89	32	65- 70	64	60- 65	128
89- 99	48	70- 75	80	65- 70	128
99-105	133	75- 80	96	70- 75	80
		80- 85	224	75- 80	80
105-110	240	85- 90	160	80- 85	144
110-115	80	90- 95	64	85- 90	192
115-120	144	95-100	160	90- 95	208
120-125	352			95-102	46
125-130	144	100-105	208		
130-135	128	105-110	64	102-105	53
135-140	80	110-121	51	105-110	128
140-146	40	121-125	160	110-115	160
146-150	80	125-130	160	115-120	80
150-155	208	130-135	240	120-125	64
155-160	144	135-140	160	125-130	48
160-165	192	140-145	80	130-135	48
165-170	144	145-150	48	135-140	48
170-175	144	150-155	96	140-145	48
175-180	192	155-160	176	145-150	48
180-185	256	106-165	176	150-155	96
185-190	192	165-171	53	155-160	48
		171-175	20	160-165	208
		175-180	32	165-168	133
		180-185	80	168-171	27
<u>I 60</u>		185-190	96	171-175	40
0- 10	64				

Depth (cm)	Ram hardness (kg)	Depth (cm)	Ram hardness	Depth (cm)	Ram hardness
175-180	80	160-165	80	130-135	144
180-185	96	165-170	64	135-140	208
185-190	80	170-175	176	140-145	112
		175-180	208	145-150	176
		180-185	192	150-155	176
<u>I 140</u>		185-190	96	155-160	112
0- 10	72			160-165	176
10- 15	96			165-170	224
15- 20	64	<u>I 160</u>		170-175	320
20- 25	48	0- 10	96	175-180	272
25- 30	64	10- 15	48	180-185	256
30- 35	192	15- 20	80	185-190	304
35- 40	240	20- 25	128		
40- 45	304	25- 30	144		
45- 50	224	30- 35	128	<u>I 220</u>	
50- 55	160	35- 40	112	0- 11	22
55- 60	128	40- 45	144	11- 17	27
60- 65	96	45- 50	128	17- 24	46
65- 70	128	50- 55	144	24- 30	40
70- 75	240	55- 60	128	30- 35	32
75- 80	256	60- 65	112	35- 39	40
80- 85	160	65- 70	128	39- 42	34
85- 90	80	70- 74	80	42- 45	27
90-101	107	74- 77	53	45- 49	20
		77- 82	48	49- 54	32
101-107	27	82- 86	60	54- 60	80
107-111	40	86- 89	187	60- 66	67
111-117	40	89- 95	480	66- 70	60
117-125	70	95-100	560	70- 75	64
125-130	128			75- 80	64
130-135	128	100-105	560	80- 85	192
135-140	80	105-110	384	85- 90	160
140-145	192	110-115	304	90- 95	80
145-150	256	115-120	240	95-100	144
150-155	160	120-126	120		
155-160	160	126-130	100	100-105	160

Depth (cm)	Ram hardness (kg)	Depth (cm)	Ram hardness	Depth (cm)	Ram hardness
<u>I 220</u>		180-185	64	170-176	48
0- 11	22	185-191	53	176-180	40
11- 17	27			180-185	32
17- 24	46			185-190	80
24- 30	40	<u>I 260</u>		190-195	128
30- 35	32	0- 15	11	195-201	40
35- 39	40	15- 20	48	201-208	34
39- 42	34	20- 30	24	208-213	48
42- 45	27	30- 35	80	213-220	69
45- 49	20	35- 42	34	220-225	48
49- 54	32	42- 46	40	225-230	64
54- 60	80	46- 50	60	230-236	67
60- 66	67	50- 56	40	236-239	27
66- 70	60	56- 64	20	239-245	40
70- 75	64	64- 66	40		
75- 80	64	66- 70	100		
80- 85	192	70- 76	53	<u>I 300</u>	
85- 90	160	76- 80	40	0- 10	8
90- 95	80	80- 85	48	10- 15	96
95-100	144	85- 90	32	15- 18	80
		90- 95	32	18- 24	27
100-105	160	95-101	40	24- 29	16
105-110	160			29- 35	40
115-120	96	101-107	27	35- 42	11
120-125	128	107-110	27	42- 57	16
125-130	96	110-114	20	57- 61	40
130-135	80	114-119	16	61- 71	24
135-140	64	119-125	27	71- 82	15
140-145	128	125-130	48	82- 89	23
145-150	48	130-134	60	89- 95	27
150-154	60	134-141	23	95-100	32
154-160	80	141-147	27		
160-164	60	147-150	27	100-107	34
164-170	80	150-160	16	107-111	40
170-176	53	160-165	48	111-118	46
176-180	40	165-170	48	118-126	50

Depth (cm)	Ram hardness (kg)	Depth (cm)	Ram hardness	Depth (cm)	Ram hardness
126-132	27	50- 55	160	235-240	96
132-140	20	55- 60	128		
140-144	40	60- 65	48		
144-147	27	65- 70	32	I 365	
147-150	107	70- 75	48	0- 10	8
150-155	64	75- 80	64	10- 15	20
155-160	64	80- 86	53	15- 21	23
160-165	96	86- 90	80	21- 25	13
165-170	112	90- 95	144	25- 30	8
170-175	112	95-101	40	30- 35	16
175-180	112			35- 39	15
180-185	64	101-105	40	39- 45	33
185-190	32	105-110	48	45- 50	16
190-196	53	110-116	40	50- 55	24
196-200	80	116-120	20	55- 60	56
		120-125	16	60- 65	56
200-205	48	125-132	23	65- 67	100
205-211	53	132-136	20	67- 70	40
211-218	23	136-141	48	70- 76	20
218-225	23	141-147	40	76- 80	20
225-230	80	147-155	40	80- 85	16
230-235	32	155-160	48	85- 90	16
235-240	48	160-166	53	90- 95	28
		166-170	20	95-100	20
		170-177	23		
		177-182	32	100-105	16
I 328		182-185	213	105-110	20
0- 10	24	185-190	64	110-115	20
10- 15	80	190-200	18	115-120	12
15- 20	128			120-125	16
20- 23	80	200-206	53	125-130	20
23- 25	80	206-210	40	130-135	20
25- 32	34	210-219	36	135-140	28
32- 35	27	219-223	60	140-145	28
35- 40	32	223-230	91	145-150	36
40- 45	48	230-235	112	150-155	20
45- 50	80				

Depth (cm)	Ram hardness (kg)	Depth (cm)	Ram hardness	Depth (cm)	Ram hardness
155-160	20	105-111	27	74- 79	32
160-166	27	111-114	27	79- 84	24
166-170	20	114-122	10	84- 88	20
170-175	20	122-128	13	88- 95	43
175-178	20	128-132	20	95-100	28
178-180	70	132-137	32		
180-185	68	137-142	32	100-105	24
185-190	40	142-150	20	105-110	24
190-195	28	150-156	40	110-115	32
195-200	36	156-172	13	115-120	32
		172-178	27	120-126	17
200-203	60	178-186	30	126-130	20
203-205	100	186-191	16	130-137	34
205-206	80	191-199	220	137-145	30
206-210	60	199-201	480	145-150	36
210-223	40			150-154	45
		201-203	1000	154-160	13
		203-204	2080	160-165	28
<u>I 380</u>				165-170	40
0- 10	32			170-175	52
10- 20	16	<u>I 400</u>		175-180	32
20- 26	27	0- 10	54	180-184	10
26- 41	5	10- 13	213	184-188	10
41- 45	20	13- 15	100	188-195	43
45- 51	13	15- 19	30	195-200	52
51- 55	40	19- 24	12		
55- 60	32	24- 31	11	200-205	60
60- 66	27	31- 35	20	205-210	48
66- 70	20	35- 41	17	210-215	64
70- 76	27	41- 46	8	215-219	40
76- 81	32	46- 51	8	219-223	10
81- 85	20	51- 55	60	223-226	80
85- 92	11	55- 60	36	226-230	30
92- 99	11	60- 65	28		
99-105	13	65- 71	13		
		71- 74	20		

Depth (cm)	Ram hardness (kg)	Depth (cm)	Ram hardness	Depth (cm)	Ram hardness
<u>I 420</u>		195-200	112	121-126	12
0- 10	56	200-207	46	126-130	15
10- 15	64	207-210	27	130-133	27
15- 20	80	210-216	40	133-135	60
20- 24	80	216-220	40	135-141	20
24- 35	15	220-225	80	141-145	20
35- 43	10	225-231	40	145-150	28
43- 46	27	231-236	80	150-156	23
46- 56	16	236-240	60	156-161	16
56- 61	16			161-166	16
61- 70	9			166-170	20
70- 76	13	<u>I 440 (1)</u>		170-176	13
76- 79	53	0- 11	9	176-180	20
79- 86	114	11- 13	20	180-185	36
86- 90	40	13- 15	50	185-189	30
90- 97	11	15- 19	25	189-190	60
97-107	8	19- 26	11	190-195	28
		26- 30	15	195-200	24
107-111	20	30- 36	13		
111-115	40	36- 40	20	200-203	47
115-123	20	40- 45	20	203-205	70
123-127	20	45- 51	10	205-208	80
127-130	27	51- 56	8	208-210	60
130-136	40	56- 60	5		
136-142	27	60- 64	10		
142-148	13	64- 71	37	<u>I 440 (2)</u>	
148-152	20	71- 77	10	0- 10	20
152-155	53	77- 84	6	10- 15	32
155-162	34	84- 89	12	15- 20	32
162-165	27	89- 93	15	20- 23	60
165-170	80	93-100	20	23- 29	20
170-173	80			29- 35	13
173-178	48	100-105	16	35- 40	12
178-185	57	105-110	60	40- 45	36
185-190	64	110-116	10	45- 50	40
190-195	80	116-121	16	50- 55	44

Depth (cm)	Ram hardness (kg)	Depth (cm)	Ram hardness	Depth (cm)	Ram hardness
55- 60	24	<u>I 460</u>		181-185	30
60- 66	17	0- 10	40	185-190	40
67- 70	25	10- 15	48	190-196	27
70- 75	24	15- 21	20	196-202	20
75- 80	32	21- 26	24		
83- 85	32	26- 33	17	202-205	93
85- 90	16	33- 45	10	205-210	208
90- 98	10	45- 50	16	210-214	60
98-105	20	50- 56	27	214-220	27
		56- 60	30	220-225	48
105-110	24	60- 65	16	225-230	96
110-114	20	65- 68	13	230-237	46
114-120	27	68- 76	10	237-242	32
120-125	24	76- 79	13		
125-130	36	79- 82	13		
130-135	32	82- 86	20	<u>I 485</u>	
135-140	10	86- 90	50	0- 11	40
140-146	10	90- 95	32	11- 19	10
146-150	25	95-100	64	19- 26	17
150-155	48			26- 37	7
155-157	20	100-104	40	37- 40	27
157-160	100	104-110	20	40- 45	16
160-165	184	110-116	20	45- 49	20
165-169	110	116-120	20	49- 52	27
169-175	33	120-125	24	52- 55	13
175-180	44	125-130	24	55- 61	13
180-185	64	130-136	20	61- 68	11
185-190	64	136-140	30	68- 71	13
190-195	56	140-145	40	71- 75	10
195-200	64	145-150	32	75- 80	16
		150-156	27	80- 85	8
200-205	60	156-160	20	85- 90	16
205-210	64	160-165	16	90- 94	20
210-211	200	165-170	40	94- 99	24
211-215	70	170-175	56	99-105	47
215-220	40	175-181	27		

Depth (cm)	Ram hardness (kg)	Depth (cm)	Ram hardness	Depth (cm)	Ram hardness
105-111	13	64- 67	13	<u>I 570</u>	
111-116	16	67- 71	20	0- 10	124
116-122	13	71- 75	30	10- 15	104
122-129	11	75- 81	13	15- 20	72
129-134	16	81- 89	5	20- 25	64
134-139	24	89- 95	20	25- 31	20
139-145	40	95-100	24	31- 41	8
145-150	40			41- 45	5
150-155	40	100-103	53	45- 53	3
155-160	40	103-111	10	53- 60	17
160-165	32	111-118	11	60- 65	32
165-171	27	118-121	13	65- 70	64
171-175	40	121-124	13	70- 75	48
175-180	24	124-130	7	75- 80	36
180-185	24	130-134	10	80- 85	12
185-190	24	134-140	13	85- 90	16
190-195	32	140-146	13	90- 96	10
195-200	32	146-150	10	96-101	16
		150-155	24		
200-205	32	155-160	32	101-105	40
205-210	56	160-165	27	105-110	112
		165-172	13	110-116	60
		172-177	16	116-120	90
<u>I 515</u>		177-181	20	120-126	33
0- 10	8	181-185	20	126-130	70
10- 16	13	185-189	30	130-136	23
16- 20	20	189-195	56	136-141	36
20- 29	9	195-200	56	141-146	20
29- 34	8			146-151	16
34- 40	7	200-206	33	151-155	5
40- 45	48	206-210	70	155-160	12
45- 46	40	210-216	40	160-165	28
46- 50	20	216-225	22	165-170	44
50- 55	16	225-230	32	170-175	40
55- 60	16	230-235	32	175-180	28
60- 64	10	235-240	24	180-185	24

Depth (cm)	Ram hardness (kg)	Depth (cm)	Ram hardness	Depth (cm)	Ram hardness
185-190	28			28- 30	320
190-195	28	100-105	20	30- 31	480
195-200	24	105-110	24	31- 34	267
		110-115	20	34- 36	160
200-205	28	115-120	20	36- 38	160
205-212	29	120-125	28	38- 40	200
212-215	20	125-131	17	40- 44	300
215-220	24	131-135	20	44- 46	200
220-225	36	135-140	24	46- 50	180
225-230	80	140-146	17	50- 54	100
230-233	107	146-150	25	54- 59	48
233-236	40	150-155	24	59- 62	133
236-240	30	155-160	44	62- 65	187
		160-165	40	65- 67	200
		165-171	27	67- 70	160
		171-175	20	70- 72	120
<u>I 600</u>		175-180	28	72- 79	137
0- 10	20	180-185	28	79- 80	400
10- 15	40	185-192	17	80- 85	144
15- 20	48	192-200	25	85- 88	187
20- 24	45			88- 90	320
24- 30	17			90- 91	800
30- 35	32			91- 93	240
35- 38	33	<u>Y' 20</u>		93- 95	400
38- 40	10	0- 10	56	95- 96	480
40- 46	10	10- 12	280	96-100	200
46- 50	15	12- 14	280		
50- 55	8	14- 15	320		
55- 63	3	15- 16	480	100-104	160
63- 66	7	16- 17	240	104-105	320
66- 69	7	17- 20	400	105-106	1120
69- 74	12	20- 22	480	106-108	600
74- 80	20	22- 23	640	108-110	920
80- 86	13	23- 24	560	110-111	960
86- 90	15	24- 25	400	111-112	880
90- 96	20	25- 27	480	112-113	800
96-100	20	27- 28	400	113-114	4080

Depth (cm)	Ram hardness (kg)	Depth (cm)	Ram hardness	Depth (cm)	Ram hardness
<u>Y' 40</u>		124-130	93	70- 74	60
0- 10	120	130-132	160	74- 78	400
10- 14	80	132-134	120	78- 80	640
14- 18	100	134-138	80	80- 81	1280
18- 21	80	138-140	120	81- 84	240
21- 26	48	140-142	200	84- 85	720
26- 28	80	142-146	120	85- 90	368
28- 32	200	146-150	120	90- 95	304
32- 35	427	150-151	160	95-100	240
35- 38	293	151-155	80		
38- 42	140	155-156	80	100-105	272
42- 46	220	156-157	80	105-110	256
46- 50	200	157-160	27	110-113	293
50- 54	120	160-164	600	113-116	427
54- 56	200			116-118	720
56- 60	200			118-119	1600
60- 63	187	<u>Y' 60</u>		119-120	1280
63- 65	200	0- 10	80	120-122	360
65- 69	280	10- 12	280	122-125	160
69- 72	160	12- 15	267	125-130	80
72- 78	40	15- 16	480	130-133	267
78- 80	80	16- 19	320	133-136	293
80- 85	128	19- 23	200	136-140	100
85- 87	200	23- 25	120	140-150	136
87- 90	133	25- 30	128	150-153	187
90- 94	120	30- 32	200	153-158	32
94- 98	120	32- 35	267	158-162	60
98-100	160	35- 37	200	162-168	67
		37- 40	373	168-172	100
100-103	133	40- 42	200	172-179	91
103-106	53	42- 45	133	179-183	60
106-110	40	45- 49	188	183-190	34
110-115	48	49- 56	80	190-192	40
115-117	40	56- 60	120	192-195	80
117-120	27	60- 66	40	195-197	80
120-124	180	66- 70	20	197-199	40

Depth (cm)	Ram hardness (kg)	Depth (cm)	Ram hardness	Depth (cm)	Ram hardness
<u>Y' 80</u>		138-142	340	80- 84	40
0- 10	104	142-146	100	84- 90	120
10- 12	160	146-154	80	90- 93	293
12- 15	107	154-160	93	93-100	526
15- 16	160	160-165	144		
16- 19	587	165-168	667	100-105	352
19- 20	1520	168-170	520	105-110	176
20- 21	5200	170-175	160	110-115	144
21- 40	very hardly	175-177	280	115-120	112
40- 45	64	177-180	240	120-125	128
45- 50	64	180-185	112	125-130	176
50- 55	224	185-190	112	130-135	208
55- 58	533	190-200	96	135-140	96
58- 60	760			140-145	144
60- 63	560			145-150	384
63- 65	160	<u>Y'100</u>		150-155	528
65- 71	133	0- 10	200	155-160	800
71- 75	200	10- 13	507	160-162	2280
75- 80	112	13- 15	706	162-164	4000
80- 85	96	15- 16	1920		
85- 91	120	16- 17	880		
91- 95	120	17- 20	400	<u>Y'120</u>	
95-101	93	20- 22	267	0- 11	51
		22- 25	91	11- 20	18
101-105	100	25- 30	64	20- 25	96
105-110	96	30- 34	80	25- 30	80
110-115	128	34- 37	160	30- 35	144
115-119	160	37- 40	240	35- 41	53
119-121	360	40- 44	180	41- 50	36
121-122	1440	44- 48	80	50- 54	40
122-123	2000	48- 56	50	54- 58	120
123-124	1200	56- 61	32	58- 64	40
124-126	360	61- 66	48	64- 70	160
126-130	400	66- 69	53	70- 75	240
130-135	640	69- 75	120	75- 81	147
135-138	533	75- 80	80	81- 85	160

Depth (cm)	Ram hardness (kg)	Depth (cm)	Ram hardness	Depth (cm)	Ram hardness
85- 89	160	55- 59	60	20- 26	40
89- 91	40	59- 63	200	26- 30	40
91- 98	11	63- 70	91	30- 35	112
98-100	80	70- 77	34	35- 40	32
		77- 80	27	40- 45	48
100-105	112	80- 85	208	45- 50	80
105-111	67	85- 88	53	50- 55	96
111-116	48	88- 93	32	55- 61	80
116-121	32	93-100	80	61- 66	48
121-125	80			66- 69	27
125-130	64	100-105	144	69- 72	27
130-136	27	105-109	100	72- 79	34
136-141	64	109-112	587	79- 85	40
141-145	300	112-115	800	85- 90	48
145-151	107	115-120	640	90- 95	96
151-156	96	120-125	640	95-101	93
156-160	120	125-131	1200		
160-164	40	131-133	40	101-107	67
164-170	107	133-138	16	107-110	320
170-175	128	138-150	20	110-115	608
175-180	192	150-155	16	115-120	192
180-185	176	155-161	27	120-125	32
185-190	144	161-165	60	125-130	16
190-195	112	165-170	48	130-135	32
		170-173	80	135-140	48
		173-177	200	140-145	64
		177-180	160	145-150	80
<u>Y'140</u>		180-183	80	150-155	64
0- 10	56	183-186	53	155-163	30
10- 16	80	186-191	32	163-168	16
16- 22	53			168-175	69
22- 30	50			175-180	80
30- 35	112			180-185	80
35- 38	107	<u>Y'160</u>		185-190	64
38- 45	69	0- 10	88		
45- 50	64	10- 15	128		
50- 55	48	15- 20	112		

Depth (cm)	Ram hardness (kg)	Depth (cm)	Ram hardness	Depth (cm)	Ram hardness
<u>Y'190</u>		70- 75	288	140-145	112
0- 10	112	75- 80	368	145-150	80
10- 15	112	80- 85	112	150-155	80
15- 20	48	85- 90	112	155-160	32
20- 25	130	90- 96	67	160-165	64
25- 30	48	96-100	20	165-170	96
30- 35	64			170-175	112
35- 40	112	100-108	10	175-180	160
40- 45	144	108-112	20	180-185	320
45- 50	96	112-120	140	185-190	320
50- 55	64	120-125	176		
55- 60	240	125-130	208		
60- 65	400	130-135	208		
65- 70	272	135-140	96		

Table 4. Catalogue of 10-m core studies in 1971 - 1975.

Coring Site	Elevation (m)	Date	St.	P	$\delta^{18}\text{O}$	Gr. β
(1971 - 1973)						
H 128	1378*	26 Jan. 1973	+	-	+	+
H 228	1657*	25 Jan. 1973	+	-	-	-
S 97	1654	19 Jan. 1971	+	-	+	+
S 122	1910	24 Jan. 1973	+	-	-	-
(1974 - 1975)						
S 40	1142	9 Feb. 1975	-	-	-	-
H 230	1659	7 Oct. 1974	-	-	-	-
Z 30	2056	6 Feb. 1975	+	-	-	-
Mizuho Camp	2230	5 Dec. 1974	-	-	-	-
Y'100	2596	17 Oct. 1974	-	-	-	-
Y'210	2880	25 Oct. 1974	+	+	-	-
I 115	3049*	29 Oct. 1974	-	-	-	-
I 235	3200*	1 Nov. 1974	+	+	-	-
I 355	3304*	5 Nov. 1974	+	+	-	-
I 485	3382*	8 Nov. 1974	+	+	-	-
J 95	3253	18 Nov. 1974	-	-	-	-
J 225	3039	22 Nov. 1974	+	+	-	-
J 364	2682	26 Nov. 1974	-	-	-	-
W 280	2405	4 Jan. 1975	-	-	-	-
W 46	1958	30 Dec. 1974	+	+	-	-

* Elevation estimated from neighboring stations
+ did, - did not or do not yet

St. : Stratigraphic observation

P : Texture analysis by thin section photograph

$\delta^{18}\text{O}$: Oxygen isotope ratio analysis

Gr. β : Fission products analysis (Gross β activity)

Table 5. Snow density of 10-m cores.

H 128

Density Data

	Depth	Density (g/cm ³)		Depth	Density (g/cm ³)
1	3	0.61	60	599	0.51
2	24	0.43	61	602	0.50
3	35	0.42	62	616	0.53
4	42	0.28	63	622	0.52
5	66	0.39	64	631	0.49
6	92	0.42	65	634	0.49
7	103	0.42	66	640	0.61
8	113	0.39	67	644	0.52
9	125	0.36	68	648	0.54
10	136	0.43	69	658	0.52
11	148	0.45	70	663	0.53
12	163	0.45	71	672	0.52
13	172	0.43	72	681	0.51
14	187	0.47	73	691	0.49
15	201	0.40	74	703	0.52
16	207	0.46	75	716	0.54
17	226	0.44	76	720	0.53
18	233	0.46	77	726	0.54
19	239	0.45	78	732	0.53
20	248	0.47	79	735	0.53
21	257	0.46	80	743	0.52
22	260	0.50	81	748	0.51
23	268	0.45	82	752	0.54
24	275	0.46	83	756	0.53
25	285	0.48	84	766	0.53
26	288	0.46	85	689	0.52
27	296	0.41	86	774	0.54
28	303	0.51	87	786	0.51
29	316	0.53	88	796	0.54
30	328	0.46	89	802	0.53
31	339	0.49	90	817	0.51
32	345	0.50	91	824	0.54
33	350	0.45	92	833	0.54
34	366	0.51	93	846	0.50
35	375	0.52	94	849	0.53
36	387	0.50	95	861	0.55
37	403	0.51	96	864	0.55
38	409	0.41	97	874	0.55
39	418	0.53	98	884	0.54
40	433	0.50	99	888	0.54
41	439	0.53	100	894	0.54
42	448	0.49	101	897	
43	456	0.52	102	901	0.54
44	467	0.49	103	907	0.57
45	478	0.52	104	912	0.56
46	483	0.54	105	918	0.59
47	495	0.49	106	922	0.56
48	503	0.52	107	930	0.57
49	514	0.55	108	936	0.54
50	523	0.50	109	945	0.56
51	527	0.53	110	954	0.57
52	530	0.52	111	964	0.60
53	537	0.47	112	974	0.58
54	545	0.51	113	984	0.57
55	550	0.50	114	990	0.58
56	565	0.50	115	996	0.55
57	574	0.53			
58	588	0.53			
59	595	0.49			

Density Data

	Depth	Density (g/cm ³)		Depth	Density (g/cm ³)
1	14	0.414	47	556	0.543
2	35	0.359	48	563	0.533
3	42	0.359	49	571	0.549
4	56	0.497	50	583	0.525
5	76	0.452	51	591	0.554
6	89	0.377	52	597	0.531
7	94	0.569	53	611	0.544
8	102	0.481	54	624	0.564
9	109	0.438	55	629	0.535
10	133	0.477	56	641	0.523
11	137	0.388	57	657	0.516
12	156	0.505	58	669	0.554
13	168	0.469	59	684	0.543
14	182	0.475	60	704	0.522
15	192	0.422	61	709	0.551
16	206	0.509	62	718	0.536
17	212	0.467	63	723	0.534
18	222	0.498	64	730	0.522
19	237	0.515	65	744	0.548
20	250	0.482	66	754	0.587
21	260	0.463	67	758	0.566
22	266	0.465	68	782	0.560
23	276	0.482	69	798	0.535
24	288	0.512	70	804	0.563
25	302	0.463	71	818	0.547
26	313	0.526	72	826	0.564
27	322	0.460	73	841	0.531
28	331	0.510	74	853	0.548
29	338	0.485	75	865	0.562
30	342	0.461	76	869	0.589
31	363	0.527	77	886	0.584
32	376	0.515	78	893	0.583
33	384	0.524	79	897	0.546
34	393	0.495	80	903	0.553
35	410	0.487	81	911	0.597
36	416	0.505	82	918	0.564
37	421	0.484	83	928	0.571
38	437	0.484	84	943	0.563
39	447	0.504	85	951	0.589
40	462	0.483	86	960	0.565
41	478	0.511	87	965	0.545
42	493	0.511	88	976	0.575
43	504	0.528	89	983	0.581
44	523	0.558	90	994	0.576
45	531	0.517	91	1000	0.576
46	547	0.534			

Density Data

	Depth	Density (g/cm ³)		Depth	Density (g/cm ³)
1	1	0.43	47	288	0.50
2	11	0.44	48	304	0.49
3	22	0.45	49	311	0.52
4	30	0.51	50	318	0.50
5	36	0.35	51	322	0.47
6	40	0.50	52	325	0.52
7	44	0.49	53	334	0.46
8	49	0.39	54	337	0.53
9	54	0.44	55	344	0.52
10	61	0.51	56	349	0.56
11	66	0.40	57	355	0.53
12	69	0.50	58	360	0.45
13	75	0.47	59	366	0.47
14	81	0.45	60	371	0.53
15	85	0.35	61	377	0.54
16	91	0.48	62	381	0.54
17	96	0.47	63	388	0.51
18	103	0.50	64	395	0.53
19	109	0.47	65	404	0.53
20	119	0.49	66	409	0.53
21	127	0.49	67	416	0.53
22	132	0.47	68	422	0.52
23	137	0.46	69	425	0.52
24	142	0.50	70	429	0.48
25	148	0.42	71	433	0.49
26	158	0.49	72	439	0.54
27	165	0.45	73	444	0.53
28	172	0.44	74	448	0.46
29	182	0.46	75	452	0.50
30	189	0.49	76	459	0.52
31	192	0.51	77	465	0.57
32	198	0.49			
33	209	0.45			
34	216	0.50			
35	220	0.48			
36	227	0.43			
37	230	0.51			
38	237	0.45			
39	241	0.55			
40	248	0.52			
41	257	0.50			
42	262	0.47			
43	268	0.50			
44	275	0.52			
45	281	0.53			
46	283	0.55			

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Density Data

	Depth	Density (g/cm ³)		Depth	Density (g/cm ³)
1	3	0.442	47	353	0.462
2	17	0.427	48	357	0.434
3	21	0.458	49	364	0.459
4	25	0.392	50	378	0.464
5	37	0.439	51	383	0.409
6	42	0.383	52	388	0.508
7	48	0.401	53	400	0.498
8	60	0.437	54	414	0.490
9	67	0.349	55	418	0.526
10	71	0.451	56	423	0.463
11	74	0.395	57	433	0.485
12	82	0.427	58	441	0.575
13	89	0.424	59	444	0.457
14	98	0.447	60	451	0.508
15	109	0.455	61	454	0.455
16	114	0.538	62	465	0.480
17	128	0.490	63	471	0.479
18	139	0.427	64	476	0.469
19	147	0.441	65	481	0.470
20	152	0.426	66	498	0.481
21	162	0.409	67	504	0.521
22	171	0.393	68	519	0.403
23	175	0.419	69	526	0.467
24	179	0.452	70	530	0.461
25	186	0.425	71	535	0.528
26	190	0.421	72	544	0.505
27	194	0.502	73	548	0.560
28	197	0.435	74	556	0.532
29	202	0.500	75	559	0.452
30	214	0.488	76	566	0.526
31	223	0.478	77	569	0.469
32	230	0.384	78	578	0.533
33	236	0.503	79	582	0.457
34	242	0.392	80	587	0.509
35	255	0.412	81	590	0.534
36	270	0.386	82	594	0.502
37	276	0.507	83	598	0.550
38	284	0.408	84	605	0.563
39	288	0.480	85	616	0.493
40	300	0.439	86	620	0.520
41	313	0.376	87	625	0.494
42	320	0.368	88	633	0.544
43	326	0.472	89	642	0.515
44	330	0.435	90	648	0.382
45	335	0.419	91	654	0.484
46	343	0.469	92	663	0.557

	Depth	Density (g/cm ³)		Depth	Density (g/cm ³)
93	668	0.540	111	808	0.510
94	678	0.494	112	814	0.536
95-1	686	0.489	113	831	0.548
95-2	692	0.478	114	835	0.551
96-1	702	0.511	115	844	0.574
96-2	706	0.564	116	847	0.535
97	711	0.512	117	852	0.562
98	719	0.534	118	857	0.545
99	725	0.535	119	862	0.563
100	734	0.544	120	866	0.543
101	745	0.555	121	870	0.588
102	751	0.556	122	878	0.570
103	757	0.560	123	881	0.564
104	765	0.568	124	885	0.562
105	774	0.559	125	894	0.573
106	780	0.549	126	900	0.574
107	783	0.511	127	905	0.602
108	786	0.546	128	914	0.581
109	794	0.502	129	920	0.581
110	798	0.540			

Density Data

	Depth	Density (g/cm ³)		Depth	Density (g/cm ³)
1	2	0.356	46	553	0.510
2	7	0.372	47	565	0.514
3	16	0.405	48	577	0.477
4	21	0.403	49	595	0.499
5	30	—	50	607	0.509
6	39	0.366	51-1	618	0.540
7	44	0.341	51-2	630	0.550
8	58	0.400	52	643	0.449
9	71	0.523	53	655	0.547
10	85	0.417	54	666	0.510
11	92	0.391	55	676	0.559
12	98	0.494	56	687	0.526
13	102	0.402	57	693	0.525
14	108	0.445	58	704	0.516
15	115	0.468	59	710	0.549
16	128	0.394	60	719	0.524
17	132	0.467	61	727	0.506
18	202	0.415	62	735	0.534
19	213	0.454	63	746	0.545
20	252	0.467	64	763	0.558
21	263	0.439	65	784	0.550
22	283	0.386	66	798	—
23	293	0.389	67	807	0.548
24	302	0.429	68	823	0.538
25	318	—	69	829	0.576
26-1	324	0.480	70	846	0.559
26-2	331	0.426	71	856	0.574
27	339	0.442	72	879	0.559
28	351	0.429	73	901	0.548
29	362	—	74	911	—
30	373	0.415	75	919	0.567
31	379	—	76	926	0.583
32	387	0.484	77	935	0.555
33	399	0.512			
34	415	0.524			
35	435	0.478			
36	460	0.469			
37	467	0.499			
38	475	0.487			
39	485	0.436			
40	495	0.485			
41	507	0.494			
42	515	0.462			
43	524	0.488			
44	535	0.508			
45	545	0.503			

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Density Data

	Depth	Density (g/cm ³)		Depth	Density (g/cm ³)
1	2	0.425	34-2	458	0.442
2	14	0.393	34-3	465	0.446
3	34	0.389	35	484	0.475
4	46	0.389	36-1	495	0.489
5	54	0.420	36-2	502	0.490
6	66	0.434	37-1	512	0.475
7	74	0.357	37-2	517	0.467
8	82	0.418	38	524	0.471
9	89	0.366	39	539	0.477
10	106	0.399	40	558	0.486
11	120	0.422	41	565	—
12-1	129	0.499	42	576	0.465
12-2	142	0.482	43	581	0.597
12-3	146	0.451	44	592	0.467
13	156	0.377	45	616	0.476
14-1	171	0.460	46-1	627	0.421
14-2	177	0.464	46-2	634	0.455
15	187	0.405	47	644	0.489
16-1	193	0.480	48	654	0.523
16-2	198	0.478	49	673	0.457
17	206	0.417	50	688	0.490
18	216	0.427	51	704	0.456
19	227	0.433	52-1	713	0.498
20	236	0.425	52-2	721	0.484
21-1	254	0.449	53	726	0.485
21-2	262	0.440	54	741	0.501
22	271	0.443	55	752	0.484
23	294	0.493	56	759	0.474
24-1	300	0.447	57	766	0.503
24-2	306	0.442	58	779	0.488
25-1	313	0.457	59	785	0.513
25-2	320	0.457	60-1	800	0.478
26-1	331	0.408	60-2	806	0.431
26-2	336	0.428	61	813	0.480
27-1	354	0.468	62	832	0.516
27-2	361	0.466	63	838	0.483
28	374	0.408	64	849	0.506
29	384	0.464	65-1	862	0.501
30-1	392	0.483	65-2	867	0.489
30-2	397	0.497	66-1	874	0.546
30-3	402	0.456	66-2	881	0.543
31	412	0.473	67	887	0.537
32	433	0.446	68	893	0.496
33	446	0.451	69	901	0.480
34-1	452	0.453	70-1	916	0.576
			70-2	922	0.560
			71	936	0.490
			72	944	0.516
			73	951	0.524
			74	966	0.495

Density Data

	Depth	Density (g/cm ³)		Depth	Density (g/cm ³)
1	45	0.385	45	728	0.473
2	55	0.394	46	750	0.449
3	70	0.409	47	768	0.436
4	89	0.445	48	773	—
5	123	0.457	49	784	0.476
6	149	0.432	50-1	789	0.485
7	162	0.414	50-2	797	0.497
8	219	0.390	51	805	0.496
9	229	0.403	52	827	0.469
10	244	0.483	53	832	0.490
11	249	0.454	54	840	0.497
12	255	0.447	55	850	0.493
13	274	0.440	56	856	0.496
14-1	293	0.491	57	870	0.466
14-2	301	0.476	58	878	0.473
14-3	308	0.473	59	884	0.475
15	321	0.516	60	894	0.448
16	329	0.409	61	898	0.493
17	335	0.422			
18	345	0.446			
19	352	0.434			
20	356	0.470			
21	370	0.473			
22	387	0.444			
23	394	0.413			
24	409	0.473			
25	415	0.433			
26	487	0.458			
27	492	0.448			
28	498	0.422			
29	505	0.461			
30	512	—			
31	520	0.468			
32	527	0.442			
33	541	0.459			
34	549	0.438			
35	556	0.416			
36	562	0.494			
37	595	0.459			
38	601	0.465			
39	608	0.417			
40	617	0.483			
41	687	0.483			
42	694	0.484			
43	702	0.502			
44	720	0.483			

Density Data

	Depth	Density (g/cm ³)		Depth	Density (g/cm ³)
1	14	0.362	44	560	0.454
2	27	0.361	45	579	0.440
3	56	0.357	46	587	0.435
4	62	0.395	47	595	0.481
5	92	0.421	48	608	0.440
6	165	0.394	49	620	0.415
7	172	0.425	50	630	0.421
8	183	0.357	51	636	0.427
9	189	0.359	52	641	0.422
10	233	0.390	53-1	662	0.465
11	239	0.476	53-2	668	0.476
12	245	0.377	54-1	676	0.478
13	252	0.406	54-2	678	0.436
14	259	0.363	55	682	0.461
15	271	0.436	56	689	0.438
16	277	0.440	57	696	0.451
17	281	0.426	58	701	0.457
18	290	0.374	59	706	0.459
19	301	0.362	60	713	0.482
20	311	0.402	61	719	0.461
21	318	0.362	62	732	0.483
22	325	0.332	63	737	0.458
23-1	340	0.457	64	742	0.467
23-2	347	0.454	65	749	0.432
24	254	0.453	66	762	0.477
25	360	0.465	67	777	0.462
26	375	0.429	68	784	0.461
27	382	0.421	69	801	0.480
28	389	0.420	70	812	0.472
29	407	0.424	71	817	0.475
30	413	0.451	72	830	0.496
31	424	0.429	73	837	0.444
32	432	0.387	74	842	0.490
33	439	0.413	75	850	0.453
34-1	445	0.460	76	857	0.458
34-2	451	0.419	77	864	0.479
35	459	0.447			
36	470	0.448			
37-1	482	0.441			
37-2	488	0.424			
38	499	0.403			
39	508	0.418			
40	515	0.436			
41	526	0.449			
42	551	0.464			
43	556	0.417			

Density Data

	Depth	Density (g/cm ³)		Depth	Density (g/cm ³)
1	20	0.408	46-3	507	0.434
2	28	0.394	47	512	0.471
3-1	42	0.425	48	518	0.442
3-2	46	0.419	49	524	0.469
4	56	0.397	50	535	0.505
5	67	0.402	51	540	0.434
6	74	0.472	52	547	0.472
7	80	0.353	53	554	0.477
8	102	0.351	54	562	0.450
9	113	0.486	55	568	0.501
10-1	120	0.423	56	596	0.488
10-2	127	0.416	57	604	0.479
11	135	0.439	58	608	0.455
12	146	0.473	59	612	0.474
13	165	0.446	60	617	0.467
14	178	0.466	61	627	0.497
15	184	0.425	62	636	0.489
16-1	202	0.492	63	652	0.459
16-2	208	0.427	64	664	0.494
17	215	0.442	65	676	0.464
18	227	0.470	66	680	0.430
19	232	0.456	67	687	0.479
20	238	0.429	68	696	0.506
21	258	0.431	69	703	0.490
22	265	0.443	70	712	0.468
23	272	0.464	71	726	0.455
24	275	0.412	72	735	0.479
25	280	0.427	73	740	0.499
26	286	0.442	74-1	749	0.498
27	299	0.459	74-2	754	0.502
28	304	0.430	75	765	0.504
29	316	0.420	76	777	0.548
30	326	0.444	77	797	0.506
31-1	333	—	78	805	0.487
31-2	339	0.430	79	816	0.494
32	346	0.403	80	825	0.511
33	351	0.451	81	834	0.469
34	357	0.441	82	839	0.495
35	370	0.474	83	858	0.509
36	380	0.475	84	863	0.502
37	386	0.460	85	874	0.520
38	397	0.488	86	893	0.514
39	408	0.499	87	899	0.510
40	418	0.461	88-1	914	0.485
41-1	440	0.445	88-2	923	0.510
41-2	445	0.457	89	932	0.507
42-1	452	0.466	90	938	0.511
42-2	458	0.473	91	944	0.512
43	465	0.477	92	953	0.533
44	474	0.476	93	960	0.521
45	478	0.478	94	964	0.478
46-1	494	0.460	95	976	0.525
46-2	499	0.474	96	981	0.510

Density Data

	Depth	Density (g/cm ³)		Depth	Density (g/cm ³)
1	3	0.351	42	510	0.501
2	16	0.448	43-1	524	0.503
3	33	—	43-2	530	0.504
4	44	0.455	44-1	535	0.500
5	53	0.472	44-2	542	0.511
6	60	—	45-1	548	—
7	63	0.499	45-2	555	0.516
8	76	0.403	46	584	0.475
9	84	0.413	47	587	—
10	101	0.382	48-1	598	0.490
11	110	0.395	48-2	604	0.509
12	117	0.426	49	613	0.517
13	128	0.456	50	623	0.510
14	141	0.480	51	628	0.520
15-1	160	0.461	52	647	0.522
15-2	165	0.464	53	661	—
16	174	0.455	54-1	673	0.509
17	192	0.430	54-2	678	0.510
18	200	0.429	55	685	0.494
19-1	207	0.521	56-1	697	0.527
19-2	215	0.515	56-2	703	0.528
20-1	236	0.506	57	713	0.535
20-2	239	0.510	58	725	0.506
21	252	0.504	59	747	0.521
22	261	0.485	60	757	0.534
23-1	270	0.492	61	770	0.546
23-2	277	0.493	62	778	0.537
24	292	0.434	63	786	0.537
25	306	0.460	64	794	0.539
26	314	0.462	65	805	0.527
27-1	323	0.486	66	823	0.506
27-2	331	0.491	67	829	0.526
27-3	336	0.490	68	836	0.529
28	355	0.480	69	847	0.540
29	364	0.489	70	852	0.550
30	380	0.479	71	863	0.545
31	385	0.479	72	873	0.539
32	390	0.454	73	880	0.542
33	397	0.465	74	900	0.512
34	404	0.473	75	907	0.533
35-1	420	0.480	76	913	0.532
35-2	424	0.489	77-1	918	0.536
36-1	435	0.481	77-2	933	0.546
36-2	441	0.499	78	943	0.541
37-1	458	0.512	79	954	0.538
37-2	464	0.506	80	963	0.523
38	476	0.508	81	969	0.536
39	484	0.502	82	980	0.552
40	489	0.510	83	986	0.541
41	497	0.479	84	994	0.544

Table 6. Oxygen isotope content of 10-m cores.

H 128

 $\delta^{18}\text{O}$ Data

	Depth	$\delta^{18}\text{O}$ (‰)		Depth	$\delta^{18}\text{O}$ (‰)
1	2	-24.3	47	311	-28.7
2	7	-26.8	48	322	-25.9
3	13	-25.8	49	329	-25.4
4	17	-27.6	50	334	-25.8
5	20	-27.8	51	344	-26.3
6	29	-28.3	52	352	-27.3
7	34	-28.8	53	359	-28.2
8	38	-27.8	54	366	-29.2
9	48	-26.7	55	370	-27.2
10	51	-26.8	56	375	-30.5
11	73	-30.4	57	392	-28.8
12	79	-30.9	58	398	-27.3
13	84	-30.5	59	403	-27.8
14	97	-29.7	60	409	-28.2
15	106	-24.6	61	415	-26.7
16	108	-23.8	62	427	-26.9
17	110	-24.4	63	433	-27.5
18	115	-26.2	64	439	-25.9
19	117	-26.2	65	442	-25.4
20	121	-27.2	66	447	-24.8
21	125	-27.4	67	455	-28.0
22	128	-26.8	68	461	-28.5
23	133	-26.7	69	473	-28.2
24	142	-28.0	70	488	-27.2
25	158	-28.5	71	498	-27.0
26	167	-26.3			
27	171	-27.8			
28	178	-26.4			
29	182	-27.0			
30	191	-27.8			
31	204	-27.7			
32	208	-27.4			
33	212	-25.4			
34	218	-25.7			
35	225	-26.4			
36	233	-25.1			
37	240	-25.5			
38	244	-26.0			
39	253	-25.8			
40	264	-27.3			
41	268	-27.4			
42	273	-27.6			
43	280	-27.0			
44	288	-24.8			
45	297	-25.5			
46	308	-28.3			

$\delta^{18}\text{O}$ Data

	Depth	$\delta^{18}\text{O}$ (‰)		Depth	$\delta^{18}\text{O}$ (‰)
1	1	-22.2	47	168	-30.3
2	5	-26.0	48	172	-29.9
3	10	-25.6	49	177	-29.6
4	16	-27.3	50	181	-28.4
5	18	-28.6	51	185	-26.9
6	23	-29.4	52	189	-25.2
7	26	-29.4	53	195	-28.2
8	31	-29.4	54	199	-27.7
9	33	-29.2	55	202	-31.1
10	36	-30.4	56	206	-32.2
11	40	-29.6	57	209	-32.2
12	42	-30.0	58	213	-31.8
13	46	-30.0	59	216	-31.7
14	49	-31.2	60	220	-32.4
15	51	-31.2	61	223	-31.3
16	54	-30.9	62	227	-32.1
17	57	-30.7	63	230	-32.4
18	60	-29.7	64	234	-32.1
19	63	-30.0	65	237	-32.4
20	66	-29.9	66	241	-32.6
21	69	-29.0	67	244	-29.8
22	71	-28.0	68	248	-30.1
23	76	-27.8	69	253	-30.3
24	80	-27.2	70	257	-31.1
25	85	-26.5	71	261	-30.1
26	88	-26.1	72	265	-29.5
27	91	-24.1	73	269	-29.3
28	96	-23.3	74	272	-27.0
29	103	-26.4	75	275	-27.6
30	106	-26.7	76	278	-25.5
31	109	-26.7	77	282	-26.8
32	114	-28.4	78	285	-26.9
33	116	-27.2	79	288	-27.3
34	120	-30.4	80	291	-30.2
35	125	-30.1	81	303	-26.2
36	129	-29.4	82	308	-29.4
37	134	-28.8	83	312	-29.9
38	139	-27.5	84	318	-29.6
39	142	-26.4	85	322	-29.2
40	145	-30.3	86	325	-28.6
41	148	-31.9	87	328	-30.7
42	151	-32.0	88	331	-31.6
43	154	-29.5	89	335	-30.6
44	158	-31.8	90	341	-30.6
45	161	-31.5	91	346	-30.6
46	164	-31.0	92	349	-30.9

	Depth	$\delta^{18}\text{O}$ (‰)		Depth	$\delta^{18}\text{O}$ (‰)
93	355	-30.4	108	415	-28.3
94	359	-30.0	109	419	-28.3
95	363	-29.2	110	422	-28.8
96	367	-29.4	111	425	-29.3
97	374	-31.5	112	429	-29.3
98	379	-28.7	113	432	-28.4
99	385	-28.2	114	436	-28.4
100	388	-30.4	115	439	-28.6
101	391	-30.4	116	443	-31.2
102	395	-29.4	117	448	-31.1
103	398	-29.4	118	452	-31.1
104	402	-29.1	119	455	-31.0
105	406	-28.6	120	459	-30.2
106	409	-28.3	121	462	-30.3
107	413	-25.5	122	465	-30.8

LOCATION ELEVATION DATE OF OBSERVATION

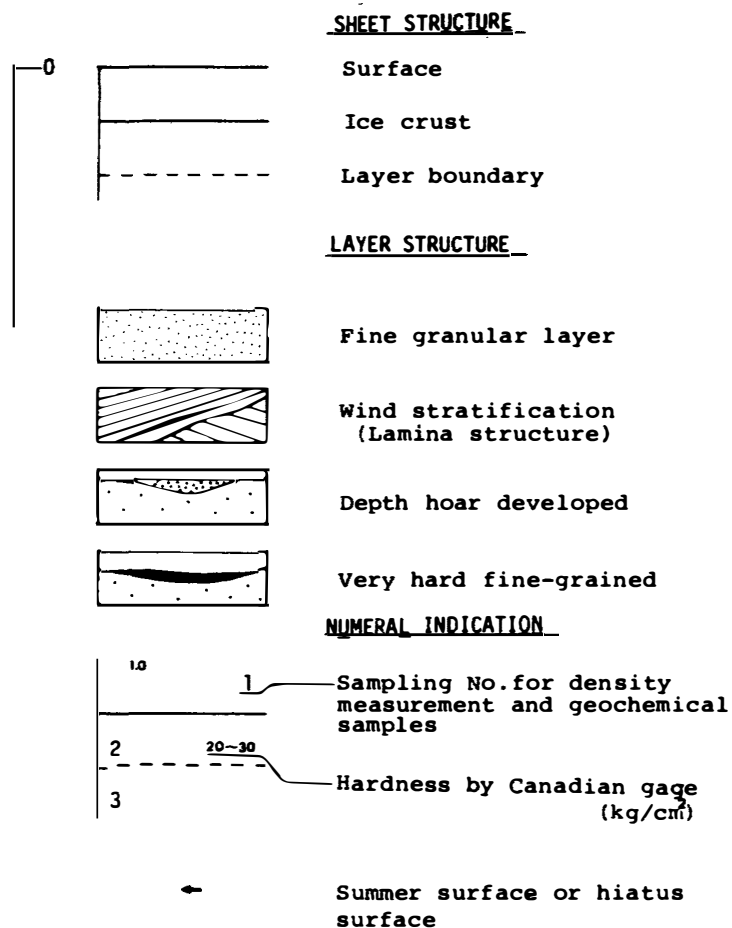


Fig. 1-1.

Fig. 1. Snow stratigraphy of 2-m pit dug in 1974-1975.

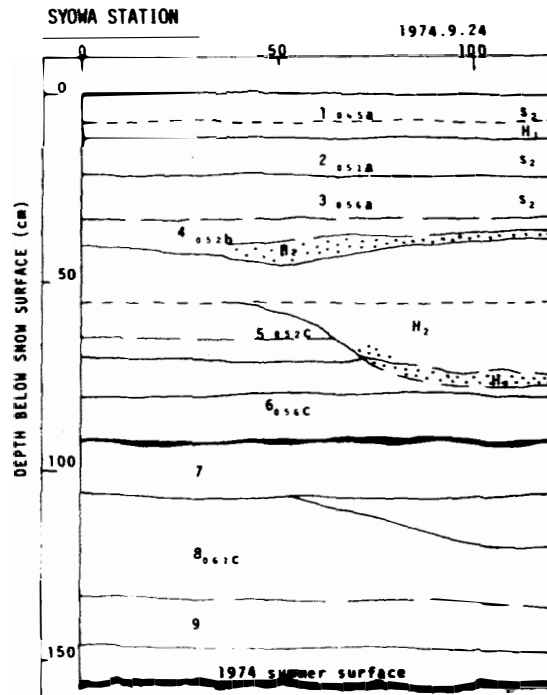


Fig. 1-2.

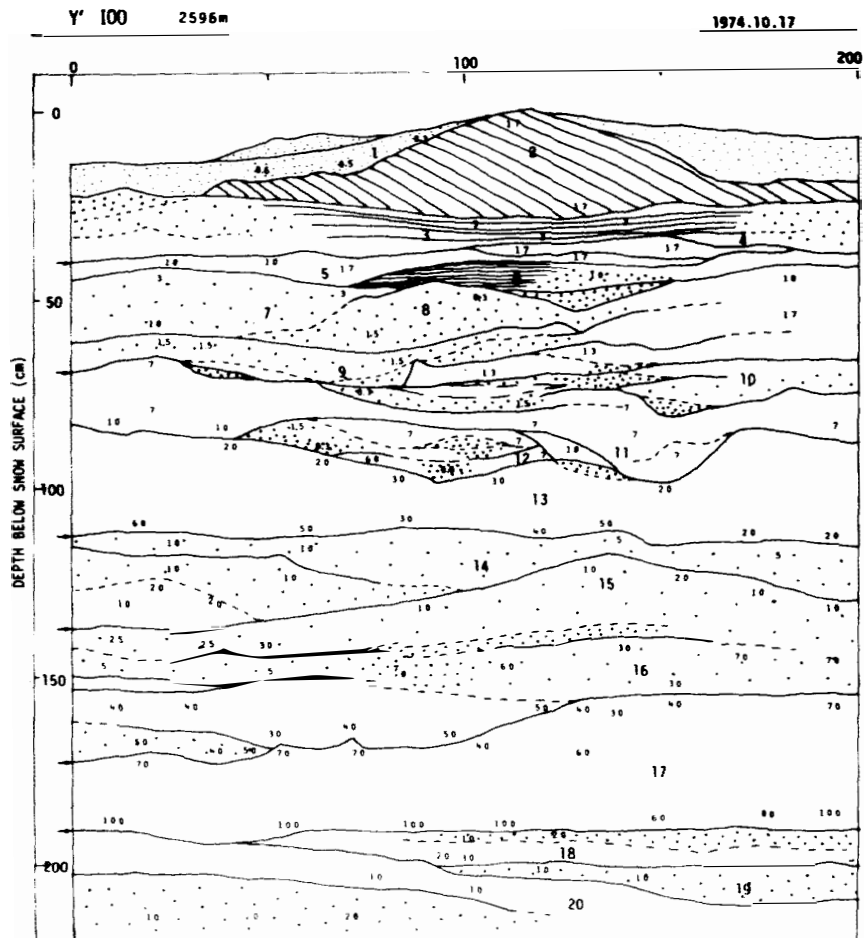


Fig. 1-3.

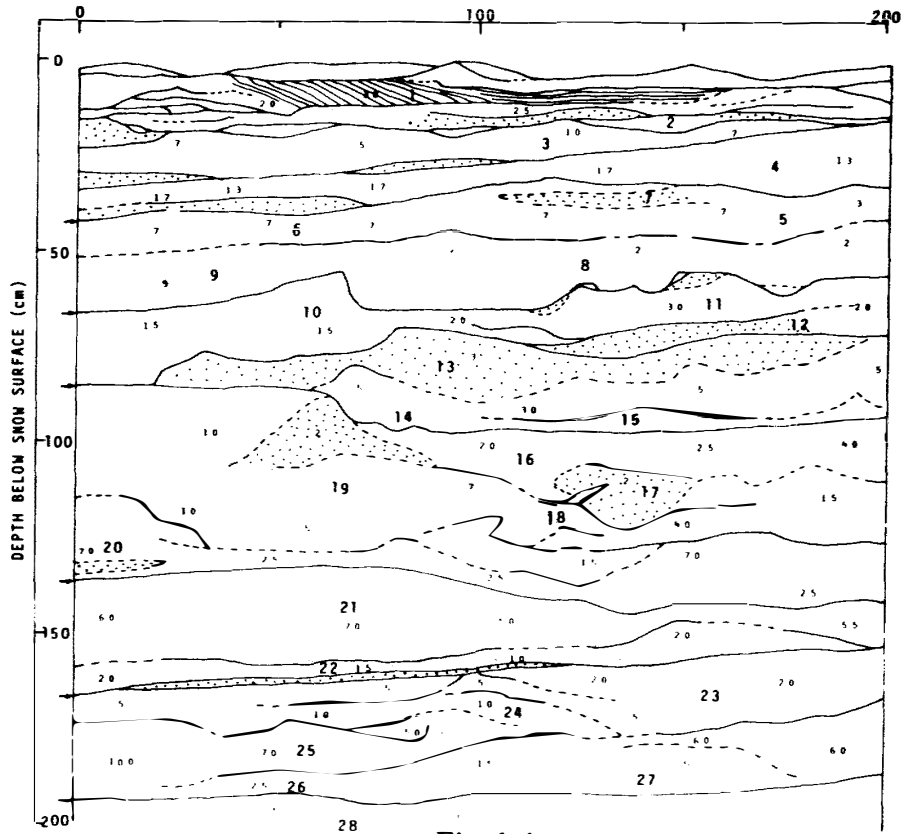


Fig. 1-4.

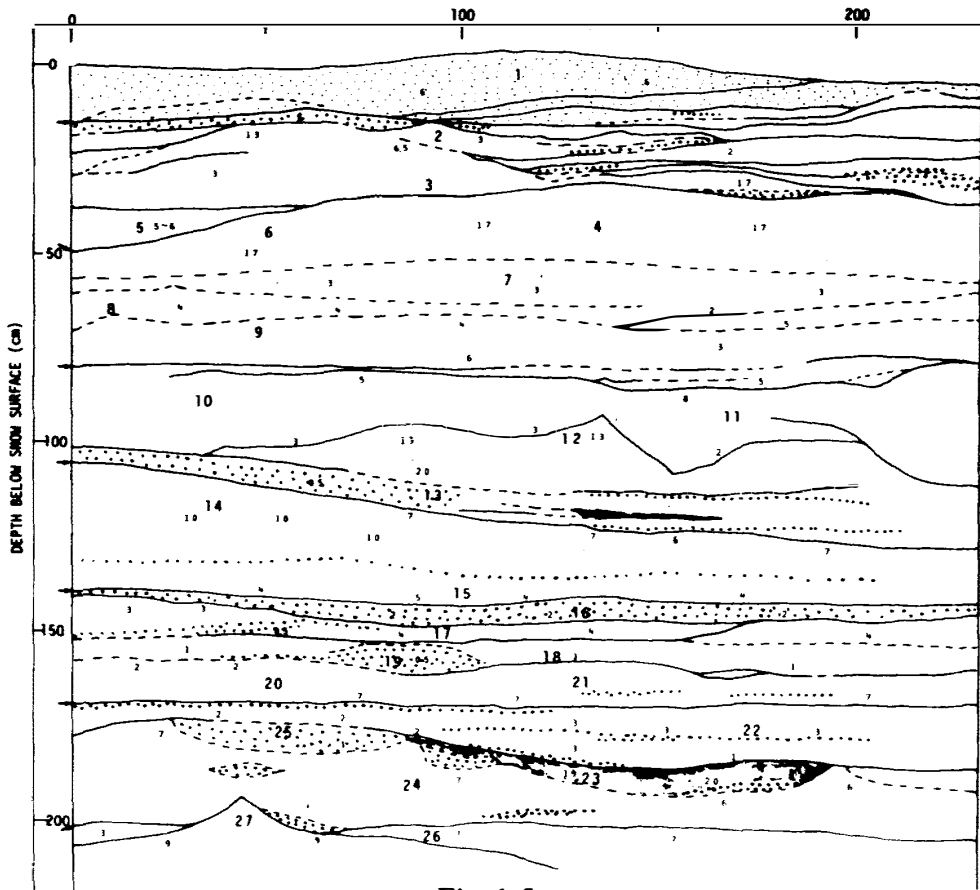


Fig. 1-5.

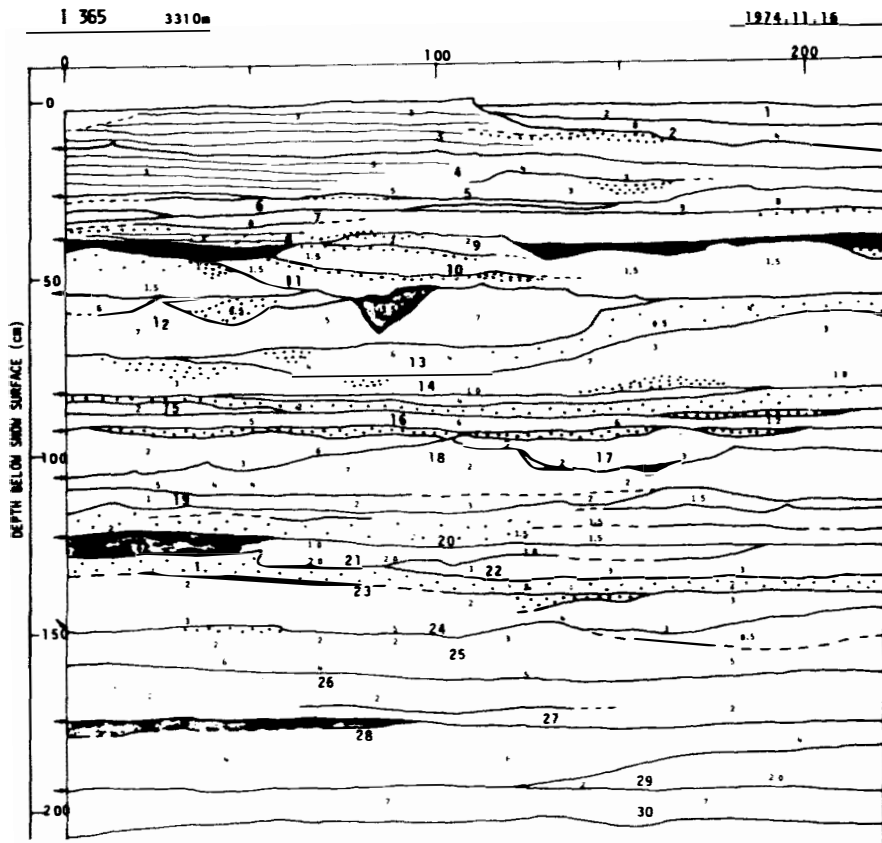


Fig. 1-6.

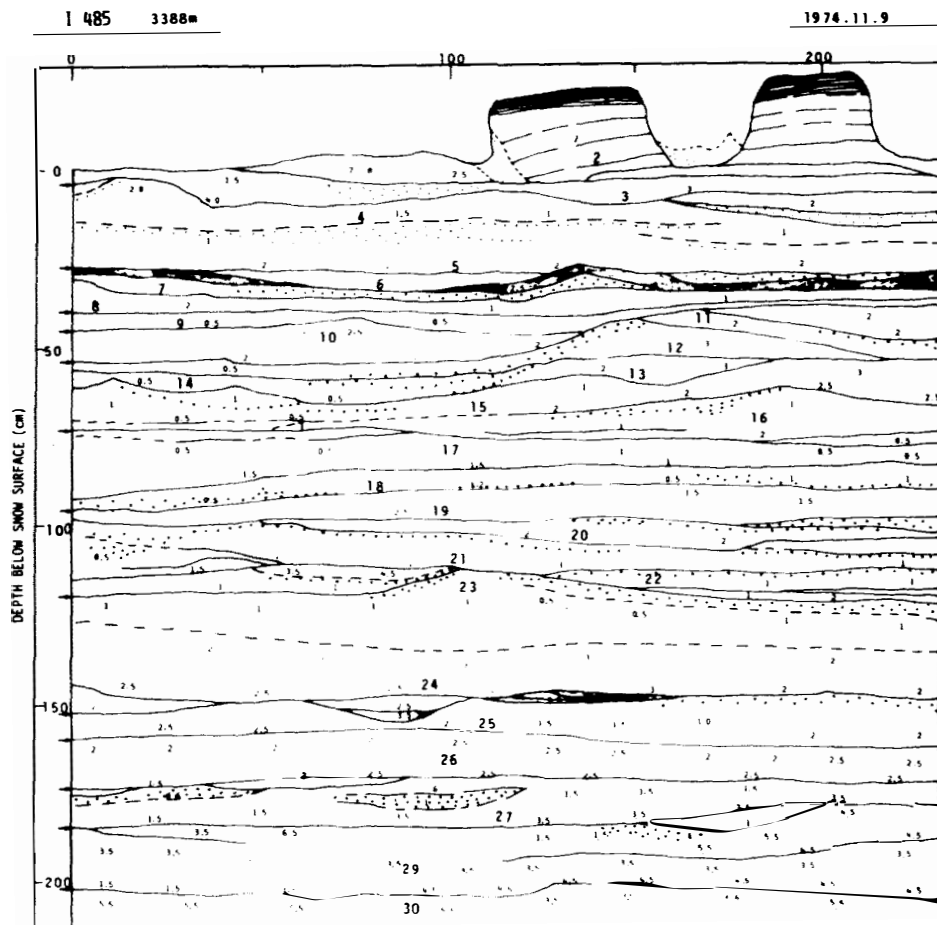


Fig. 1-7.

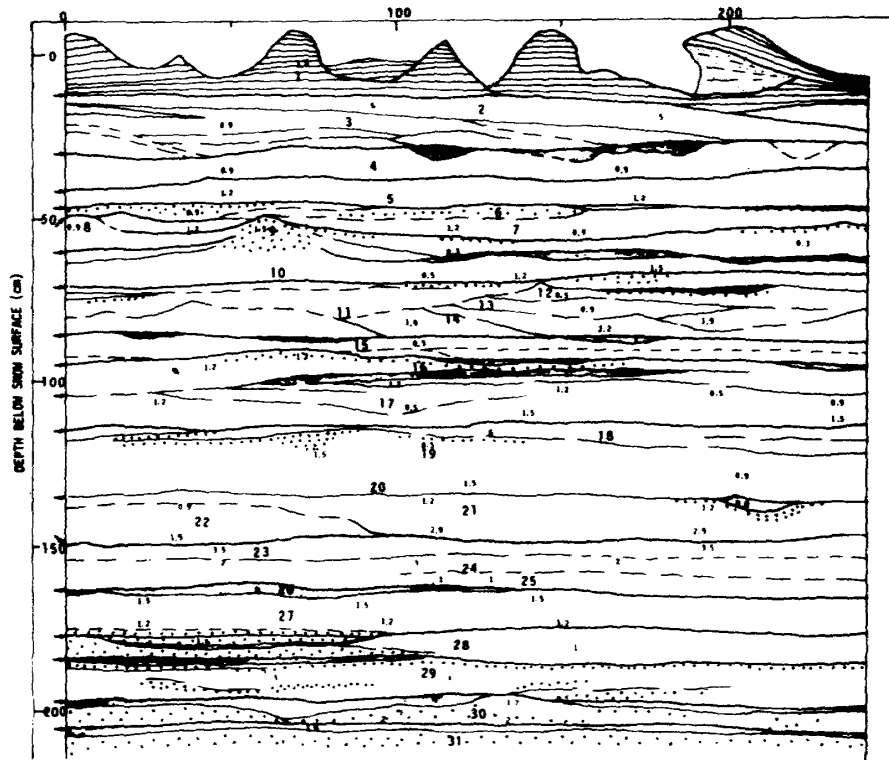


Fig. 1-8.

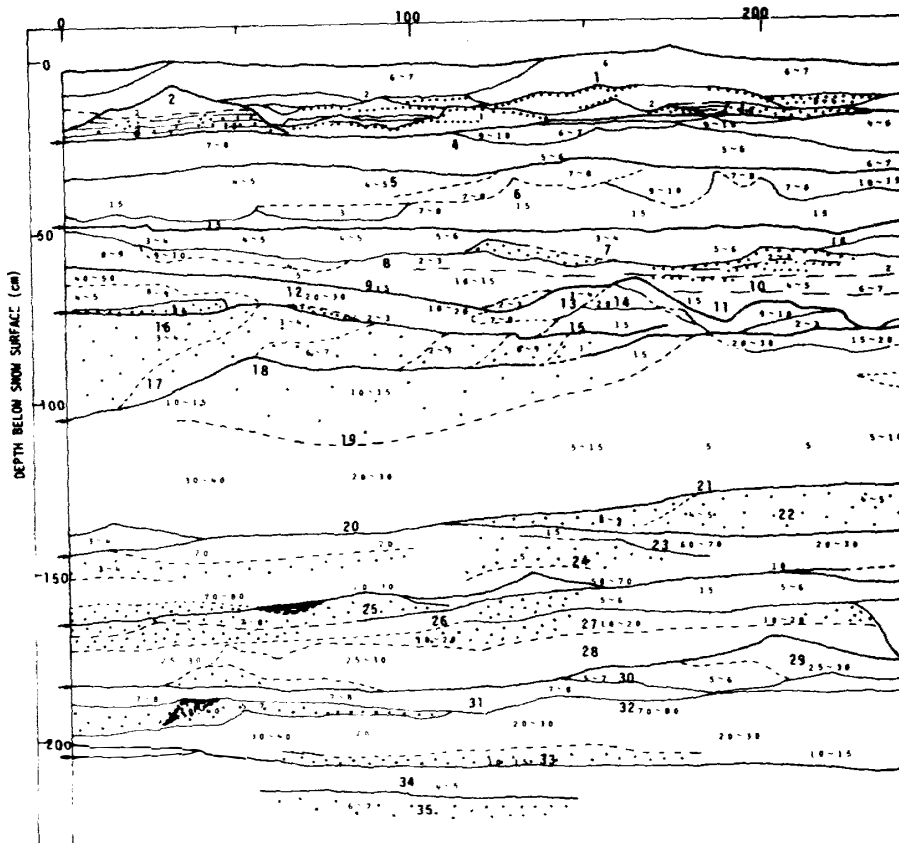


Fig. 1-9.

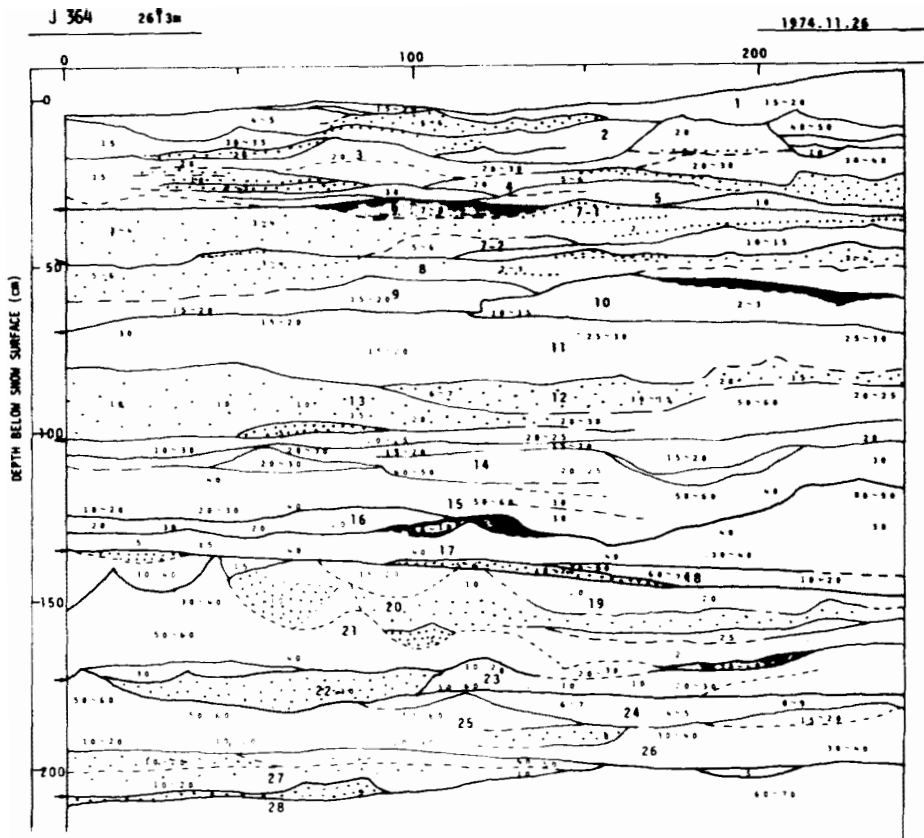


Fig. 1-10.

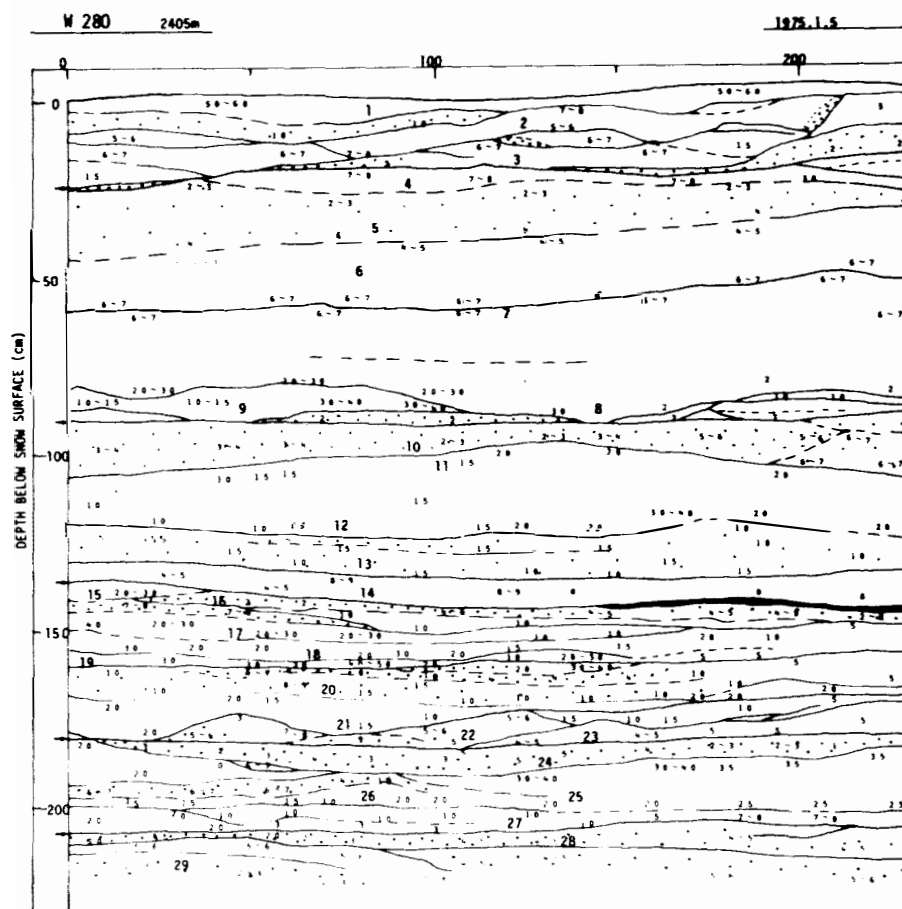


Fig. 1-11.

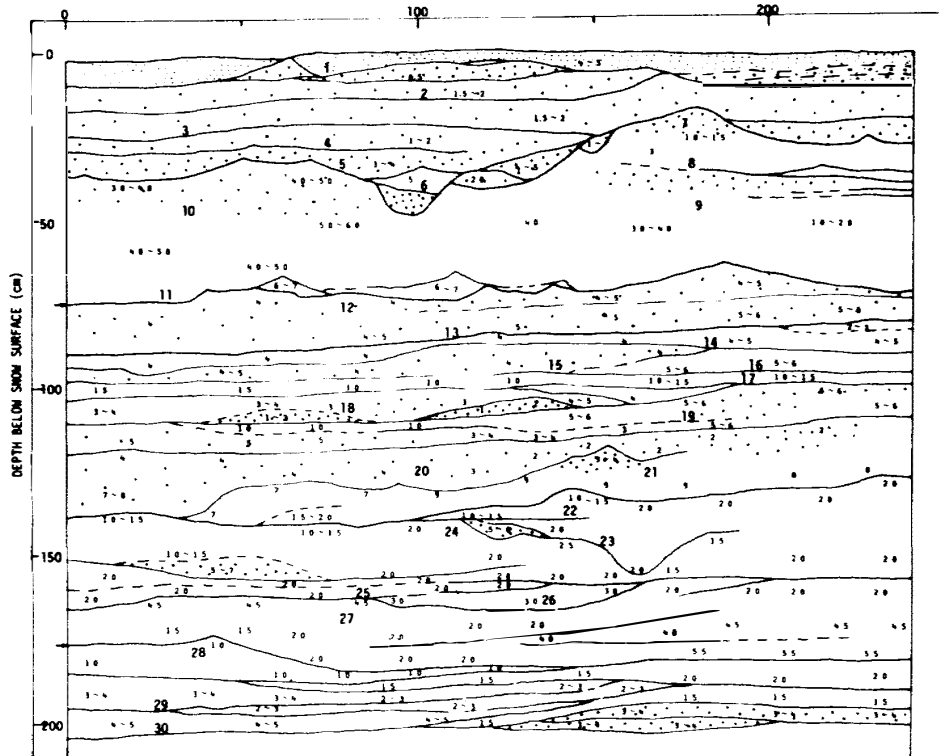


Fig. 1-12.

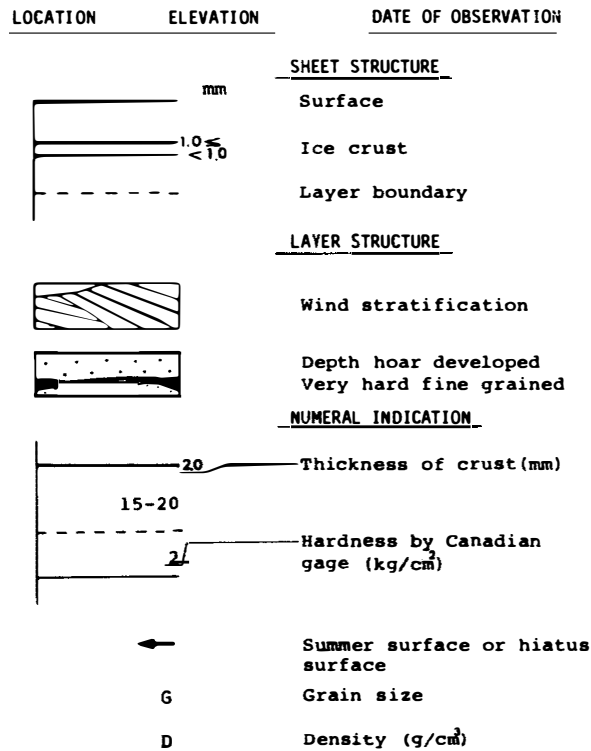


Fig. 2-1.

Fig. 2. Snow stratigraphy of 1-m pit dug in 1974-1975.

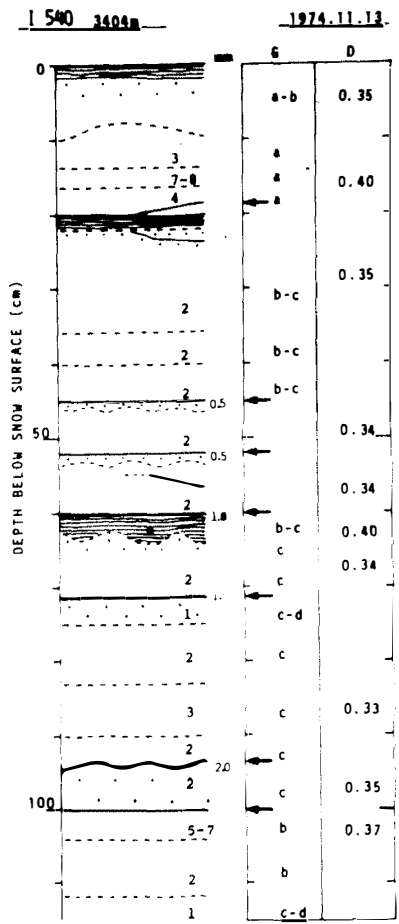


Fig. 2-2.

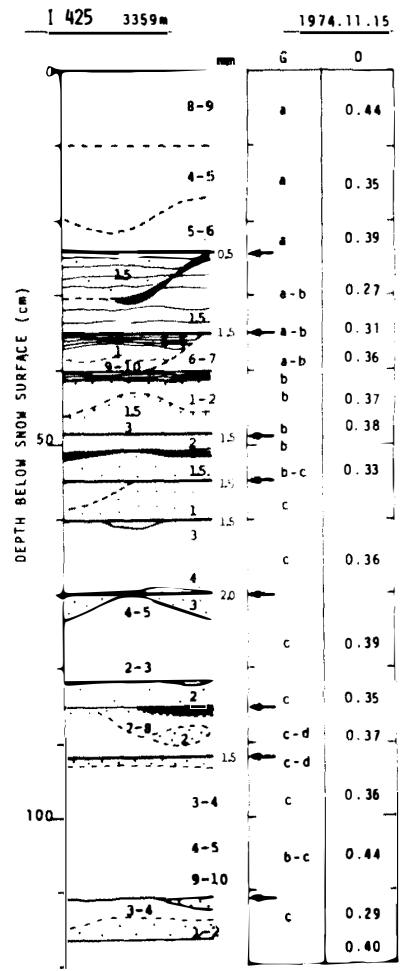


Fig. 2-3.

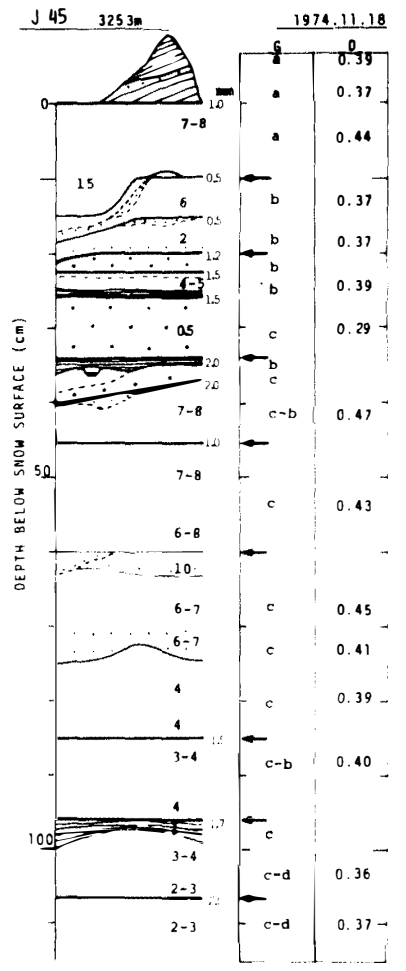


Fig. 2-4.

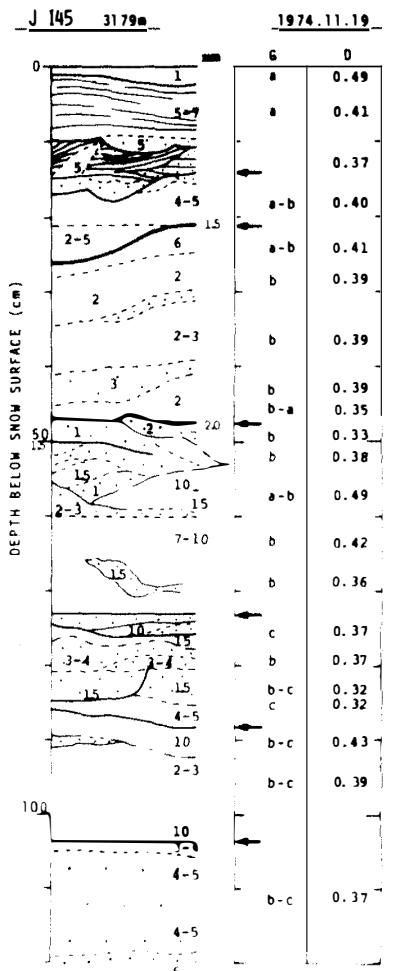


Fig. 2-5.

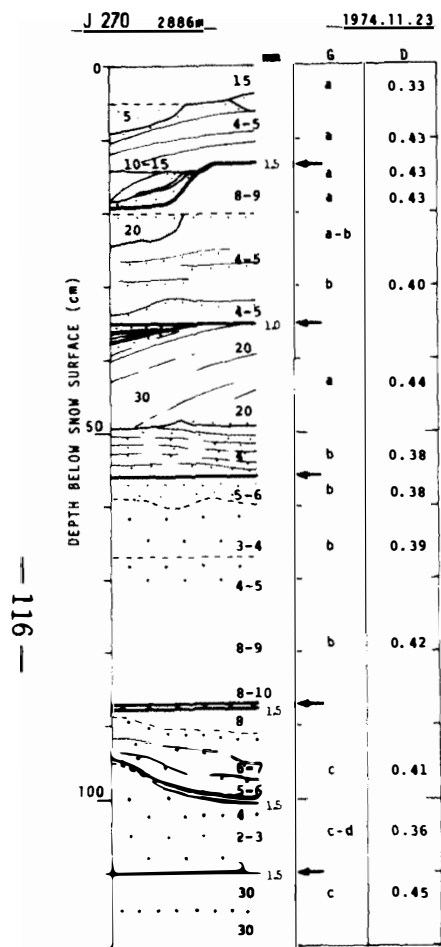


Fig. 2-6.

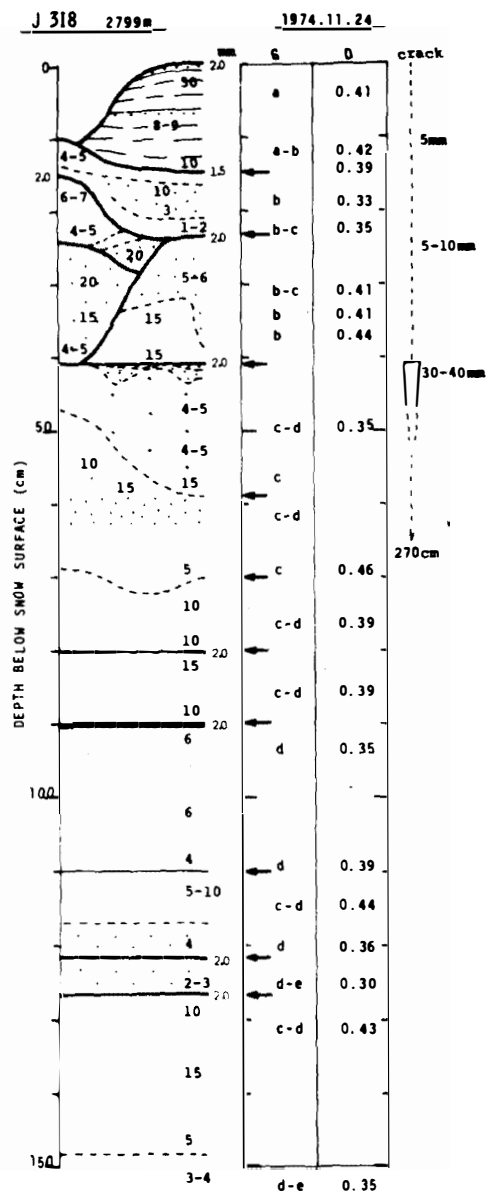


Fig. 2-7.

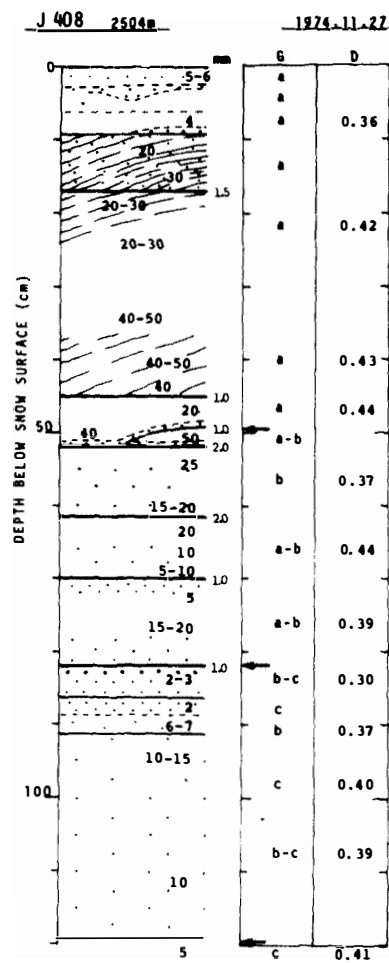


Fig. 2-8.

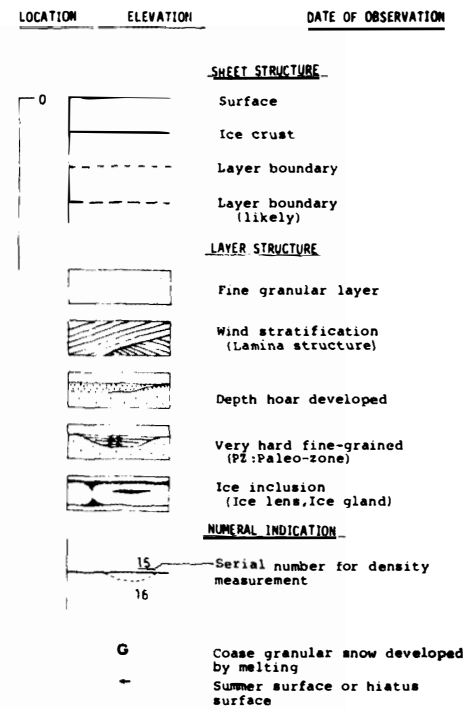


Fig. 3-1

Fig. 3. Snow stratigraphy of 2-m pit dug in 1969-1970.

S 16 554m

1970.1.27

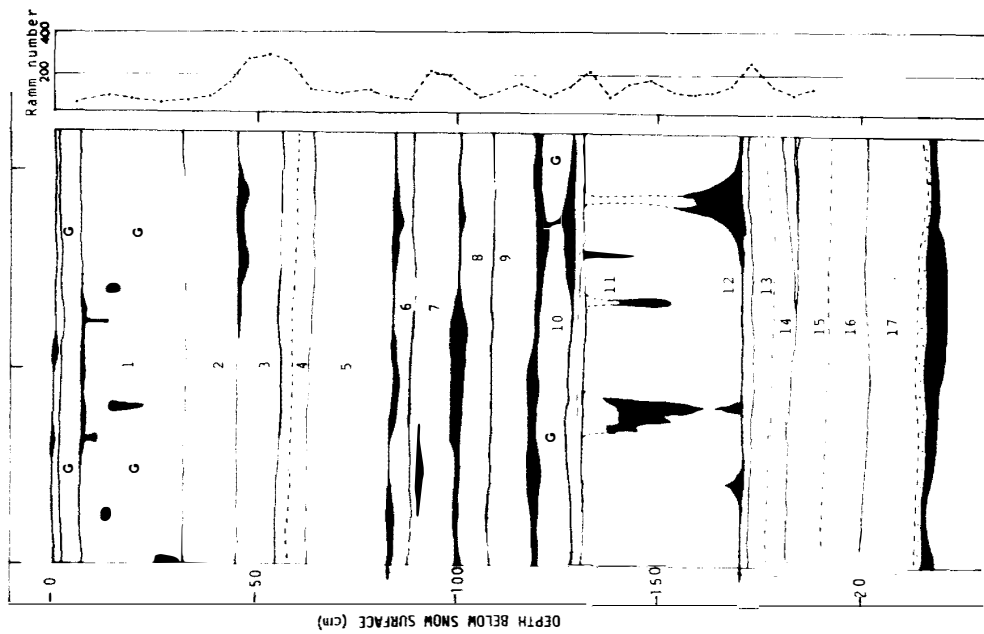


Fig. 3-2.

S 122 1910m

1970.1.18

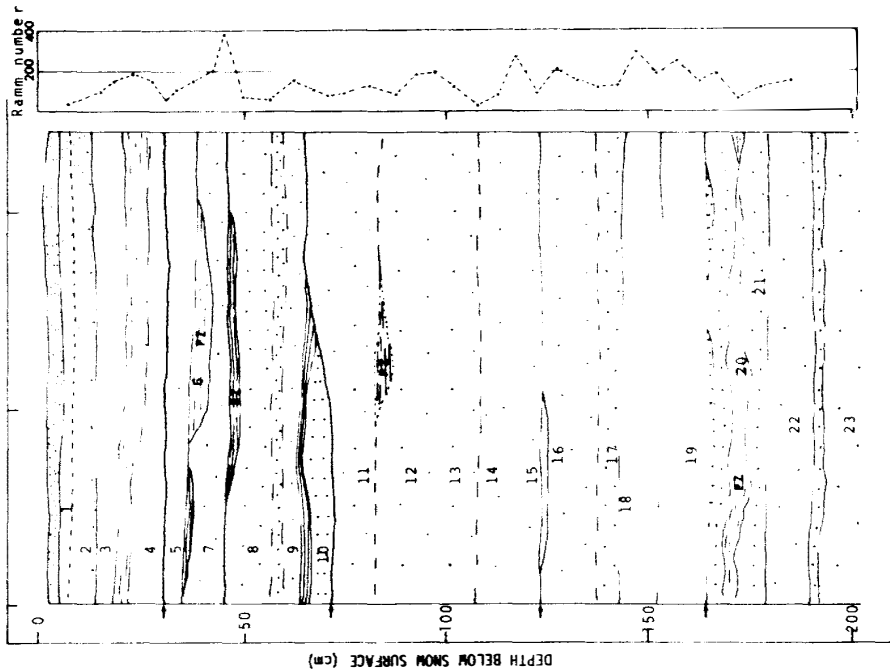


Fig. 3-3.

W 55 2168m

1969.12.31

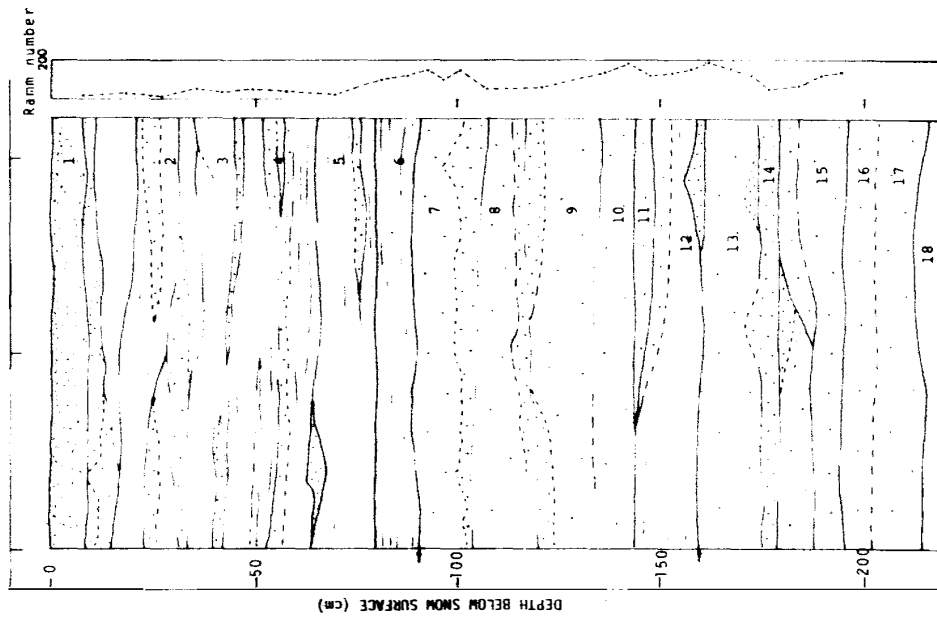


Fig. 3-4.

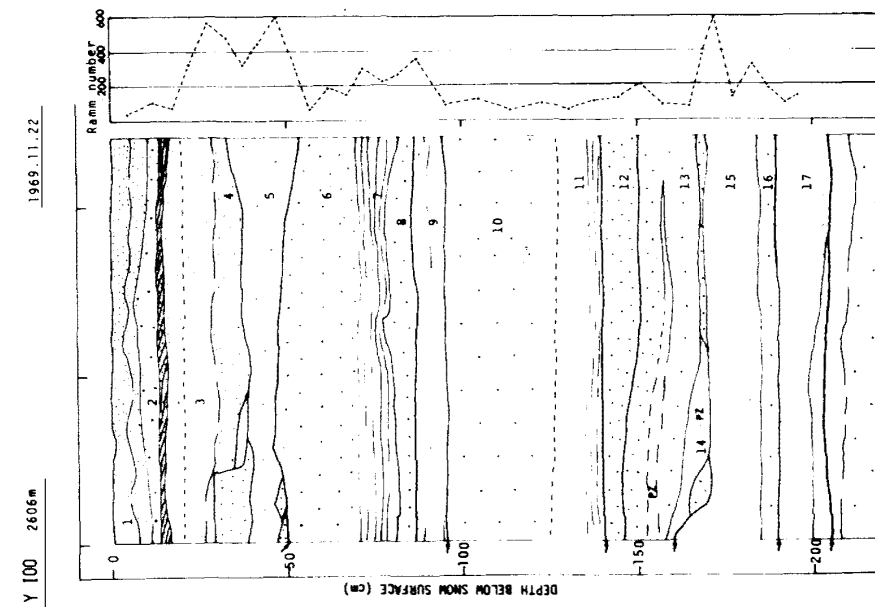


Fig. 3-5.

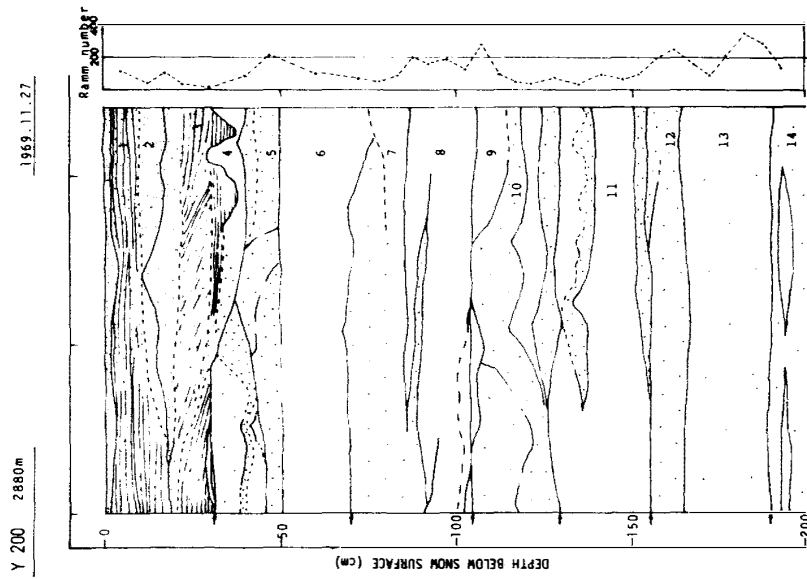


Fig. 3-6.

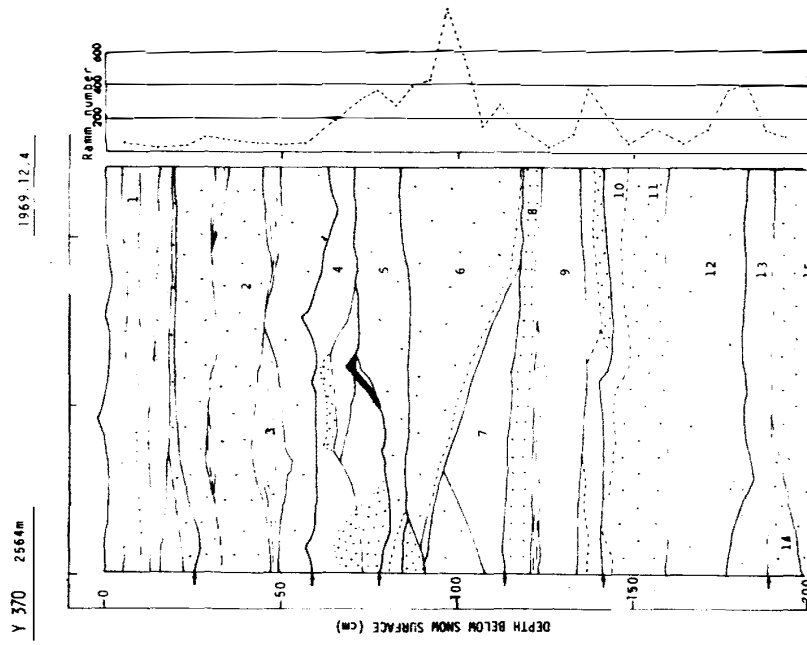


Fig. 3-7.

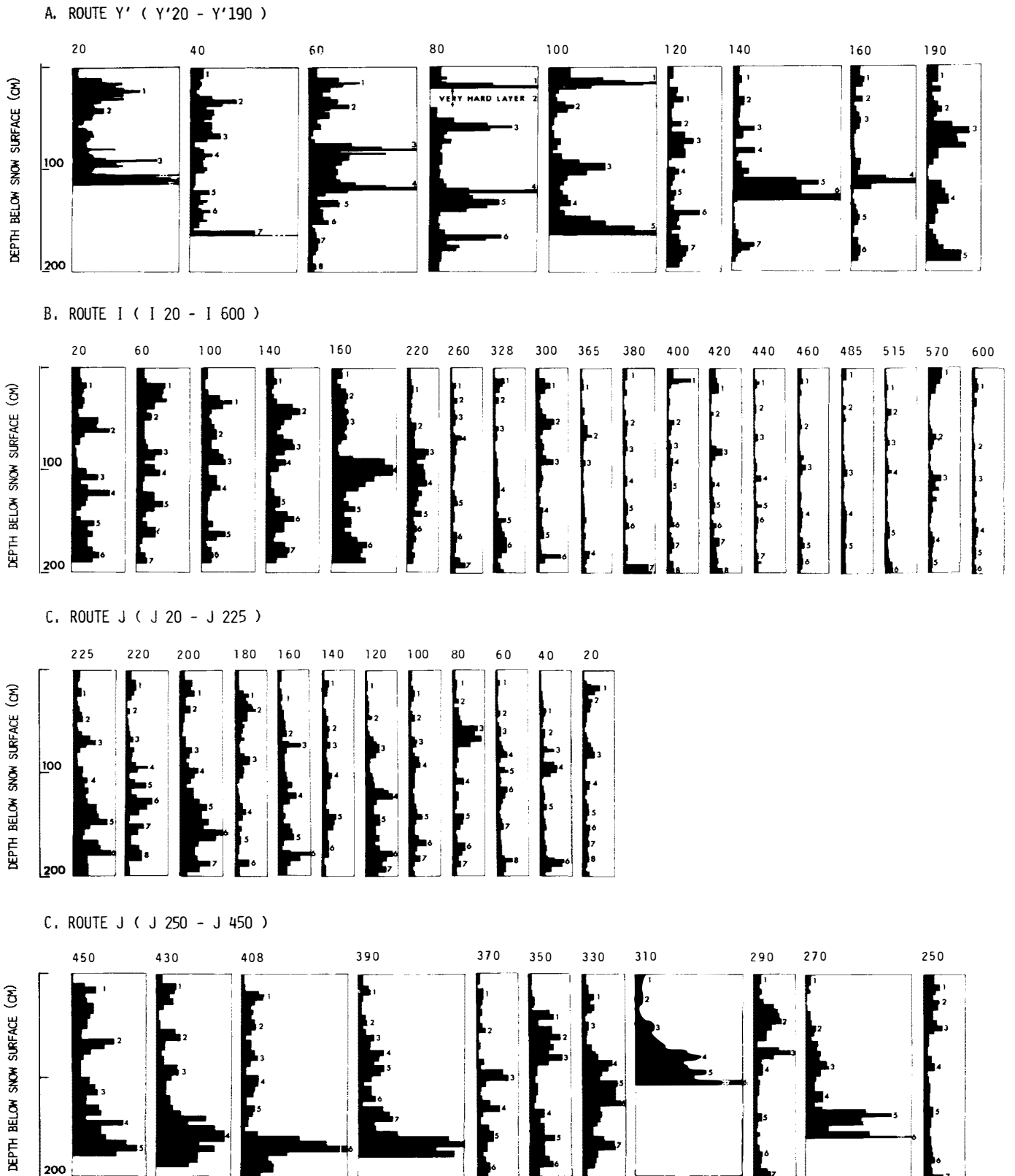


Fig. 4. Ram hardness profiles along the Routes of Y'-I-J.

LOCATION H 128 DATE 1973.1.28

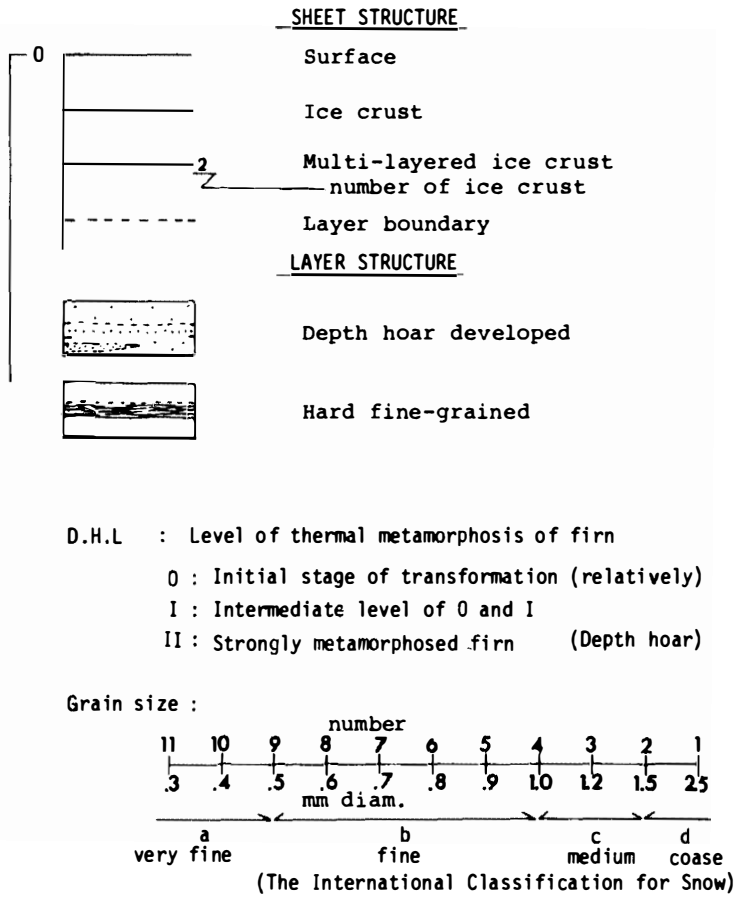


Fig. 5-1.

Fig. 5. Snow stratigraphy of 10-m long core obtained at 10 stations in 1969-1975.

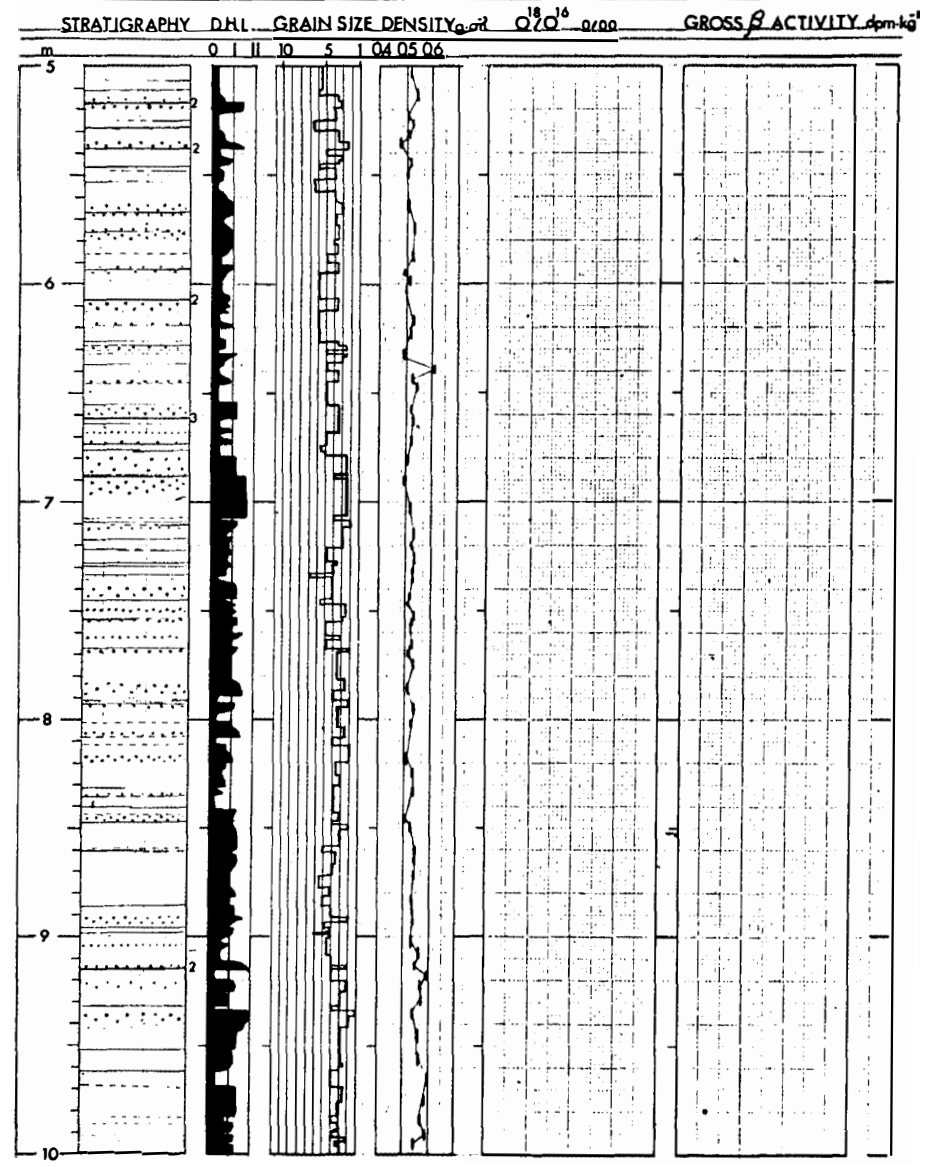


Fig. 5-2 (1)

LOCATION H 128

DATE 1973.1.28

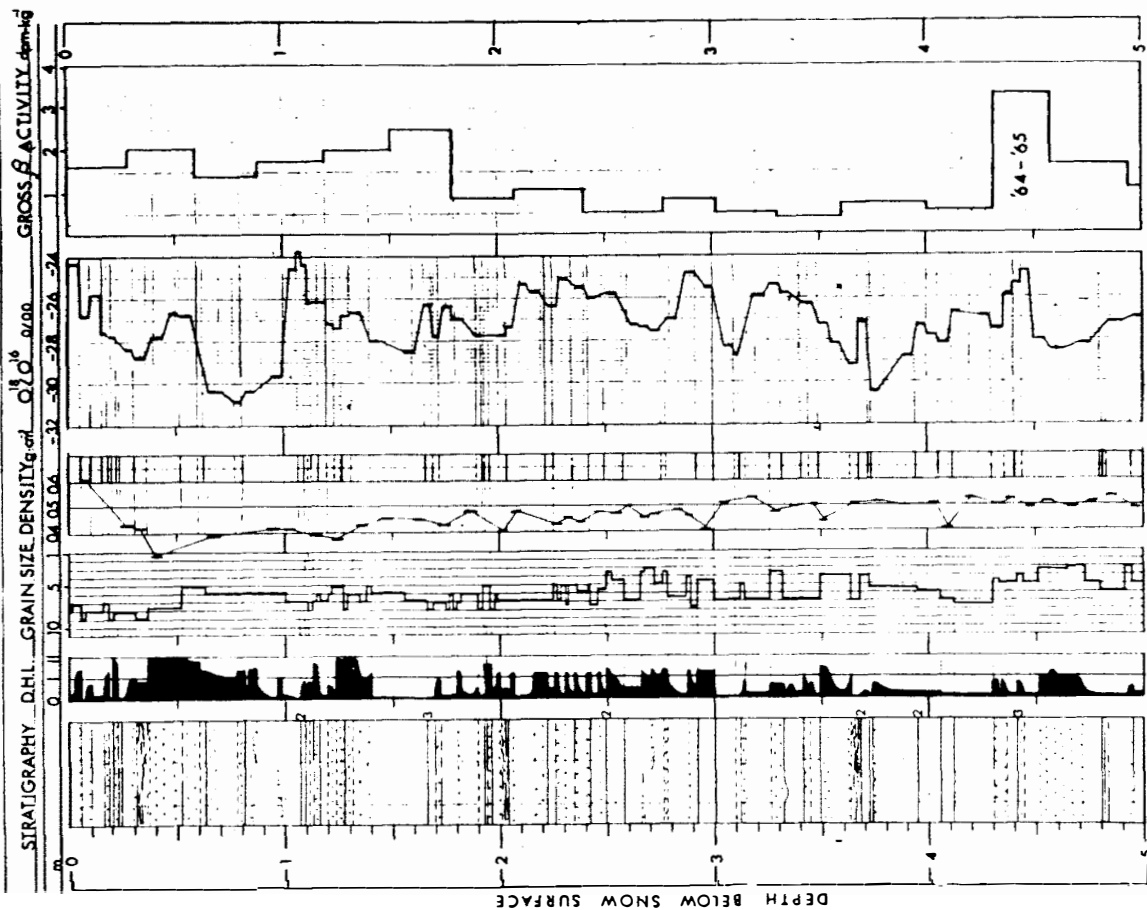


Fig. 5-4.

LOCATION H 228

DATE 1973.1.25

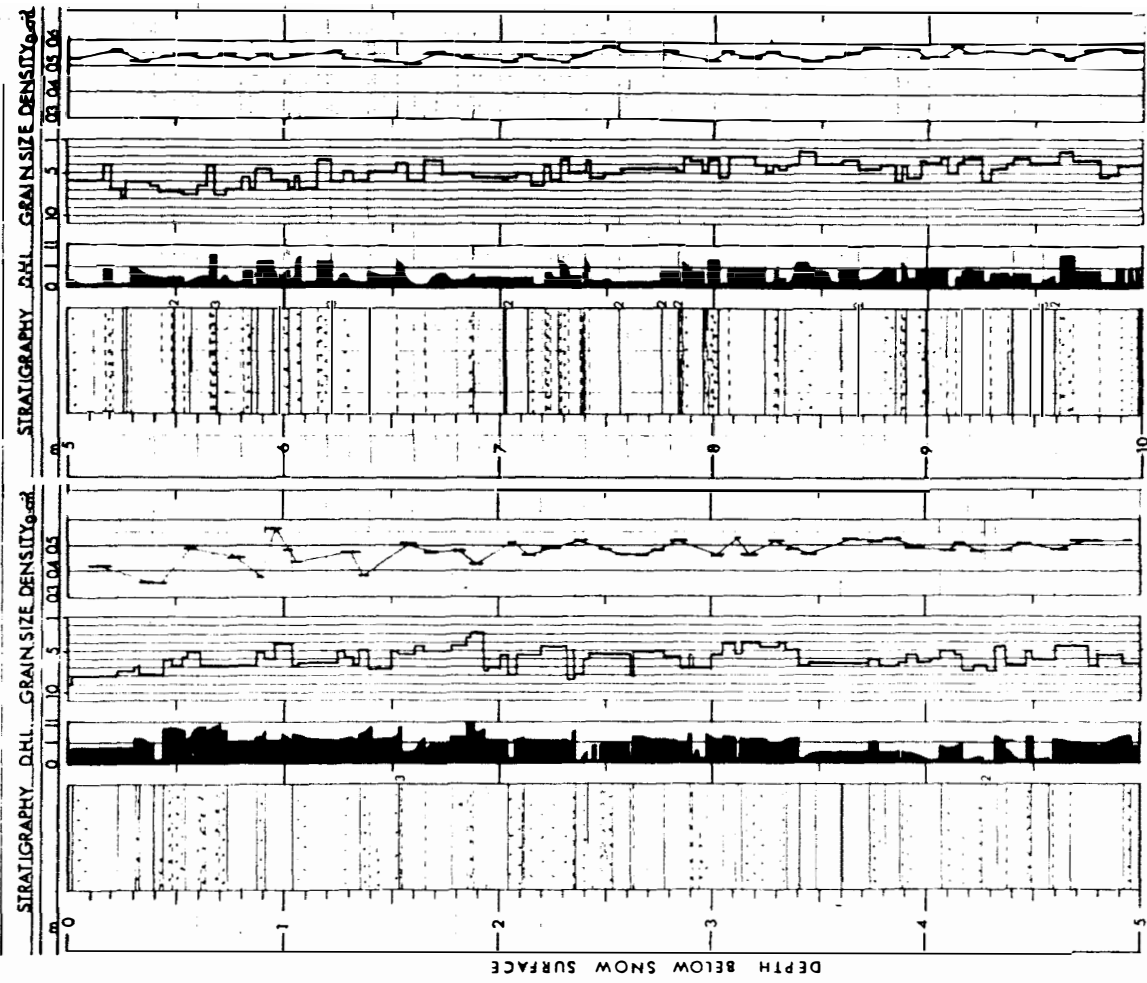


Fig. 5-5.

LOCATION S 97

DATE 1971.1.19

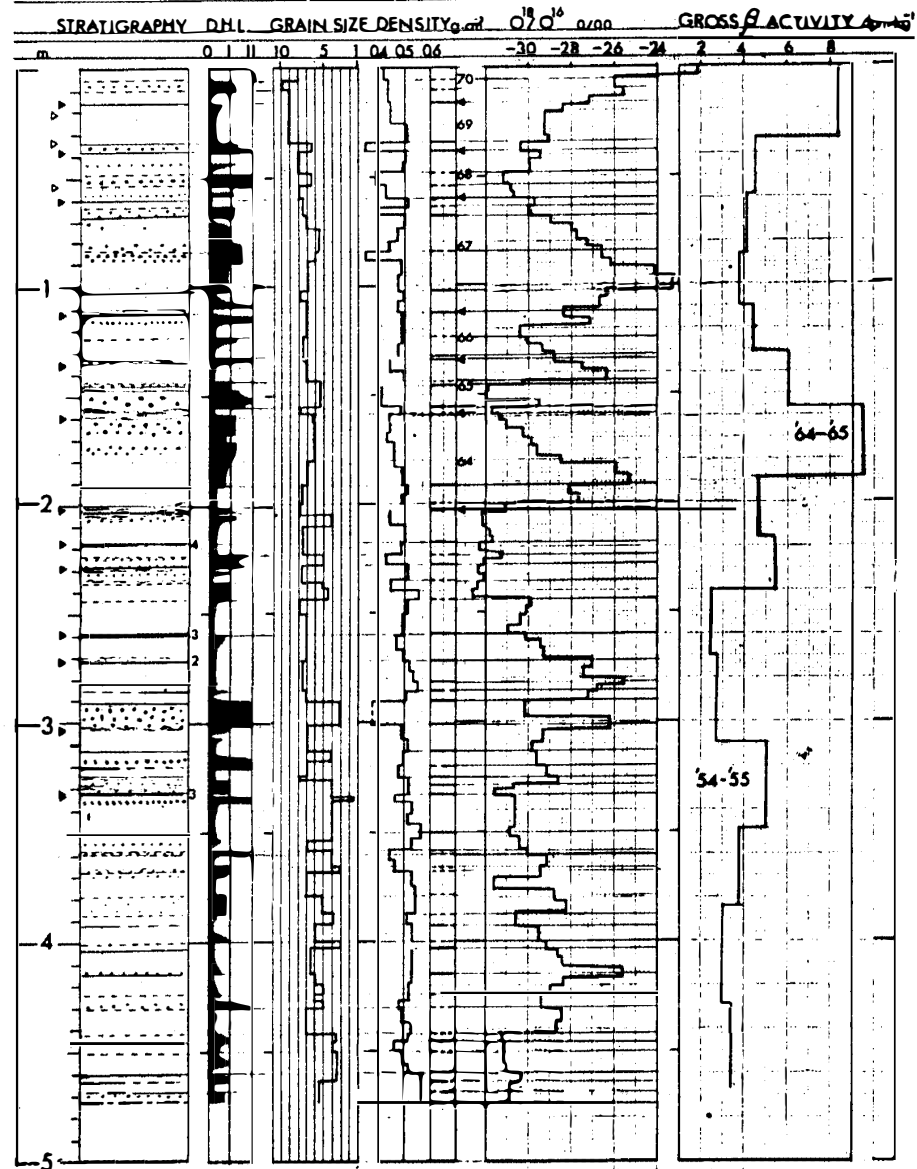


Fig. 5-2 (2)

LOCATION S 122

DATE 1973.1.24

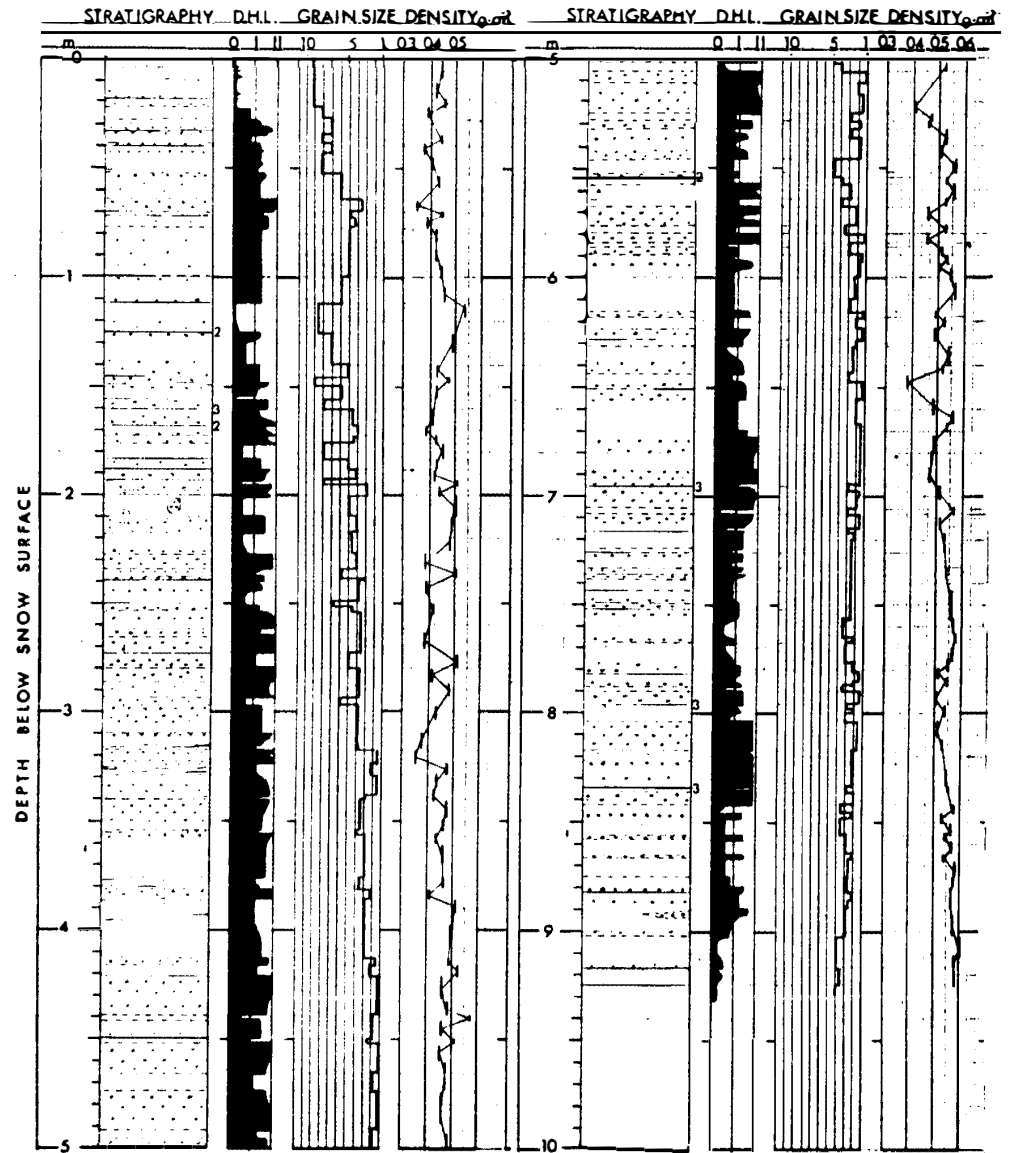


Fig. 5-3.

LOCATION 730 DATE 1975.2.6

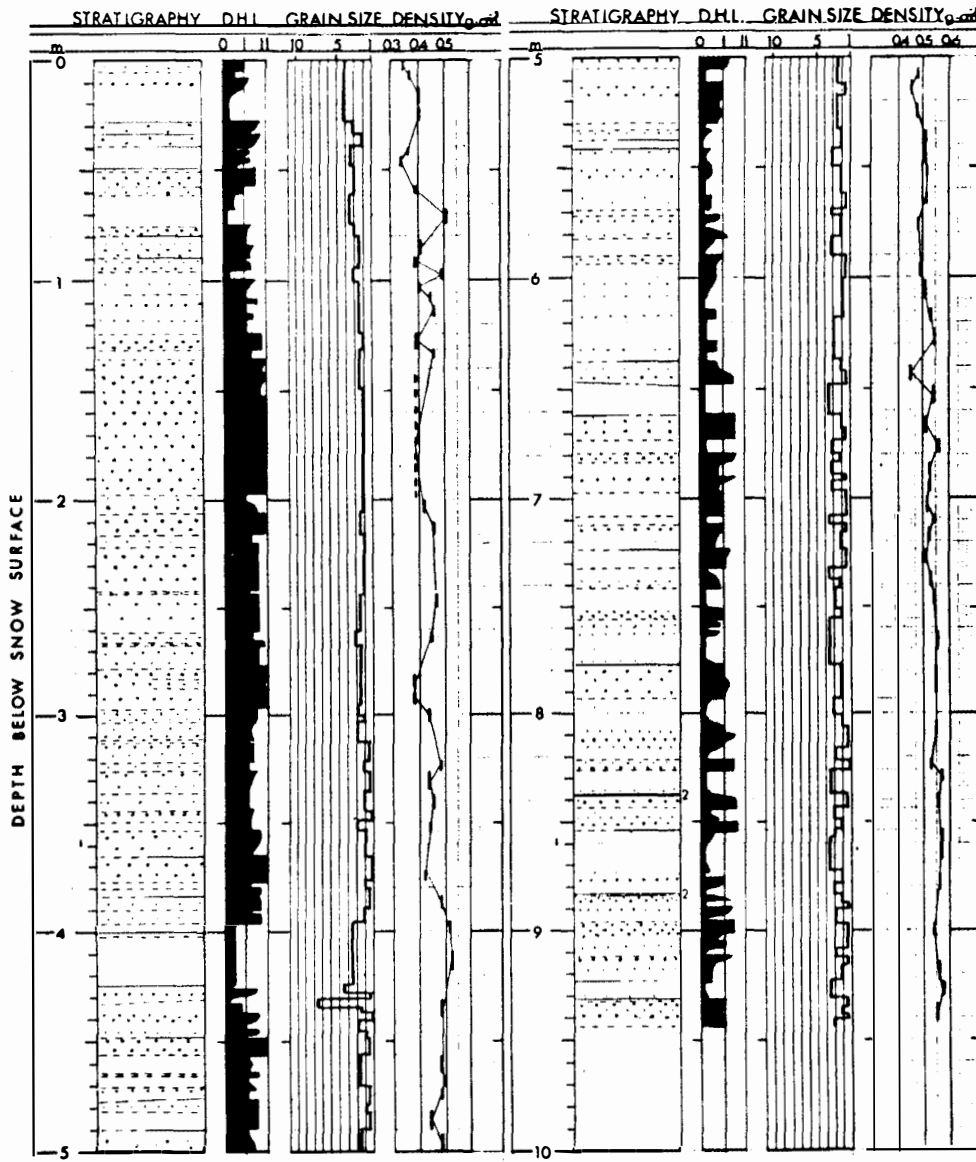


Fig. 5-6.

LOCATION V210 DATE 1974.10.25

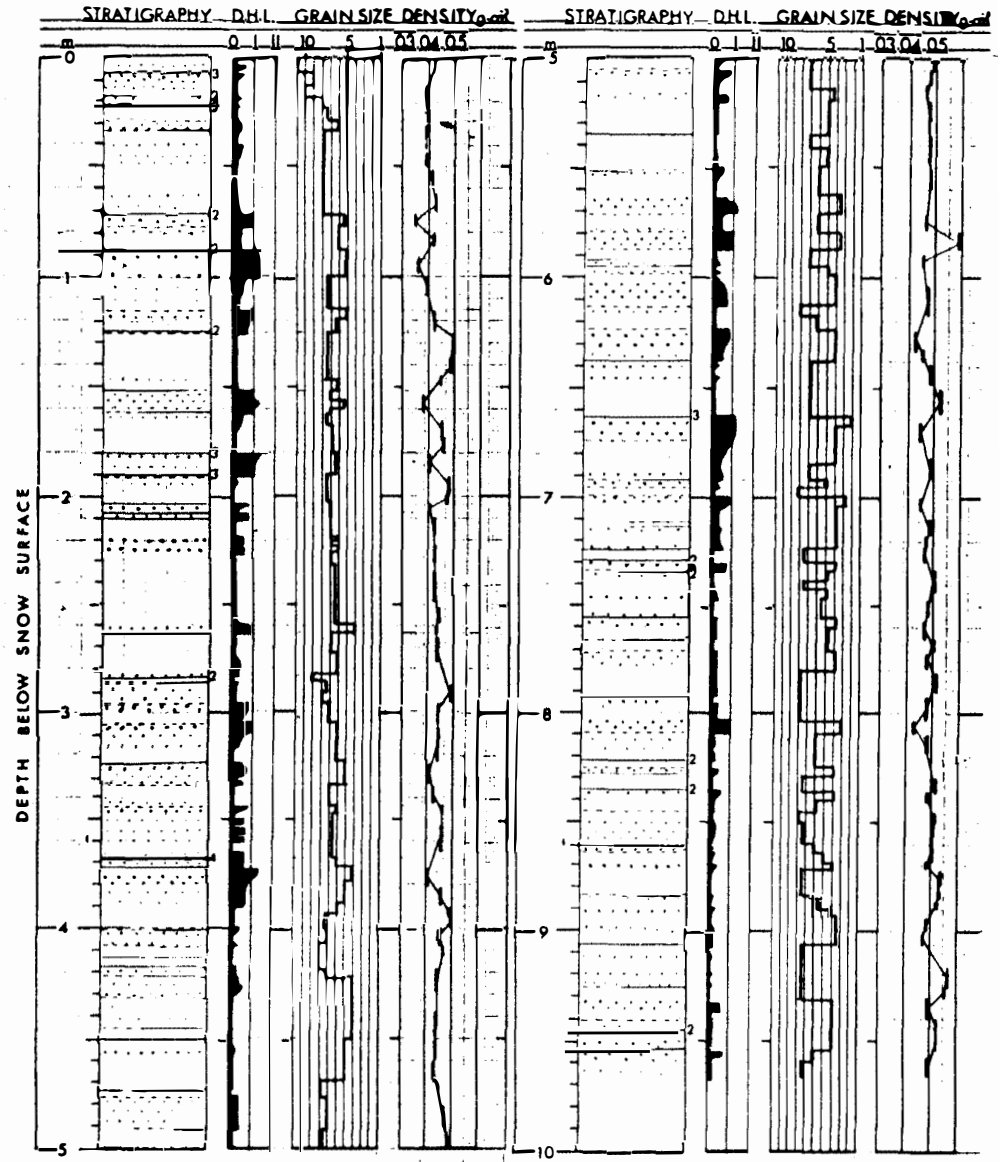


Fig. 5-7.

LOCATION 1 235 DATE 1974.11.1

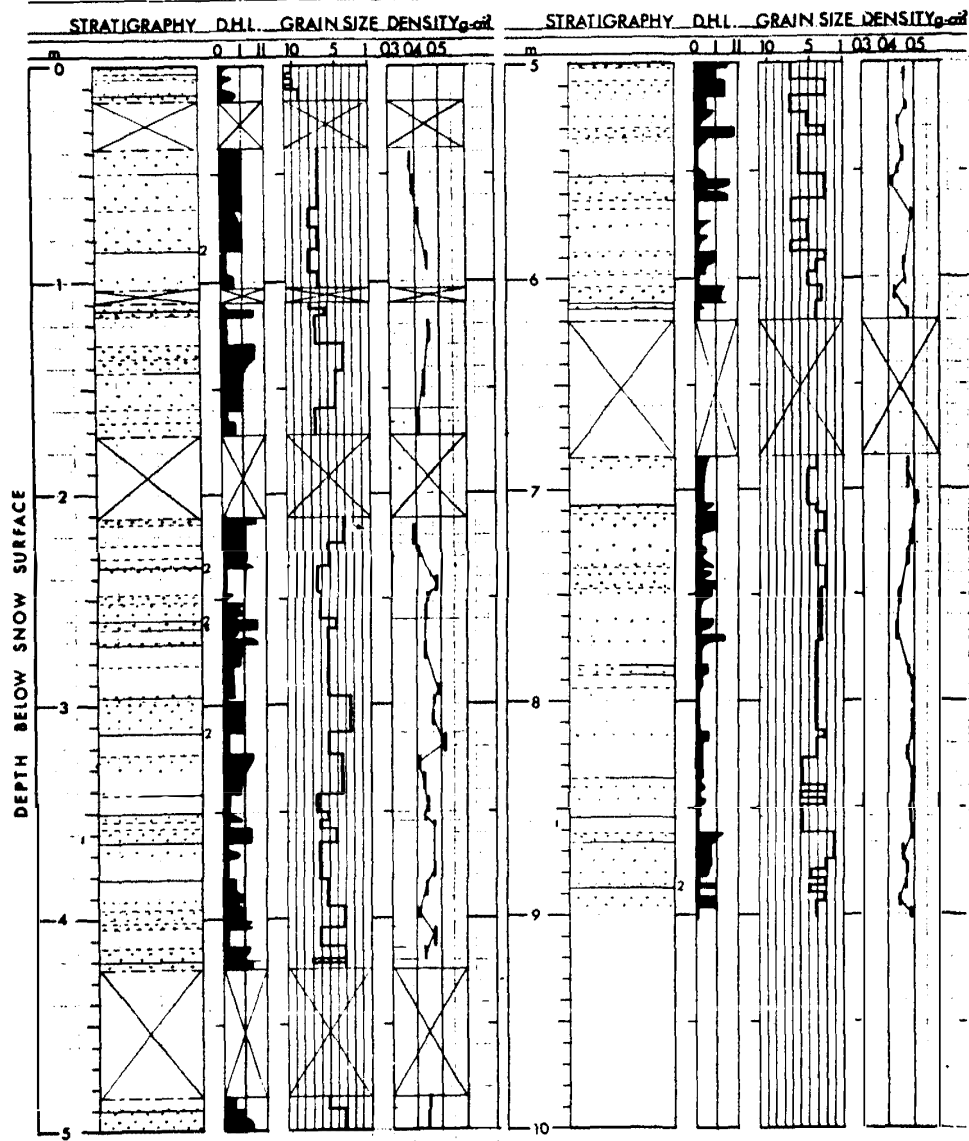


Fig. 5-8.

LOCATION 1 355 DATE 1974.11.5

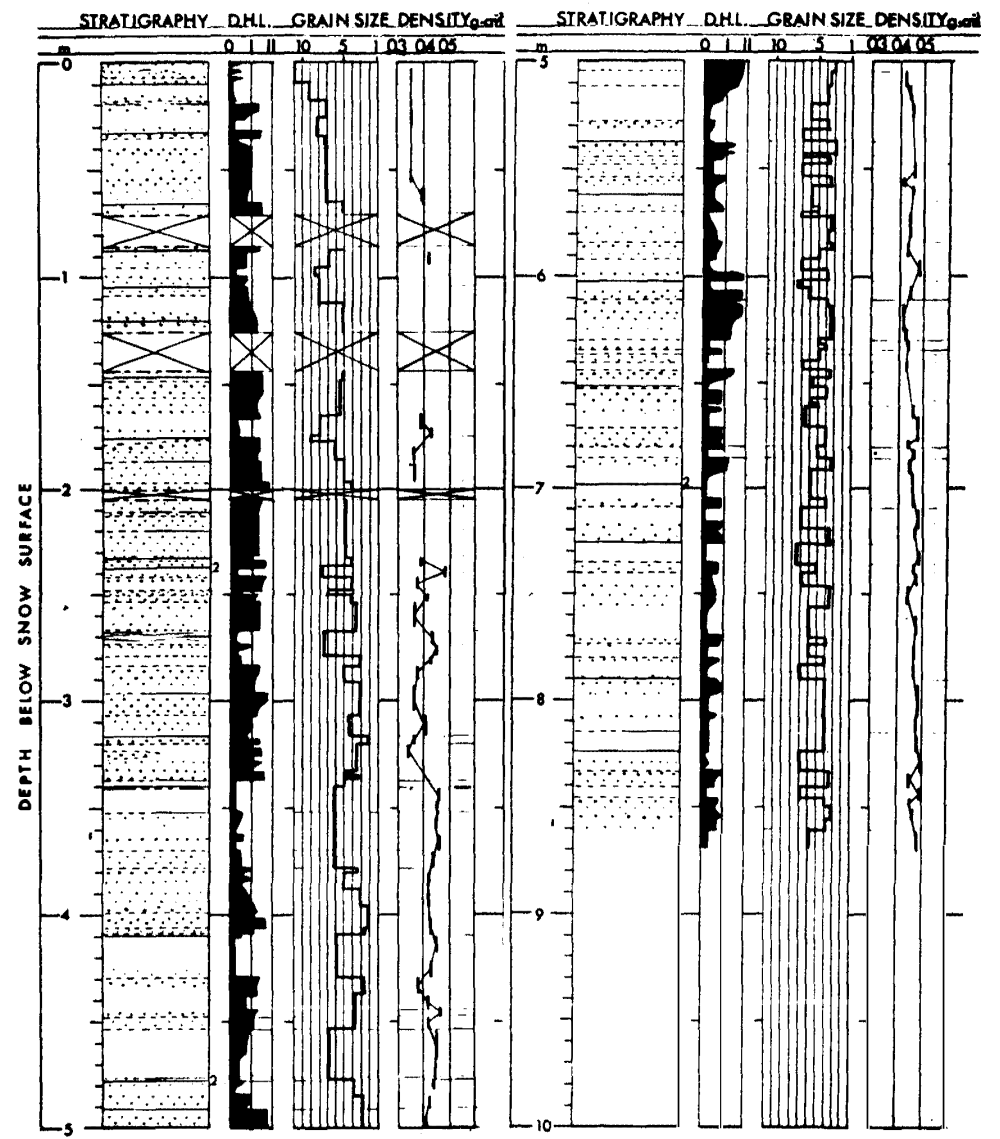


Fig. 5-9.

LOCATION J 225

DATE 1974.11.22

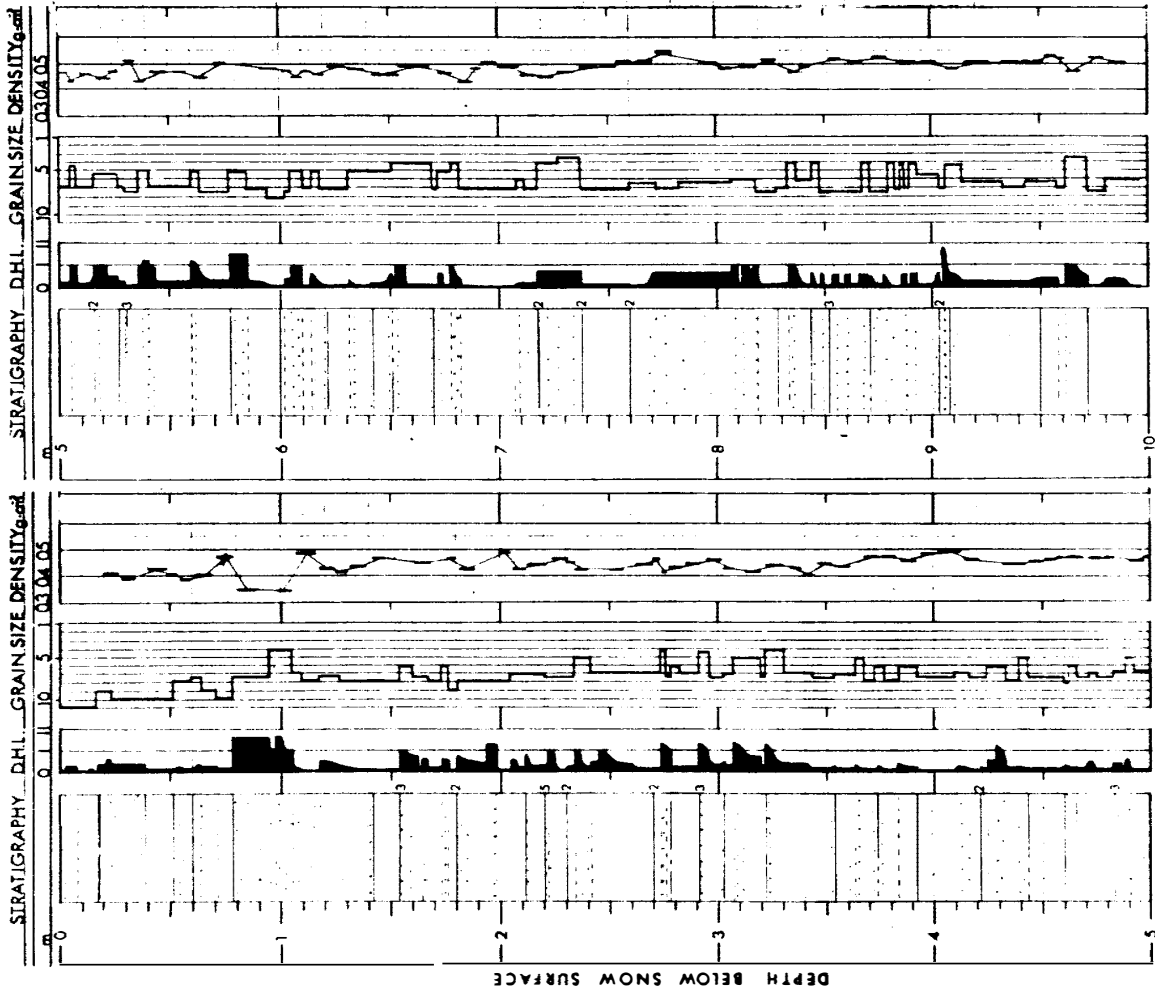


Fig. 5-10.

LOCATION W 46

DATE 1974.12.30

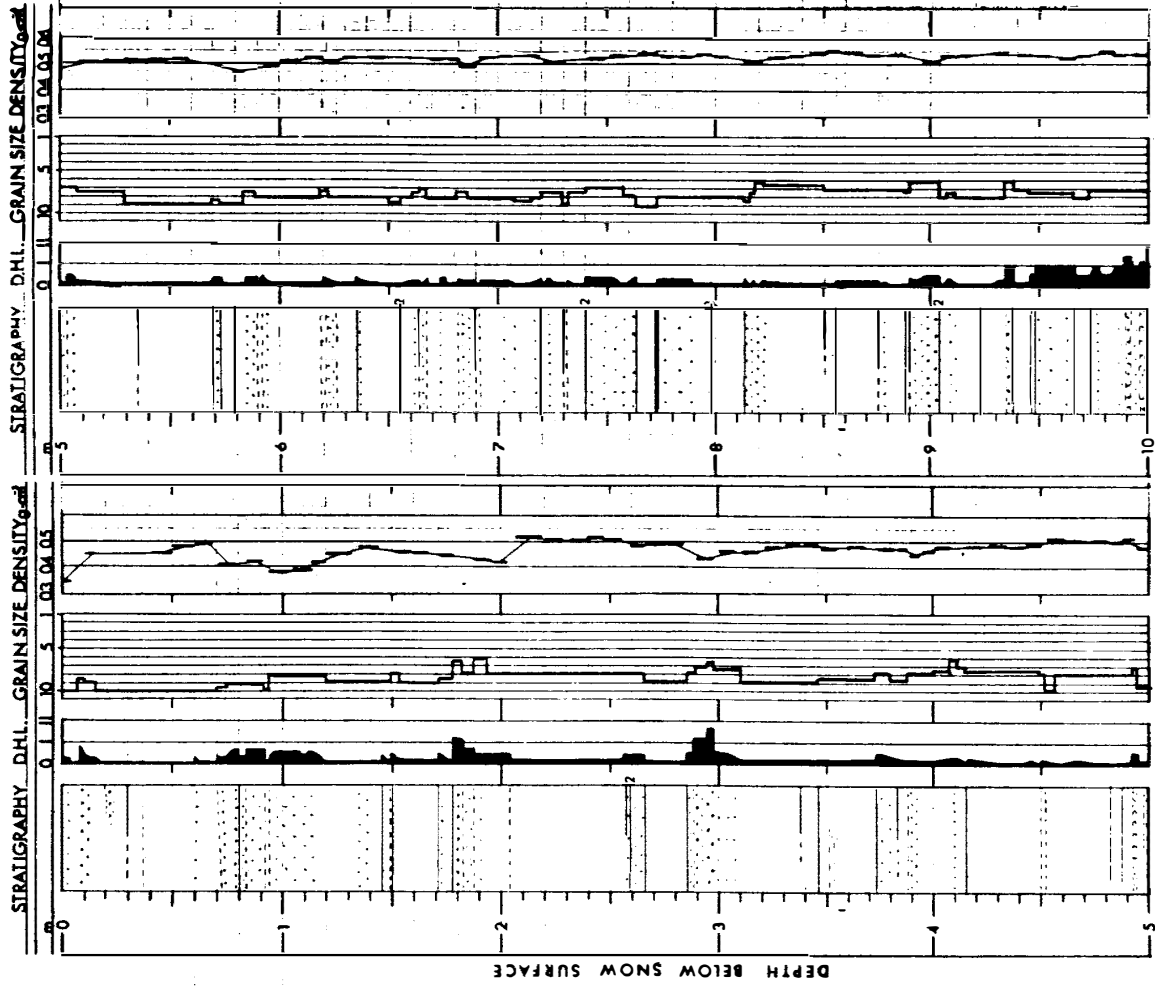


Fig. 5-11.