of the Antarctic ice sheet results in the invasion by ice of a region to which glacierization is not characteristic. This invasion of ice is accompanied by a sharp change in the water-substance and heat balance of the earth's surface and a considerable change in climatic conditions.

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GLACIER OBSERVATIONS IN NORTH-WEST SPITSBERGEN

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ABSTRACT. Results of observations on several glaciers in the Kongsfjord area are described, and comments are made concerning accumulation and ablation, glacier flow and the variation of glacier fronts. The findings are compared with those of previous workers in this district and, in particular, with those of H. W. Ahlmann. A history of the fluctuation of several ice fronts during the present century has been compiled from various sources, and some observations dating back to 1837 are mentioned.

ZUSAMMENFASSUNG. Die Resultate von Beobachtungen an mehreren Gletschern in der Nähe von Kongsfjorden werden beschrieben, mit Bemerkungen über Zuwachs und Abtrag, Gletscherbewegung und die Änderung der Gletscherenden. Die Ergebnisse werden mit früheren aus derselben Gegend verglichen, vor allem mit denen von H. W. Ahlmann. Eine Geschichte der Schwankungen mehrerer Gletscherenden während dieses Jahrhunderts wird aus verschiedenen Quellen zusammengestellt, die zum Teil bis 1837 zurückgehen.

INTRODUCTION

During the summer of 1955 an expedition from Nottingham University visited the Kongsfjord area of Vestspitsbergen to examine the geology and glaciology of the region. Owing to a last minute disruption of transport arrangements the period spent in the field was much shorter than had been planned, and a comprehensive glaciological study became impossible.

The area is shown in Fig. 1 (p. 63). Names used in inverted commas are intended to facilitate reference. Two journeys to the accumulation areas of the Kongsbre system were made and the snouts of glaciers terminating in Kongsfjorden were mapped. During a boat journey to Krossfjorden the margin of Fjortende Julibreen was also surveyed. Flow measurements were made on two sections of Kongsbreen and on Blomstrandbreen.

Weather conditions generally were very poor.

ACCUMULATION AND ABLATION

In 1934, during a detailed study of Fjortende Julibreen Glacier, H. W. Ahlmann[1] plotted a number of firn profiles on Isachsenfonna. A pit was dug in the same area and at the same altitude in August 1955, and the profile shown in Fig. 2 (p. 65) was drawn. The system of dates adopted is believed to be correct, but some mention of the uppermost ice band must be made. Although this might be expected to mark the 1954 surface, its occurrence without change of thickness in a series of small pits dug at altitudes from 850 m. down to a little above 600 m. leads to the belief that it is a false band. It may have been formed during a warm spell in December 1954. Specific gravity measurements were made at the points indicated by circles in Fig. 2, and the values were then adjusted for ice content in the manner mentioned by Ahlmann. In the lower, heavily-iced layers the values were taken to the lowest reasonable figure. The profile was plotted on 15 August and a generous allowance for ablation after that date was made (200 mm. of water, or about 14 days' steady ablation). Ahlmann took the snow surface on 15 August 1934 as the upper limit of the 1933–34 layer.

The average annual surplus for the period 1945–55 was 277 mm. of water. Leaving out the exceptional 1954–55 layer, the average over the 9-year period 1945–54 was 262 mm. of water. The average annual surplus between 1924 and 1934 was 200 mm. of water. This value was calculated from three profiles covering 10 years and four shorter profiles. The 1955 profile is best compared with those from the deep pits of 1934. From Table I it will be seen that Station VIII yielded the highest annual average for any one pit, the amount being 235 mm. of water. The depth of a 10-year accumulation appears to have increased, but the equivalent overall specific gravity is the same.

TABLE I

Pit		*Annual Layers*										*Total*	*Average*
		1945/46	1946/47	1947/48	1948/49	1949/50	1950/51	1951/52	1952/53	1953/54	1954/55		
1955	Thickness, cm.	57	38	27	25	37	52	28	65	63	79*	471	
	Spec. grav.	0·62	0·60	0·64	0·64	0·62	0·61	0·62	0·61	0·54	0·51		(0·59)
	Equiv. water, cm.	35·4	22·1	17·3	16·0	22·9	31·4	17·4	39·7	34·0	40·3	276·5	27·7
		1924/25	1925/26	1926/27	1927/28	1928/29	1929/30	1930/31	1931/32	1932/33	1933/34		
1934 Station I	Thickness, cm.	46	20	22	43	38	30	40	56	50	53	398	
	Spec. grav.	0·64	0·65	0·62	0·62	0·55	0·63	0·58	0·54	0·56	0·56		(0·59)
	Equiv. water, cm.	29·5	13·0	13·6	26·7	20·9	18·9	23·2	30·3	28·0	29·7	233·8	23·4
1934 Station V	Thickness, cm.	44	16	27	38	38	30	35	62	50	54	394	
	Spec. grav.	0·66	0·59	0·62	0·56	0·52	0·69	0·58	0·56	0·56	0·54		(0·58)
	Equiv. water, cm.	29·1	9·4	16·8	21·3	19·8	20·7	20·3	34·8	28·0	29·2	229·4	22·9
1934 Station VIII	Thickness, cm.	40	20	26	40	40	35	30	60	50	55	396	
	Spec. grav.	0·61	0·61	0·64	0·60	0·52	0·65	0·58	0·61	0·58	0·56		(0·59)
	Equiv. water, cm.	24·4	12·2	16·6	24·0	20·8	22·8	17·4	36·6	29·0	30·8	234·6	23·5

* Reduced value.

No ablation measurements were made, but during the early part of August it was estimated that the recrystallized firn on the surface of Kongsbreen at 350 m. was being melted at a rate of about 5 cm. per day.

On 1 August a pit was dug down to the ice at the "Dorking North" camp (altitude approximately 650 m.) and a cover of 86 cm. of firn was measured. On 4 August, after a spell of bad weather, two more pits were dug and the mean cover was then found to be 94 cm. The first pit was cleaned out again on 16 August and a cover of 93 cm. still remained. During the first half of August, therefore, a rough balance obtained at this altitude, and accumulation probably exceeded ablation above 650 m.

Frequent deposition of hoar was experienced at altitudes above 500 m. Skins of ice often formed on the tents and, if snow was not falling, the snow surface would be given a brittle crust. Ski standing upright could collect a layer of ice 2 cm. thick overnight. It was noticed that new snow was sometimes stabilized by the deposition of hoar. This is of interest, as it has been mentioned previously by several writers that large quantities of snow are transported by wind action from high areas down the glaciers and into the fjords during the winter.

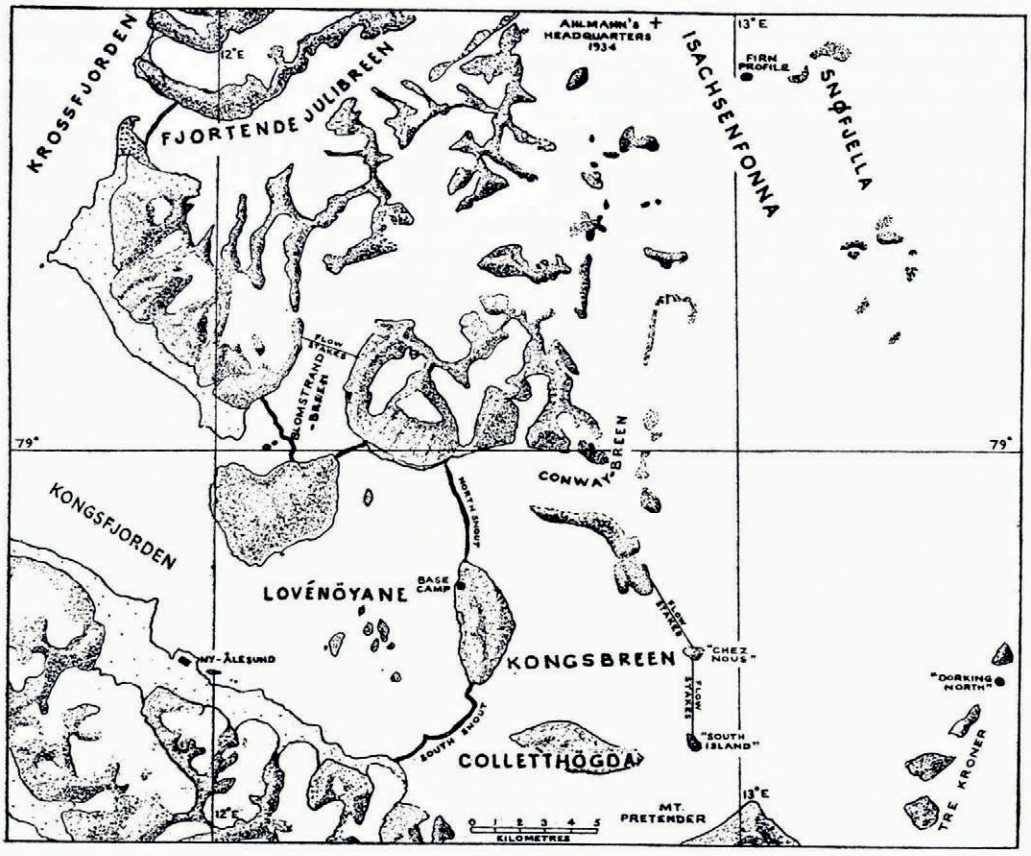

Fig. 1. Map of the area

Another transfer of material from high to low areas in the form of melt water was noticed. Most of the melt water seemed to follow surface drainage routes, and in the area immediately west of Tre Kroner a number of fairly large lakes had formed. It was also discovered that some concealed lakes existed in snow-filled depressions. It is likely that much of this water would be transformed into glacier ice in the autumn. Some time between 10 and 18 August two lakes were completely drained, and the bed of one of them was examined. Several new crevasses were seen and the ice was covered by a layer of detritus, much of which was believed to have come from nearby screes. A short but marked intensification of a discoloured current issuing from the south snout of Kongsbreen was tentatively assumed to have been caused by one of these sudden drainages.

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Firn Limit

On 23 July the snow line was at about 320 m. on Kongsbreen. By 30 July it had risen to 350 m. and on 10 August had reached 380 m. The last observation on 22 August gave the altitude as about 410 m. and it was believed that the firn line for 1955 would not have been higher than 450 m. above sea level.

A. Hoel[2] determined the altitude of the firn line on Lilliehöökbreen as 400 m. during the period 1907–12. H. Ritter's observations in 1931 and 1932[3] gave the elevation of the firn line in the Kongsfjord area as 350–400 m. In 1934 Ahlmann found that the firn line on Fjortende Julibreen was at a height of 650 m.[1]. From an examination of the aerial photographs taken by B. Luncke in 1936 it would seem that the firn limit on Kongsbreen was not lower than 550 m. in that year.

Pit digging did not yield much information owing to the difficulty of differentiating between refrozen water and wet firn and the glacier ice proper.

Glacier Flow

Flow measurements were made on Blomstrandbreen and two sections of Kongsbreen at the places shown in Fig. 1. The movements are shown diagrammatically in Figs. 3 (p. 65) and 4 (p. 66). The measurements on Blomstrandbreen were made 3 km. (Fig. 7, p. 53) from the snout at an altitude of 300 m. and showed a maximum speed of 21 cm. per day (Fig. 3). This glacier is similar in character to its immediate neighbour, Fjortende Julibreen, which was found by Ahlmann to have a maximum speed of 12 cm. per day 6 km. from the snout and at an altitude of 300 m.[1].

It will be seen that the ice to the north of the "Chez Nous" nunatak has quite a high rate of flow, the maximum speed being 61 cm. per day. The section between "Chez Nous" and "South Island" showed a maximum rate of movement of 22 cm. per day (Fig. 4). This ice stream makes an almost negligible contribution to the ice front.

Margin Variations

In Fig. 5 (p. 65), the 1955 position of the ice front of Fjortende Julibreen is compared with earlier positions as presented by Ahlmann[1]. There has been a considerable advance of up to 700 m. from the 1934 position, although the ice cliffs are still about 300 m. back from their 1906 line. It is interesting to note the change in shape of the ice front between 1934 and 1955.

The main front of Blomstrandbreen had retreated up to 480 m. from the 1928 position. According to Hoel[4] the front of this glacier was in approximately the same position in 1861 and 1892, but between 1892 and 1907 it receded 700–800 m. Between 1907 and 1911 there was an advance, and from 1911 to 1928 there was no appreciable movement. In the period 1928–1932 there was a recession of 250 m. Two islets, one of which was causing a bulge in the 1928 ice front, have now been revealed, although the smaller one bears a large block of glacier ice. The distance from this stranded ice to the snout is nearly 100 m. The 1936 aerial photographs show the larger islet clear of the glacier and carrying a block of ice, while the smaller is partly visible where the ice front projects. The small east snout of this glacier has retreated about 180 m. since 1906.

Some variations in the margins of the Kongsbre system are indicated in Fig. 6 (p. 65). Previous changes in the north snout have been recorded: in 1837 it was considered to have receded 300 m. from an earlier position, and in 1861 it was of the same extent as in 1907. Between 1861 and 1869 it advanced and subsequently receded, but its front in 1897 was about 100 m. further forward than in 1907. There was a retreat between 1907 and 1924, but from 1924 to 1932 there was no appreciable movement. The 1955 position is about 950 m. behind that of 1906. A comparison of photographs leads to the belief that there is little difference between the 1936 and 1955 positions. Conwaybreen is thought to be the dominating factor in changes of this ice front. A well-defined trim line on the south side of the Stemmeknausane ridge was found to be 40 m. above the present glacier surface at a point 2 km. from the ice front.

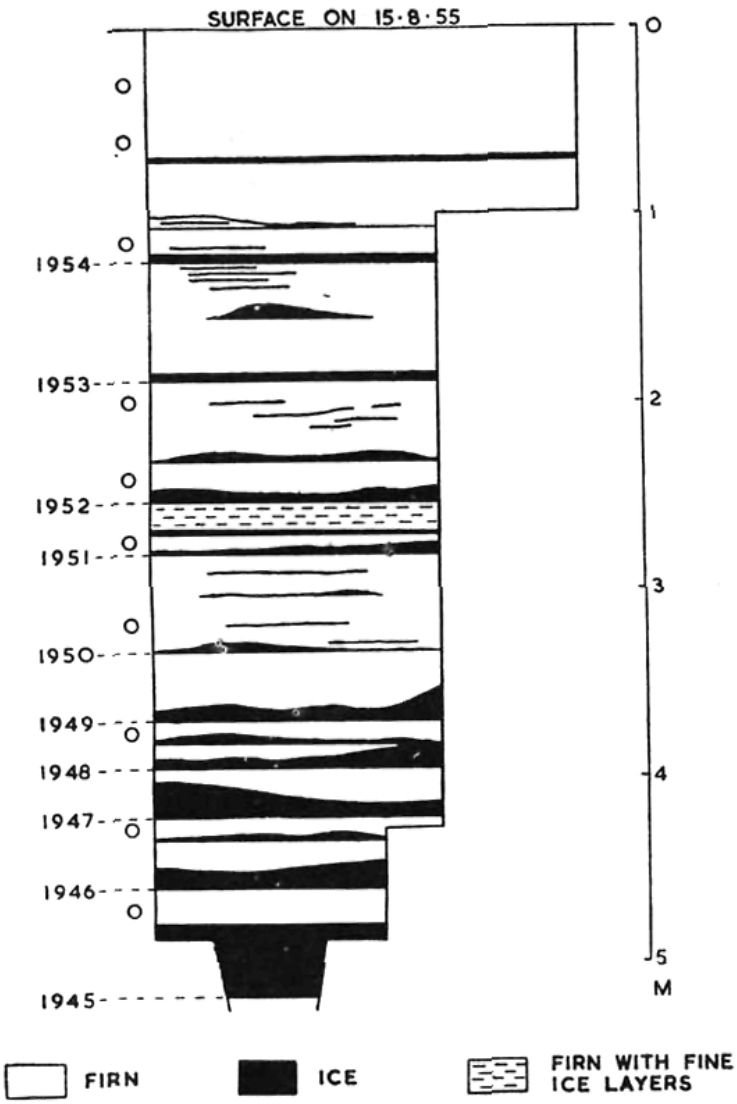

Fig. 2. Firn profile drawn on 15 August 1955, at an altitude of 850 m. on Isachsenfonna

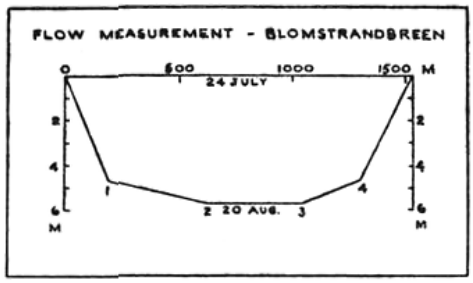

Fig. 3 (above). Movement of stakes on Blomstrandbreen between 24 July and 20 August

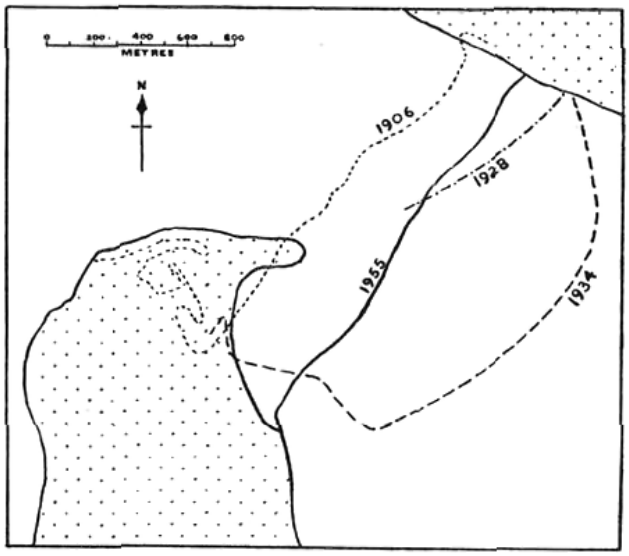

Fig. 5 (centre). Snout of the Fjortende Julibreen in July 1069, July 1928, August 1934 and August 1955

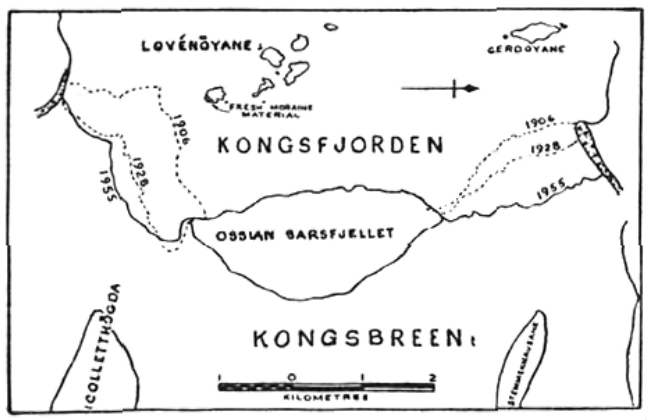

Fig. 6 (below). Margin variations in the Kongsbre system

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The south snout is now up to 1000 m. behind its 1906 line. A. Koller recorded a recession of 250 m. between 1928 and 1932, which would place the 1932 front close to the 1955 position. Moraine material on one of Lovénöyane (Fig. 6) probably marks the maximum extension of the glacier in recent times.

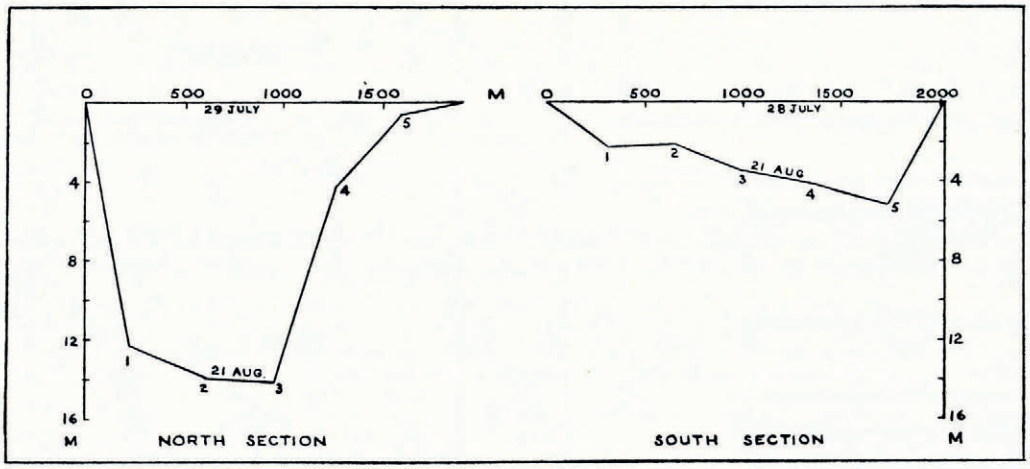

Fig. 4. Movement of stakes on part of Kongsbreen

Conclusions

1. The annual accumulation surplus in this region appears to have increased in recent years.
2. The firn line in the Kongsfjord area may vary in height a good deal from year to year.
3. The glaciers are in a strongly active state.
4. There has been an overall drop in the rate of recession of these glaciers since 1936 or thereabouts. In contrast, Finsterwalderbreen, which lies about 160 km. to the south, had a fairly constant total volume of ice between 1920 and 1936 but decreased in volume from 1936 to 1950 [5].
5. Variations of glacier margins not representative of climatic fluctuation may occur. F. E. Matthes' statement on periodic flows provides an explanation of this [6].

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