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Snow samples collection at the South Pole Station for geochemical and cosmic dust investigations

FIELD REPORT

December 1962

by

E. PICCIOTTO

Université Libre de Bruxelles
Service de Géologie et Géochimie Nucléaires

W. DE BREUCK

Rijksuniversiteit te Gent
Laboratorium voor Fysische Aardrijkskunde
on mission for the Physikalisches Institut, Universitat Bern

U.S. Antarctic Research Program
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1. INTRODUCTION

This report details the execution of Project n° AA-422 of the United States Antarctic Research Program (National Science Foundation) entitled : "Snow samples collection at the South Pole for geochemical and cosmic dust investigations", by J.GEISS and E.E.PICCIOTTO.

The aim of the operation was that of collecting snow and firn samples at various American Antarctic stations and of bringing these samples back to Europe in the solid state for chemical and isotopic analysis. These studies are in the line of work being carried out in the last few years at the Nuclear Geology and Geochemistry Laboratory of the University of Brussels.

This operation was undertaken in December 1962 by the two authors of this report, the scientific program and the equipment designed at the following institutions :

- Service de Géologie et Géochimie Nucléaires, Université Libre de Bruxelles (Belgium),
- Physikalisches Institut der Universität Bern (Switzerland),
- Laboratorium voor Fysische Aardrijkskunde, Rijksuniversiteit te Gent (Belgium).

Apart from the financial support of the N.S.F., the operation benefited from the Military Air Transport Service (M.A.T.S.) facilities and from logistical support given by the U.S. Antarctic Research Program and by the Task Force 43 of the U.S. Navy.

This report has the following three purposes :

1) As a field report to the sponsors of the Project,
2) To describe the methods of collection and preservation of samples used,
3) To set down detailed information concerning the samples brought

back for the use of the research workers carrying on the laboratory investigations.

Aim of the operation

The operation was set up to collect and bring back between 100 to 300 kilograms of solid state snow samples. The measurements and analyses are to be carried out on the following isotopes and elements :

1) natural radioactive nuclides : Pb-210 (Radium D), tritium,
2) artificial radioactive nuclides originating in nuclear weapons tests,
3) trace elements, particularly Cl, Na, K, Mg, Ca, Fe, Ni,
4) abundance, composition and origin of the insoluble particles,
5) variations in the stable hydrogen and oxygen isotope ratios.

The overall scientific interest of this program has been discussed elsewhere, particularly in the text of this project and that of N.S.F. n°AA-487 entitled : "Geochemical and isotope investigations on Antarctic ice" by E.E.PICCIOTTO.

II. CHRONOLOGY OF THE OPERATION

12 November 1962	:	Equipment and containers (total weight : 455 kg) dispatched by MATS to the United States via Châteauroux Air Force Base (France).
20 November	:	Departed Brussels for New York and Washington, by commercial air carrier.
24-28 November	:	Travel Washington-Christchurch (New Zealand) by MATS with stopovers of between 2 and 12 hours in California - Honolulu - Canton Island - Fidji Islands.

2 December : Departed Christchurch for McMurdo Station (10 hours flight).

4-9 December : McMurdo Station. Reconnaissance of the Ross Ice Shelf for later samplings.

10 December : Flight from McMurdo Station to Amundsen-Scott South Pole Station in Hercules C-130 (3 hours flight).

11-12-13 December : South Pole. Harrington House (HH) trench : stratigraphy, photography, density measurements, collection of samples for stable isotopes and for fission products.

14-18 December : South Pole. Excavation of pit P1 at about 0.5 km from the Station. Stratigraphic studies. Samples from P1.

18-21 December : Return from South Pole to McMurdo with the frozen samples in an unheated Hercules C-130. Samples stored in McMurdo Station refrigerators.

21-24 December : Ross Ice Shelf : excavation of pit RIS at 3.5 km to the South of Scott Base. Samples collected to the depth of 4.40 m.

24-25-26 December-

11 January 1963 : Visiting and lecturing tour at the following institutions : University of California at Berkeley and La Jolla ; California Institute of Technology at Pasadena ; Kansas University, Lawrence ; CRREL (U.S. Army Cold Regions Research and Engineering Laboratory), Hanover, New Hampshire.

12-13 January : Return New York - Brussels.

III. SAMPLING SITES

Samples were collected in three regions :

1) South Pole, in the neighbourhood of the Amundsen-Scott Station,

2) Ross Ice Shelf, near McMurdo Station,

3) Byrd Station.

Detailed information on the topography and meteorological conditions of these three regions will be found in the literature and reports cited in this text. We recall some facts of importance for the continuation of the work on the samples of Project n° AA-487 :

1) Region of the South Pole and the Amundsen-Scott Station

The Amundsen-Scott South Pole Station was established in the summer 1956-1957. It is situated on the Antarctic plateau at the geographical South Pole at an altitude of 2.800 m. For orientation in this area, North is defined as being in the direction of the Greenwich meridian. The N.E. quadrant around the station is reserved for glaciological study and the movements of men and machines there are kept to a minimum. The overall topography of the region is flat, with a slight slope rising towards the N.E. The mean annual temperature at a height of 2.50 m. above ground level is -49°C. The predominant winds are from the N.E. quadrant. During the summer the climatic conditions are reasonably stable with temperature from -20°C to -30°C, very little wind and little cloudiness.

The annual net accumulation is low and difficult to measure. GIOVINETTO (1960) reports an average annual accumulation of 7.4 cm of water over the last 100 years, on the basis of his stratigraphic studies. Direct measurements have only been carried out over a limited number of years. The most significant direct measurements have

been obtained using stakes installed in February 1962 which formed two perpendicular lines each of length 7 miles and centered on the Station, staked out every 0.2 miles. The accumulation from February to November 1962 as measured and communicated to us by L.ALDAZ was an average of 20 cm of snow, or about 7 cm of water. The variations at the various stakes were very large. Other groups of stakes planted in the close vicinity of the Station since 1957 indicate the same order of accumulation.

The stratigraphy of the snow cover of the Antarctic plateau has already been the subject of some reported work (GIOVINETTO, 1960 ; AVERYANOV, 1960 ; KOTLYAKOV, 1960 ; GOW, 1962). Our own observations are in good agreement with the findings of these authors.

Over the first two meters the firn is relatively homogeneous, being formed of approximately isometric grains with dimensions laying between 0.5 and 1 mm. Sublimation crystals are dispersed over the total height of the section. There is no evidence of fusion. The density ranges from 0.3 in the superficial layer to 0.40 below 0.75 m.

Over a fresh section the firn shows clear stratification (Fig.1, Ph.4a and b). This is evidenced by two types of intercalations within the homogeneous firn :

a) extremely porous layers, consisting mostly of hoarcrystals and having a thickness of from 0.5 to 2 cm,

b) iced crusts of between 1 to 2 mm thickness. The crusts frequently accompany the porous layers, their presence is clearly seen in the ramsonde profile (Fig.1).

Ths layered structure is believed to be due to a seasonal effect, the porous layers being formed under summer conditions.

Over a section of sufficient extent, it will be seen that the stratification is not always horizontal and that some layers are wedge-ended (Ph.3).

The large amount of water in the vapor phase transported through the superficial layers of firn is attested by the abundance of the sublimation crystals dispersed throughout the depth of the firn and by the striking development of hoar crystals at the surface (Ph. 1 and 2). The temperature of the firn, measured in December 1962, shows a very steep gradient. It varied between -27.7°C at a depth of 2 cm and -49.5°C at 220 cm.

As in the rest of the Antarctic, the surface of the snow is cut by sastrugi (Ph.1 and 2), the height of which varies appreciably according to the month of the year. The sastrugi are almost completely flattened at the end of the summer as a result of sublimation, deflation and by the filling of the hollows by drift snow. During our stay, sastrugi of heights up to 50 cm were frequent, a height much greater than the accumulation over a whole year.

These facts may be expected to raise appreciable difficulties in the interpretation of stratigraphic characteristics and of the stable isotope variations.

The South Pole samples were collected at three sites :

- the "Snow-Mine",
- a pit dug at about 0.5 km from the Station (pit P1),
- the trench leading to the radiation recorders shelter named "Harrington House" (HH).

a) The Snow-Mine

The Snow-Mine is a wide gallery inclined at 45° and reaching to the -26 m level as measured from the 1957 surface. The entry is situated in the Station itself. Its stratigraphy has been studied and described by GIOVINETTO (1960). Its vertical section represents an interval of over 200 years (Fig.3). This gallery is of great value for glaciological studies and was extremely useful for our Pb-210 sampling program.

We did not, however, collect any samples for chemical investigations, the danger of contamination from the Station being too great.

b) Pit P1

This pit was dug at 500 m from the N.E. of the Aurora observation dome to a depth of 2.50 m. The bottom of the pit definitely reached to layers deposed prior to the establishment of the Station, which were thus clean of any possible contamination from this source. At this distance it is unlikely that the accumulation after 1957 would have been influenced by the presence of the Station.

Stratigraphic information on the pit is collected in Fig.1. According to our interpretation, the vertical section of the profile should represent the interval between 1950 and 1962.

c) "Harrington House" trench (HH trench)

This covered trench, 2.10 m deep, was dug in 1961, and is used as the entry way to a shelter containing the radiation measuring instruments. The entrance to the trench is situated about 300 m North of the Aurora observation dome.

The stratigraphic profile is shown in Fig.2, in which the vertical

section approximately represents the interval 1952-1961. Considering the proximity of the Station, we may expect the accumulation to be slightly higher than average.

2) Ross Ice Shelf

The Ross Ice Shelf samples were collected in the vicinity of Scott Base, at about 2.5 km South of Pram Point (77°51'S-166°41'E) where we dug a shallow pit (pit RIS).

This region of the Ice Shelf has been described by STUART and BULL (1963).

The average annual temperature at Scott Base is -32°C, the summer temperature rarely rising above 0°C.

STUART and BULL studied the stratigraphy of a 7 m deep pit, dug 5 km East of Scott Base. According to them, the average annual accumulation for the period 1913-1959 is 17.6 cm of water.

Our specimens were collected to a depth of 4.25 m , with the help of the SIPRE coring auger. We were stopped at this depth by a very hard layer, probably composed of compact ice. Assuming the value of the accumulation proposed by STUART and BULL, this layer would correspond to 1954.

We were unable, due to the lack of time, to study the stratigraphy of these cores.

3) Byrd Station

Byrd Station was established in 1957 at an elevation of 1515 m in Mary Byrd Land at 79°59'S and 120°01'W. The thickness of the ice cap is estimated at 2.350 m at this site.

The mean annual ground temperature is -28°C. The predominant winds are of the N.E. and the mean annual accumulation is 18 cm of water

(GIOVINETTO, 1960).

The Byrd Station specimens were collected by members of the CRREL group in the glaciological trench between the 1962 surface-level and the 2.20 m depth at New Byrd (Fig.6).

IV. COLLECTION AND STORAGE OF THE SAMPLES

Every point in the program necessitates the taking of different precautions in collecting and storing the respective samples. It is practically impossible to devise a single collection procedure uniformly satisfactory for samples destined for radioactive measurements, chemical studies and isotopic measurements.

The plastic containers, made of 5 mm thick polyethylene, proved to be very satisfactory down to -35°C, at which temperature they became brittle. At -45°C all containers cracked when handled.

1. Radioactive nuclides

For the measurement of fission products and of Pb-210, all radioactive contamination must be avoided. Moreover, the introduction of foreign matter may give rise to an appreciable solid residue and should be avoided.

The size of the specimens lies in the range of a few kgs. The specimens were cut out with a saw made of an aluminium alloy (Antico). They were broken up and placed in wide-necked 20 litres polyethylene bottles, which had been previously rinsed out with nitric acid followed by thrice-distilled water. The gross fragments were broken up with an aluminium bar and packed into the containers.

Some samples were, however, collected by horizontal or vertical drilling with the hand drill or by pushing 1 meter long aluminium

tubes of 10 cm diameter into the walls of the pits.

a. Fission products

Samples, for the measurements of fission products and of the present Pb-210 concentration, of a total weight of about 290 kg, were collected in the following localities :

- South Pole, HH trench

A continuous section of the wall was cut in such a way as to result in a sample of about 10 kg weight for each year between 1949 and 1960 (12 samples n° HH-1949 to HH-1960, Fig.2).

- South Pole, pit P1

A discontinuous set of 10 samples was obtained by horizontally pushing an aluminium tube into the wall at intervals of 20 cm between the level -10 cm (1961) and the level -190 cm (estimated to be 1952). This set gives the samples P1-10 to P1-190 (Fig.1, Ph.6).

- Ross Ice Shelf

A continuous sampling was made between the zero and -4.25 m level from the wall of the pit RIS, and by vertically drilling into the bottom of the pit (5 samples RIS-1 to RIS-5, Fig.5).

- New Byrd Station

A continuous sampling was made between zero and -2 m from the CRREL glaciological trench, by members of the CRREL summer team (samples B3 to B24).

The samples corresponding to 1961 and 1962 were collected on the surface. (Samples B1 and B2) (Fig.6).

b. Pb-210

In order to measure the Pb-210 concentration as a function of depth, samples of between 2 and 10 kg were collected in the Snow-Mine

at the Amundsen-Scott South Pole Station. These samples were collected at the following levels (in feet) : 11-12, 24-25, 35-36, 55-56, 79, 80-83 (samples SM 11-12 to SM 80-83, Fig.4).

According to the estimates of GIOVINETTO, this series would correspond approximately to one specimen every 20 years between 1830 and 1940, each samples covering an interval of 2 to 3 years.

2. Chemistry and insoluble particles

For this particular program a minimum level of foreign matter contamination is necessary.

We considered the local conditions unsuitable for the immediate treatment of the specimens and therefore adopted the following procedure : the firn blocks cut out with the Antico saw are smoothed to a regular parallelepiped shape (approximately 40 x 30 x 30 €m), using an Aluman saw (aluminium alloy, a spectrographic test shows no detectable Ni, Co, Fe or Mg).Every block is wrapped in a sheet of plastic and placed in a snow-packed wooden case (Ph.5). The whole cargo was brought back in the frozen state and was never allowed to melt. Before use, the outer layer will be recut in a dust free refrigerated room.

All the samples originate from pit P1 at the South Pole (samples P1-A1 to P1-A7, B1-B1 to P1-B9 and BB0-15 to BB0-18, about 130 kg in all) (Fig.1).

3. Stable isotopes

The samples for this measurement should have a volume of about 100 cc each. The only noteworthy precaution to be taken is avoiding any evaporation of the samples. The samples are broken up and packed in wide-necked 100 cc polyethylene bottles.

The samples originated in the following localities :

- South Pole, HH trench : every 2 cm between 0 and -204 cm (samples HH-0 to HH-204)
- South Pole, pit P1 : every 2 cm between 0 and -178 cm (samples P1-2 to P1-150)
- Ross Ice Shelf,RIS pit: every 5 cm between 0 and -420 cm (samples RIS-1 to RIS-85)

Transport of the samples

All the South Pole samples were flown to McMurdo Station in a special flight, the cabin temperature of the Hercules C-130 being held below the freezing point. The stable isotopes samples were allowed to melt at room temperature. They were flown from California to Brussels by commercial line and were stored at -20°C on arrival. It turned out that the containers should have been more tightly sealed for air shipment. Unfortunately a number of bottles emptied their content due to the bow being turned upside down and to the low pressure of the aircraft.

The other samples were kept at -15°C at McMurdo Station and later dispatched to Davisville (Rhode Island) in the refrigerated hold of the U.S.S. ARNEB. The 980 kg of cargo was freighted to New York by refrigerated truck, where it was transferred to the refrigerated hold of the M.S. Mormac Pride (McCormac Lines). On arrival at Antwerp, the cargo was freighted by refrigerated truck to cold storage. About 100 kg of samples intended for chemical measurements were transported to the Institute of Physics of the University of Bern by refrigerated truck.

Inspection of the samples at their arrival showed no evidence of melting.

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We acknowledge the collaboration of the CRREL team at Byrd Station (Messrs R.ROWLAND, T.PAVLAK, G.HENDRIKSON) in collecting the samples at this Station for us.

The writers thank all the U.S.Navy personnel of Task Force 43, who furnished transportation for the field work.

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FIGURES

Fig.1. Pit P1 in the vicinity of the Amundsen-Scott South Pole Station.
Description of the profile and localization of the various samples. A tentative time scale is given on the right side of the figure.

Fig.2. Harrington House trench, in the vicinity of the Amundsen-Scott South Pole Station.
Brief description of the trench, localization of the various samples.

Fig.3. Photo and stratigraphic profile of a section of the wall of the Harrington House trench.

Fig.4. Amundsen-Scott South Pole Station.
Localization of the Snow-Mine samples for Pb-210 measurements.

Fig.5. Ross Ice Shelf, Pit RIS.
Localization of samples for the study of fallout and stable isotopes.
List of the samples of precipitation at McMurdo Station and at Amundsen-Scott South Pole Station.

Fig.6. Byrd Station.
Localization of samples collected in the CRREL trench, for the fallout measurements.

PHOTOGRAPHIES

Photos 1 and 2. The snow surface near the South Pole in December 1962. Hoar crystals are well developed and cover the whole surface. The sastrugi are often 50 cm high, which represent the accumulation of about two years. Their base is eroded by wind action. In summer the hollows may be filled up with drifting snow. The undercut noses of the sastrugi bend down so that a snow layer may become burried under earlier deposited snow that drifted afterwards. This may cause difficulties and errors in the interpretation of the stratigraphy and of the stable isotope ratio variations (see photo 5).

Photo 3. Upper part of the W wall of pit P1.
Fine grained layers are seen to wedge out. Thus a counting of the annual layers will yield different numbers of years depending of the position of the section.

Photo 4 a and b At about 0.5 km West from pit P1 a 2.50 m deep trench was dug by a bulldozer. The height of the shovel is 75 cm.
Stratification is very well pronounced and may be traced over the whole profile.

Photo 5. At pit P1. Firn blocks are sawn out from layers deeper than 1.60 m (older than 1956-1957).

Photo 6. Sampling in the wall of pit P1.

LIST OF SAMPLES

Program	Location	Sample n°	Depth (cm)	Container	Weight (kg)	Estimated year
Fallout	South Pole Pit P1	P1 10	6-14	Al tube	1.4	1961
		P1 30	26-34	"	"	1960
		P1 50	46-54	"	"	1959
		P1 70	66-74	"	"	1958
		P1 90	86-94	"	"	1957
		P1 110	106-114	"	"	1956
		P1 130	126-134	"	"	1955
		P1 150	146-154	"	"	1954
		P1 170	166-174	"	"	1953
		P1 190	186-194	"	"	1952
		P1 1962	surface	polyeth.bottle	8	1962
		P1 1961	10-25	"	8	1961
	South Pole HH trench	HH 1960	6-16	polyeth.bottle	8	1960
		HH 1959	16-34	"	8	1959
		HH 1958	34-55	"	8	1958
		HH 1957	55-73	"	8	1957
		HH 1956	73-88	"	8	1956-1957
		HH 1955	88-103	"	8	1955-1956
		HH 1954	103-118	"	8	1955
		HH 1953	118-133	"	8	1954-1955
		HH 1952	133-153	"	8	1954
		HH 1951	153-168	"	8	1953
		HH 1950	168-188	"	8	1952
		HH 1949	188-208	"	8	1951
	Ross Ice Shelf	RIS 1	0-100	"	8	1961-1962
		RIS 2	100-185	"	8	1959-1960
		RIS 3	185-270	"	8	1957-1959
		RIS 4	270-355	"	8	1956-1957
		RIS 5	355-440	"	10	1954-1955
	Byrd Station CRREL trench	B1	surface	polyeth.	7	1962
		B2	"	"	7	1961
		B3-B11	0-101.6	9 polyeth.tubes	14.4	-
		B12-B22	101.6-200.7	11 " "	17.6	-
		B23	200.7-209.5	5 " bottles	7	-
		B24	209.5-218.4	4 " "	7	-

Ra D	South Pole Snow-Mine	SM 11-12	536- 566	2 Al tubes	3.2	1940-1939
		SM 11-12	"	1 polyeth.	8	"
		SM 24-25	732- 763	2 Al tubes	3.2	1918-1917
		SM 24-25	"	1 polyeth.	8	"
		SM 35-36	1068-1098	2 Al tubes	3.2	1896-1894
		SM 35-36	"	2 polyeth.	16	"
		SM 55-56	1678-1078	2 Al tubes	8	1851-1850
		SM 55-56	"	1 polyeth.	8	"
		SM 79	2410	1 Al tube	1.6	1781
		SM 80-83	2440-2532	1 Al tube	1.6	1778-1770
Dust Chemistry	South Pole Pit P1	P1 A1	160-200	plastic box	5	1953-1952
		P1 A2	"	"	"	"
		P1 A3	"	"	"	"
		P1 A4	"	"	"	"
		P1 A5	"	"	"	"
		P1 A6	"	"	"	"
		P1 A7	"	"	"	"
		P1 B1	200-240	"	"	1952-1950
		P1 B2	"	"	"	"
		P1 B3	"	"	"	"
		P1 B4	"	"	"	"
		P1 B5	"	"	"	"
		P1 B6	"	"	"	"
		P1 B7	"	"	"	"
		P1 B8	"	"	"	"
		P1 B9	190-230	1 plastic	"	"
		BBO 15	175-240	1 block in wooden case	12	1952-1950
		BBO 16	"	"	"	"
		BBO 17	"	"	"	"
		BBO 18	"	"	"	"
Stable isotopes	South Pole Pit P1	P1 150 to P1 2 and P1 100 to P1 72	0-150 every 2 cm	90 polyeth.bottles	0.596	1962-19
	South Pole HH trench	HH 0 to HH 204	0-204	98 polyeth. bottles	0.667	1960-19
	Ross Ice Shelf	RIS 1 to RIS 85	0-400 every 5 cm	85 polyeth bottles	0.598 to 1954	1961-19 -19
	McMurdo Station	07/12/ 1962	precipi-tation	1 polyeth	0.010	
		08/12/ 1962	"	"	"	

S A M P L E S

Cosmic dust | Fallout | Stable-Isotopes

Depth (cm)

0 10 20 30 40 50 60 70 80 90 100 10 20 30 40 50 60 70 80 90 200 10 20 30 40 50

1962
1961

P1 10
P1 30
P1 50
P1 70
P1 90
P1 110
P1 130
P1 150
P1 170
P1 190

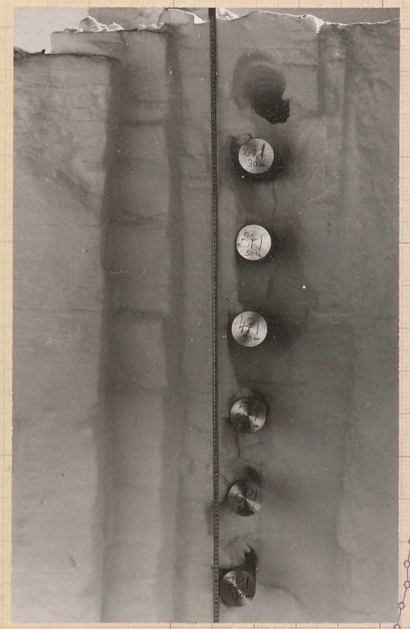
P1 150
P1 2
P1-100
P1-72

P1A1 to P1A7

BB015 to BB018

P1B1 to P1B8

P1B9



Temperature (-°C)
50 45 40 35 30 25

Ram hardness (kg)
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10

Stratigraphic profile

Density (kg/m^3)
100 200 300 400 500

Grain size (mm)
2 4

Year
1962 1961 1960 1959 1958 1957 1956 1955 1954 1953 1952 1951 1950

Ice crust
Depth hoar

Pit P1 situated at 500 m North-east of the station, near the 3rd pole of the new field

Grid North / Flag (5000')
main sastrugi direction
wall described
aurora dome

Dug on December 14 1962

Cosmic dust samples	on	December 15, 18, 19,	1962
Ramresistance	on	December 16 ,	1962
Stratigraphic description	on	December 16 ,	1962
Fallout samples	on	December 17, 18, 20,	1962
Stable isotopes samples	on	December 19 ,	1962

AMOUNT AVAILABLE OF SAMPLE.

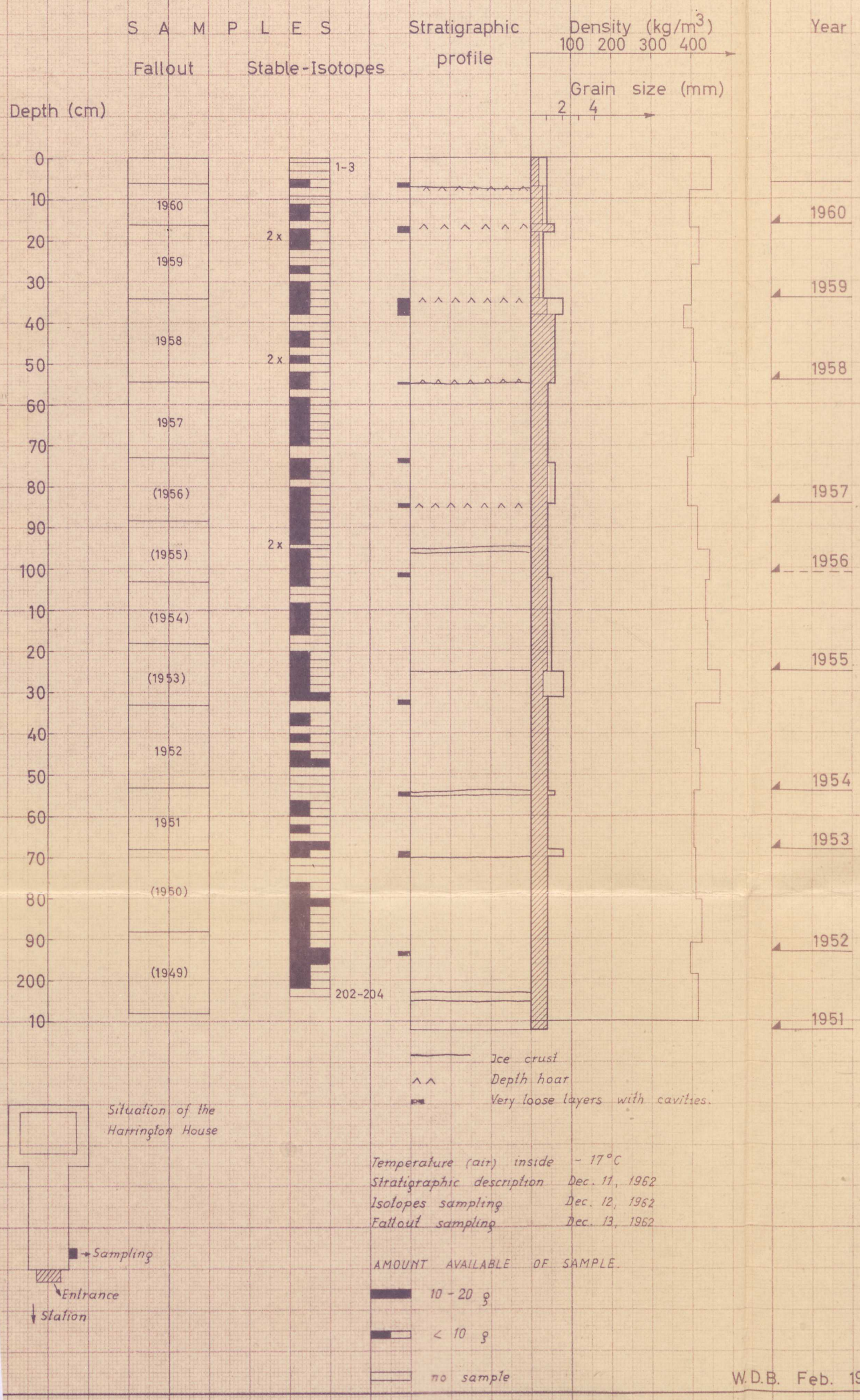
10 - 20 g
< 10 g
no sample

AMUNDSEN-SCOTT SOUTH POLE STATION
PIT 1.

W.D.B. Feb. 1963

Fig 2

AMUNDSEN - SCOTT SOUTH - POLE - STATION
HARRINGTON - HOUSE



Temperature (air) inside - 17°C
Stratigraphic description Dec. 11, 1962
Isotopes sampling Dec. 12, 1962
Fallout sampling Dec. 13, 1962

AMOUNT AVAILABLE OF SAMPLE.

10 - 20 g

< 10 g

no sample

W.D.B. Feb. 1963

HARRINGTON HOUSE

Fig 3

LEGEND

Ice crust

Depth hoar

(very) Loose layer

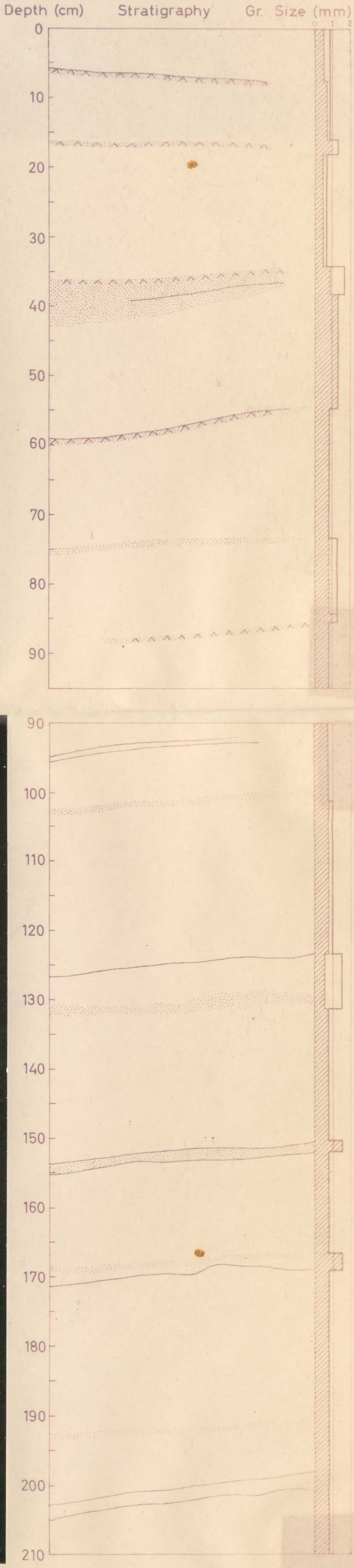
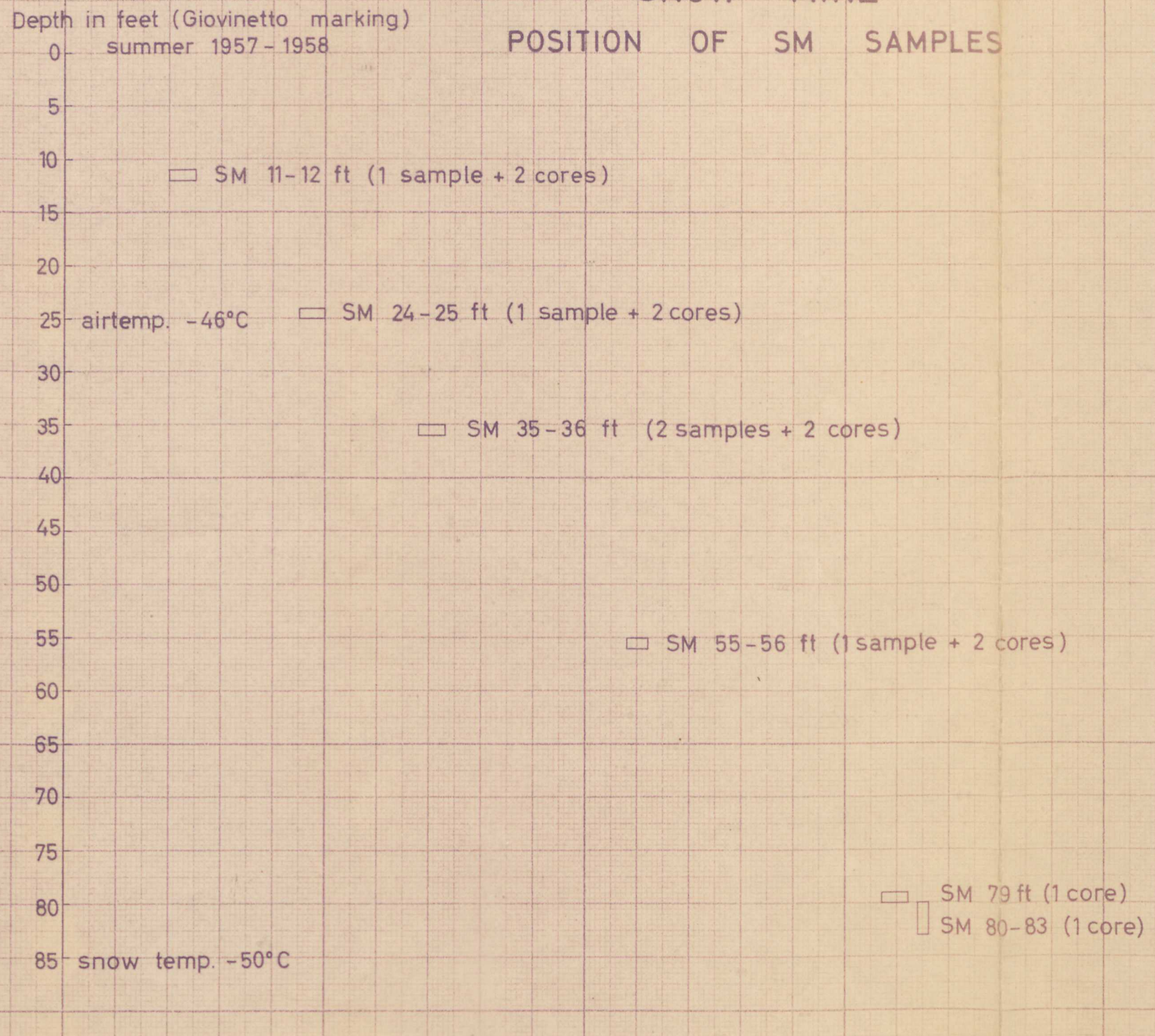


Fig. 4

AMUNDSEN - SCOTT SOUTH - POLE - STATION

SNOW MINE

POSITION OF SM SAMPLES



Sampling on December 18 and 21 1962.

Fig 5

ROSS ICE SHELF

Position of samples

Depth (cm)

0
50
100
50
200
50
300
50
400

RIS 0-100 (pitwall)

RIS 100-185 (4 cores)

RIS 185-270 (3 cores)

RIS 270-355 (3 cores)

RIS 355-440 (3 cores)

1
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85

3,5 km South-east of Scott Base (New-Zealand)
Sampling on December 22, 1962.
Pit of 100 x 200 x 100

Amount available
10 - 20 g.
< 10 g.
no sample

Precipitation samples

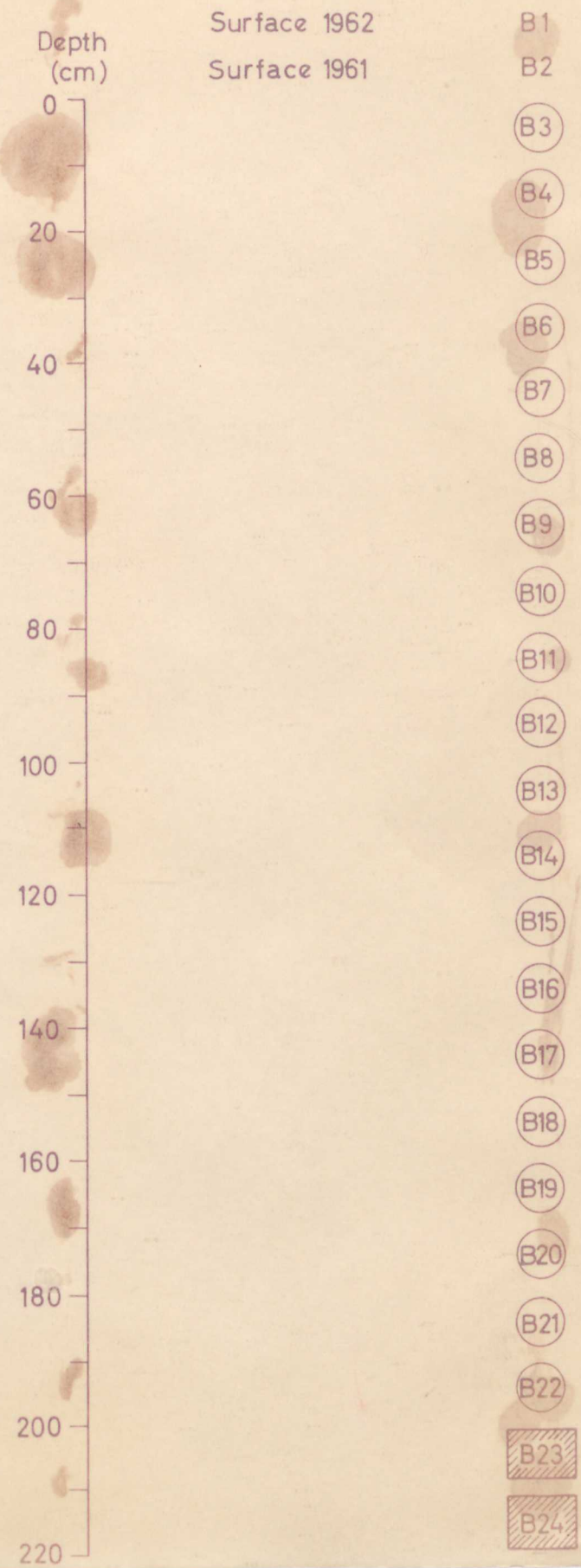
Mc Murdo Pr 07, 12, 1962 22 00 h
Mc Murdo Pr 08, 12, 1962 nuit 7-8 0900 h
Amundsen-Scott Pr P1 15, 12, 1962
Amundsen-Scott Pr P1 16, 12, 1962 la nuit du 15 au 16 ou pendant 16
Amundsen-Scott DD P1 20, 12, 1962

W.D.B. Feb. 1963

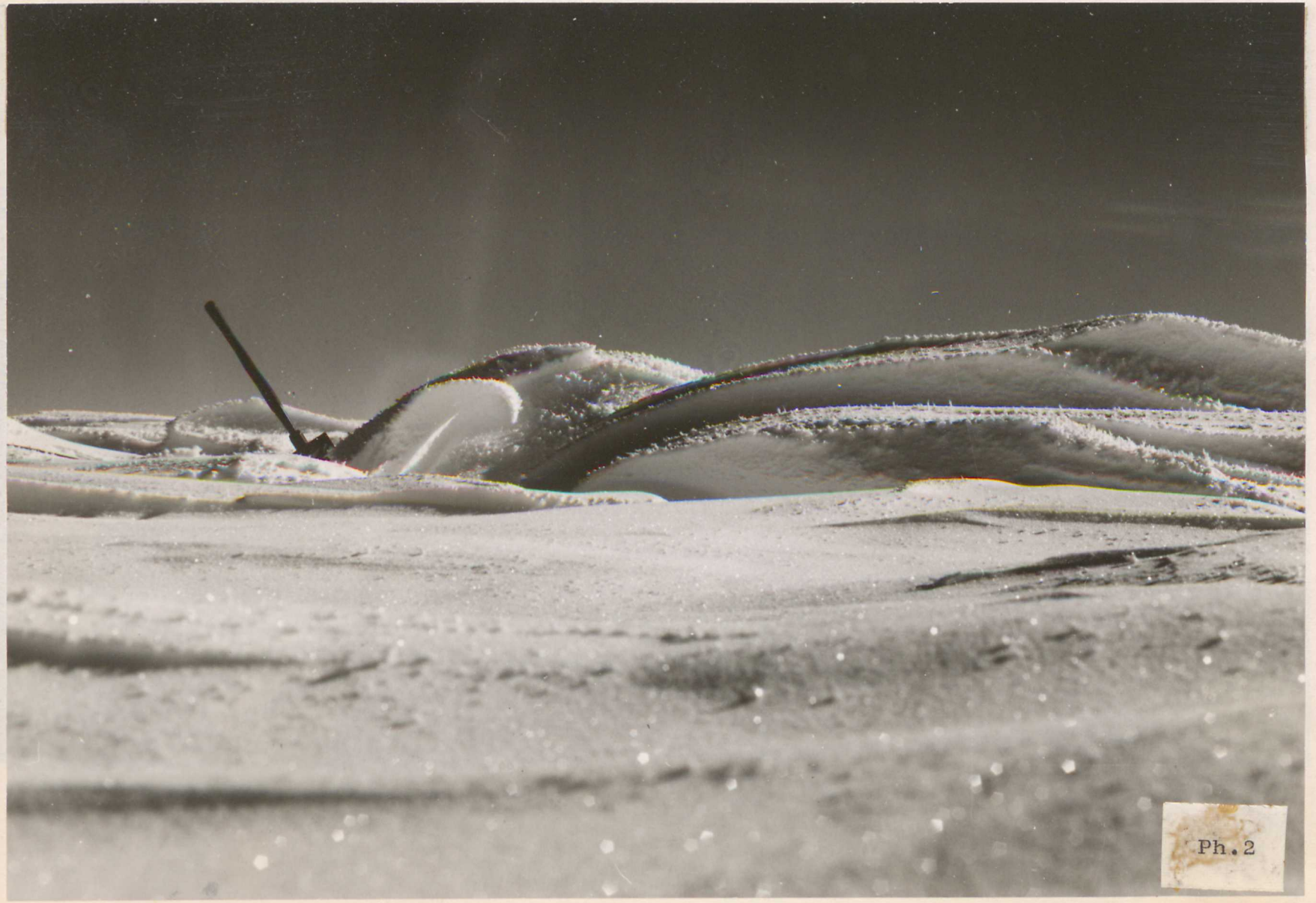
Fig. 6

BYRD STATION
CRREL TRENCH

Position of Samples

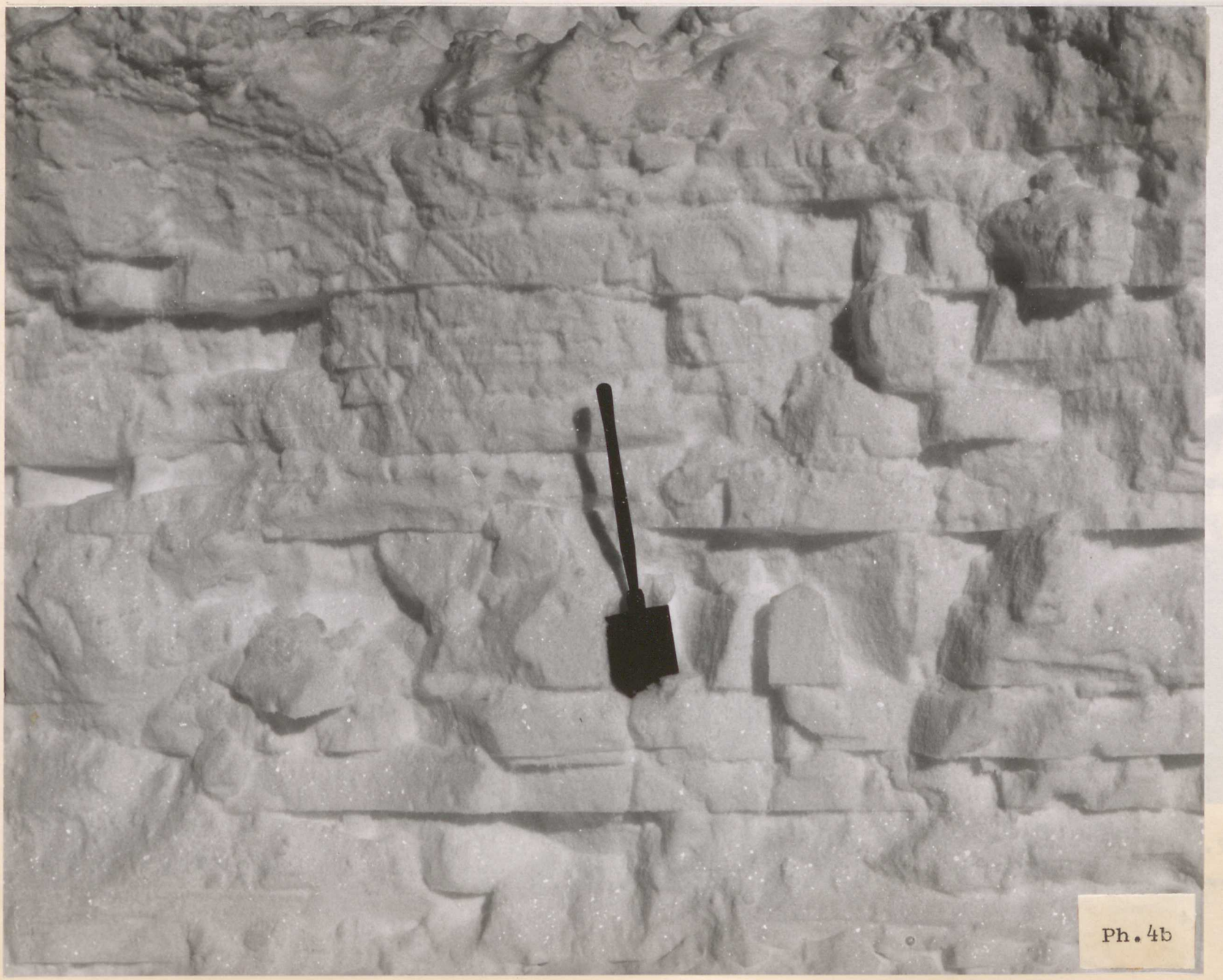


Ph.1


Ph.2


Ph. 3

Ph.4a



Ph. 4b

Ph. 5

Ph.6