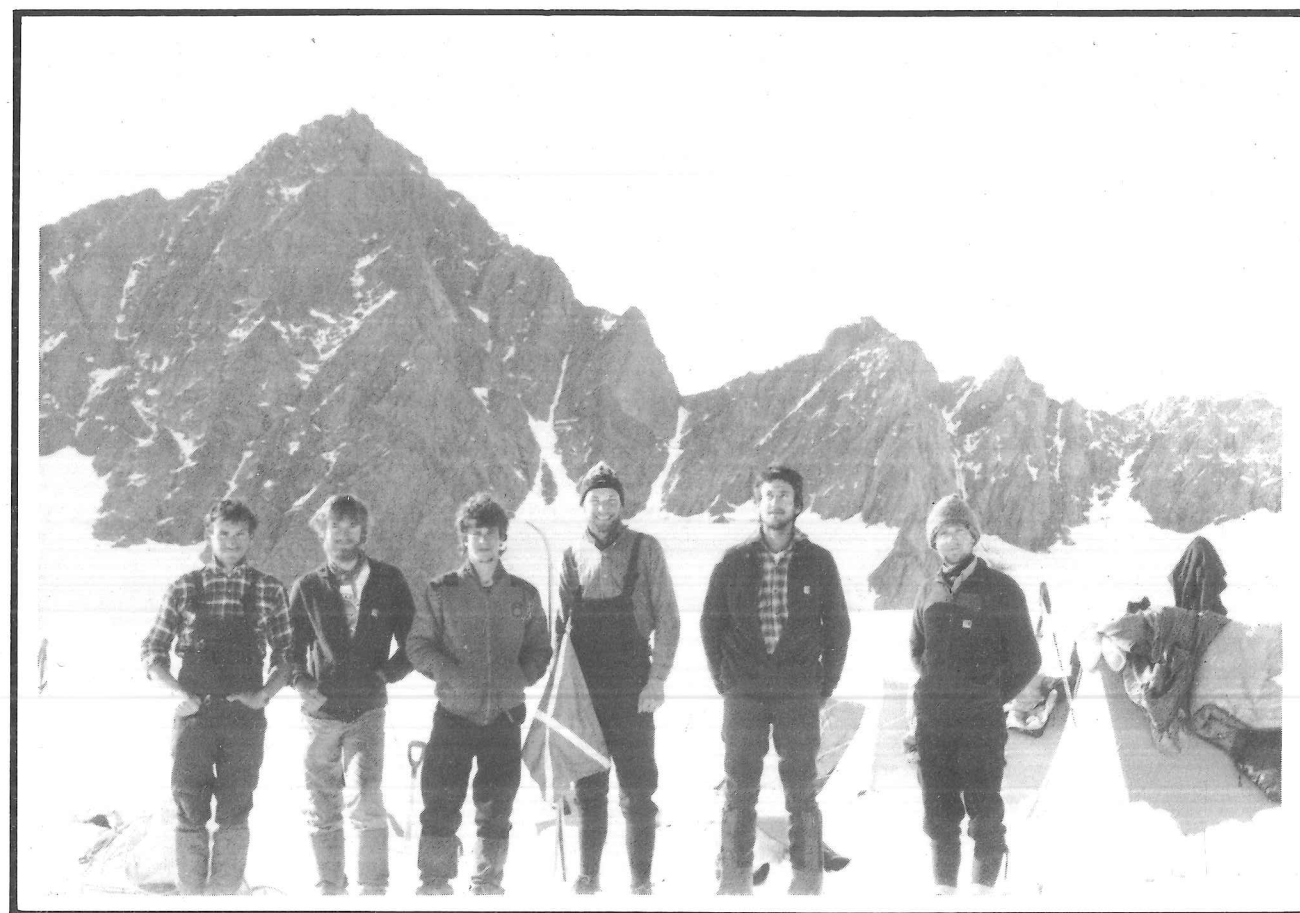




EDINBURGH UNIVERSITY
EAST GREENLAND
EXPEDITION 1982

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[1982]

REPORT



SIMON PETE NICK HUGH DAVE CHARLES

EDINBURGH UNIVERSITY EAST GREENLAND EXPEDITION 1982

Patron: The late Lord Birsay K T

Nick Rose (Geologists; Leader)

Hugh Mackay (Geologist; Equipment)

Dave Thomson (Geologist; Research)

Pete Brownsort (Chemist; Food)

Simon Durkin (Engineer; Treasurer)

Charles Morton (Medical Student; M.O.)

A report of the Activities and findings of the expedition, which visited the Kruuse Fjord region of East Greenland in July and August 1982.

Names of Features

During the course of the expedition we named a number of peaks and other topographical features, mainly in the vicinity of our basecamp. These names are used in this report, however they are not, as yet officially recognised.

Introduction and Narrative

Nick Rose

"The Kruuse Fjord is not the easiest place in the world to visit". So began the first line of a letter we received upon declaring our intention to go there. When we eventually reached it in July 1982 none of us had much difficulty in accepting this rather prophetic statement.

I can't remember exactly when the idea for an expedition was first proposed, various people suggested that four years of student life would be well rounded off by an adventure of sorts and eventually a small group formed in mid-1981. I think we chose Greenland because we imagined it would be more accessible than the greater ranges, an idea which couldn't have been further from the truth.

Initial planning consisted of research into various regions, much advice was sought and contact made with the Greenland 'mafia'. The mountains at the head of the Kruuse Fjord, first suggested to us by Dave Matthews, seemed to combine the qualities of geological interest (consisting of a little known layered gabbro) with an ideal setting in a relatively unexplored part of East Greenland. Only the 1978 Westminster expedition had penetrated this far into the Kronsprins Frederiks Bjerger overland.

During the autumn of 1981 and early 1982 we worked hard at raising the necessary funds and assembling food and equipment. The mound of gear on my living room floor grew steadily until one day we crammed it all into a huge crate, built in situ, a few tense moments were spent easing it through the window. We were greatly encouraged by the generosity of various companies and organisations that donated food, equipment and money.

When the gear was shipped in June we thought we had everything taped. The plan seemed simple enough: Fly to Greenland, charter a boat or helicopter to drop us off in the coastal region north of Angmagssalik and continue across the glacier systems using skis and man-hauled sledges, taking advantage of the reputed but seemingly fictitious "settled Greenland summer". Logistical planning worked out to the last detail even involved complicated calculations of helicopter payloads and fuel consumption.

However "The best laid schemes o'mice an'men gang aft agley". For, on arrival in Angmagssalik the bulk of our carefully thought out forward planning had got lost in transit, things were not as they seemed and anyway, we discovered that getting things done in Greenland is a fairly leisurely pursuit. The result was a frantic ten days spent in Angmagssalik, dodging BBC film crews and negotiating various deals concerning transport. At this time we received a great deal of friendship from Ruth and Heinrich Nielsen, without whose local expertise we would have been helpless.

1982 was a bad year from the point of view of pack-ice. The pack was so thick that it still encroached on Angmagssalik harbour. It soon became clear that any attempt to make a sea journey northwards would be bound to fail, in addition we discovered that the helicopter had too small a payload to transport us and all our gear. We were on the verge of cancelling all our original plans when a chance arose to share the cost of two helicopter flights with an Italian expedition who wanted to return from a base camp they had established at the foot of the Pourquoi-Pas glacier. At the same time we were able to arrange to be picked up by a small trawler, the "Ulimaut", on the 25th August from Tasilaq Fjord for the return journey.

The final go-ahead for the helicopter flight north was given on July 10th, two journeys were required to deposit ourselves and all our equipment on the Pourquoi-Pas Glacier, from where the journey to the Kruise Fjord, 95 miles to the north, would take a winding route through the glacier systems. As the helicopter whirled off into the distance we were left, marvellously free from the clutter of civilised

life and faced with the problem of completing a 95 mile journey over fairly uncertain terrain before the first of August. On this date we were expecting to receive two weeks supply of food, dropped in by helicopter on its way north to support a group of geologists working at Kangerdlugssuaq, this was therefore a kind of deadline, but we felt we had ample time to complete the journey.

Adopting a system of travelling by night when conditions were coldest and the glacier surfaces in good condition, we made excellent progress until, after turning the brow of the Pourquoi-Pas glacier, we were confronted by a large and complicated crevasse field which brought us to an abrupt halt. Huge crescent shaped crevasses had formed at the confluence of several glaciers at the head of the KIV Steenstrups Brae. We had to ferry half loads along routes which we had previously surveyed and this proved to be a very slow business, further hampered when our luck with the weather ran out. A severe storm forced us to camp in the centre of this crevassed section and we were confined to our tents for three days. When the storm cleared we had to fix ropes across a particularly bad 200 metre section and spent a night ferrying loads. The main problem was that the new snow had obliterated most of the crevasses so that you didn't really know if you were standing on one until a black hole opened between your feet.

We got underway again by the 18th July and crept nearer our destination. On occasions we would curse and swear at our sledges as they wallowed in soft snow on uphill gradients, at other times the surface would harden up and give exhilarating sledging with the loads only reminding us of their presence by an occasional light tug at the traces.

We finally reached the Kruise Fjord on the 27th of August, the last two days journey being made in thick fog. With visibility down to 50 yards, we had to travel by dead reckoning, with the front sledging pair being guided by those behind ("left a bit, no, no, too far, hard right" needless to say tempers were lost occasionally).

Having arrived at base camp we dug our tents into pits for shelter and erected radio masts. The first five days at base camp coincided with the finest weather of the whole expedition and we took this opportunity to do a number of routes on the surrounding peaks as well as undertaking a geological reconnaissance. In all six new routes were done on five peaks. The climbing, nowhere difficult, was nevertheless an exhilarating exercise and for most of us our first experience of new routing.

The 1st of August was the day that we received our airdrop of supplies. The previously agreed landing site was marked out with orange bivouac bags and we sat around with smoke flares at the ready. The helicopter was heard in the distance but seemed unwilling to come any closer, we later discovered that the pilot was having map reading difficulties. However we eventually received our food and were given a good display of aerobatics on takeoff.

Shortly after this bad weather returned with a vengeance and we found ourselves confined to tents for five days, by this time the great endurance test of the expedition would appear to have been the ability to fester while maintaining one's sanity!

This stint of bad weather effectively brought any chance of more activity at the Kruuse Fjord to a halt. There were still a number of routes which we wanted to complete, most of which were picked for their geological interest. In particular we wanted to survey one of the long ridges that radiated from Beinn Birsay or Point John since they gave a good cross section of the layered gabbros that we had come to study. However we decided to leave base camp on the 10th of August in order to make use of good weather. We set off but were again brought to a halt by another storm after only three days travelling. This developed into a severe blizzard which deposited around 4 to 5 feet of snow over a 60 hour period. We lay in our tents and watched the snow level rising until it reached the ridge poles and airshafts had to be excavated.

We dug ourselves out and took stock of the situation which didn't look all that hopeful. We sank up to our knees even with skis on and it was impossible to pull even half lasso to pull even half laden sledges. Wind conditions caused the fresh snow to drift and compaction seemed non-existent. Our chances of reaching Tasilaq Fjord on time to meet the Ulimaut seemed to be diminishing, and it was felt that even Pete's generous food allowance would not last through the winter. We came to the inevitable conclusion that we would have to dump everything that wasn't absolutely essential and make a forced march to get us within safe distance of Tasilaq.

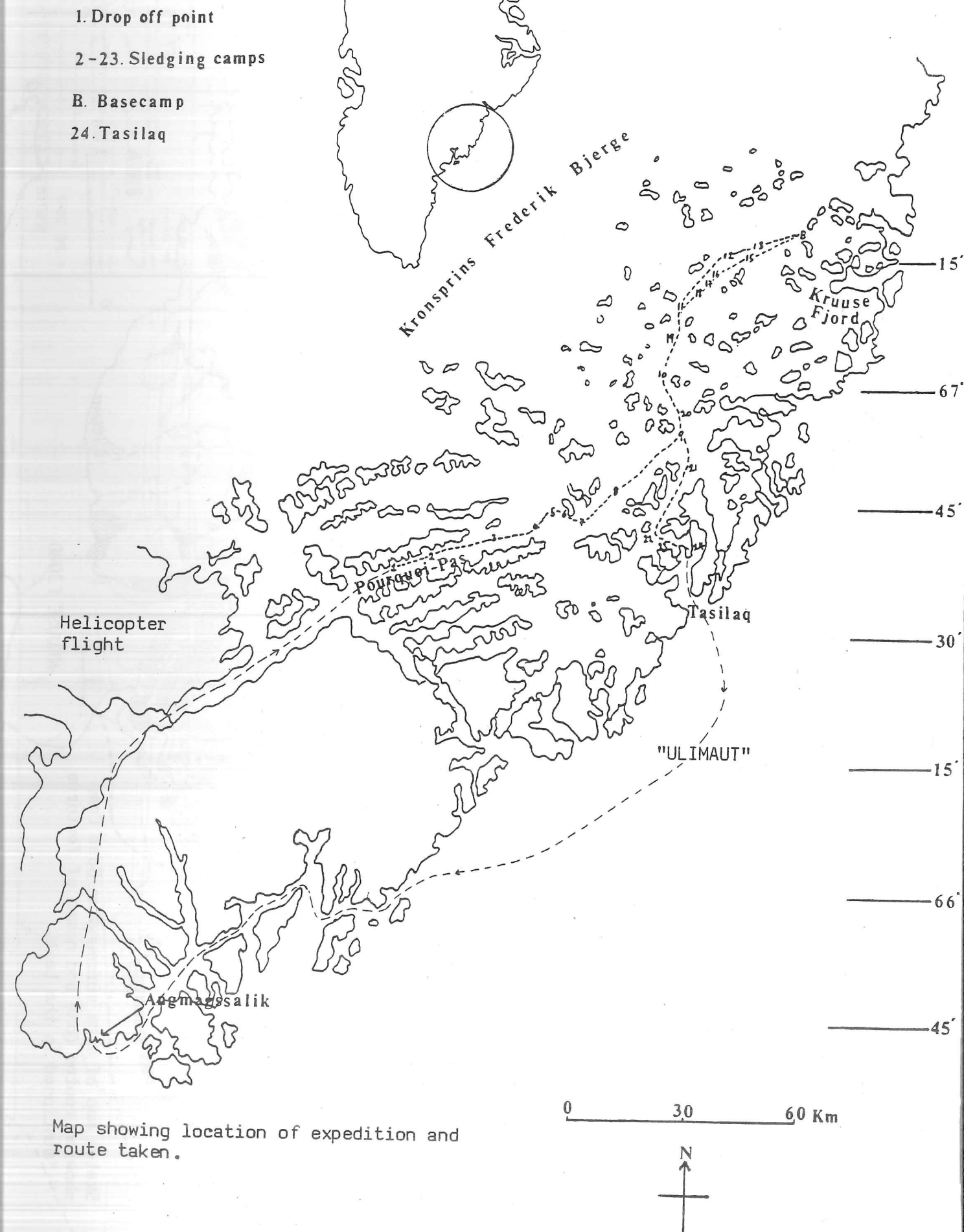
We piled all our climbing gear and spare clothing into tea chests which soon became buried in drifts, other items were burnt, our saddest loss was two boxes full of rock samples that we had collected - the whole point of the expedition!

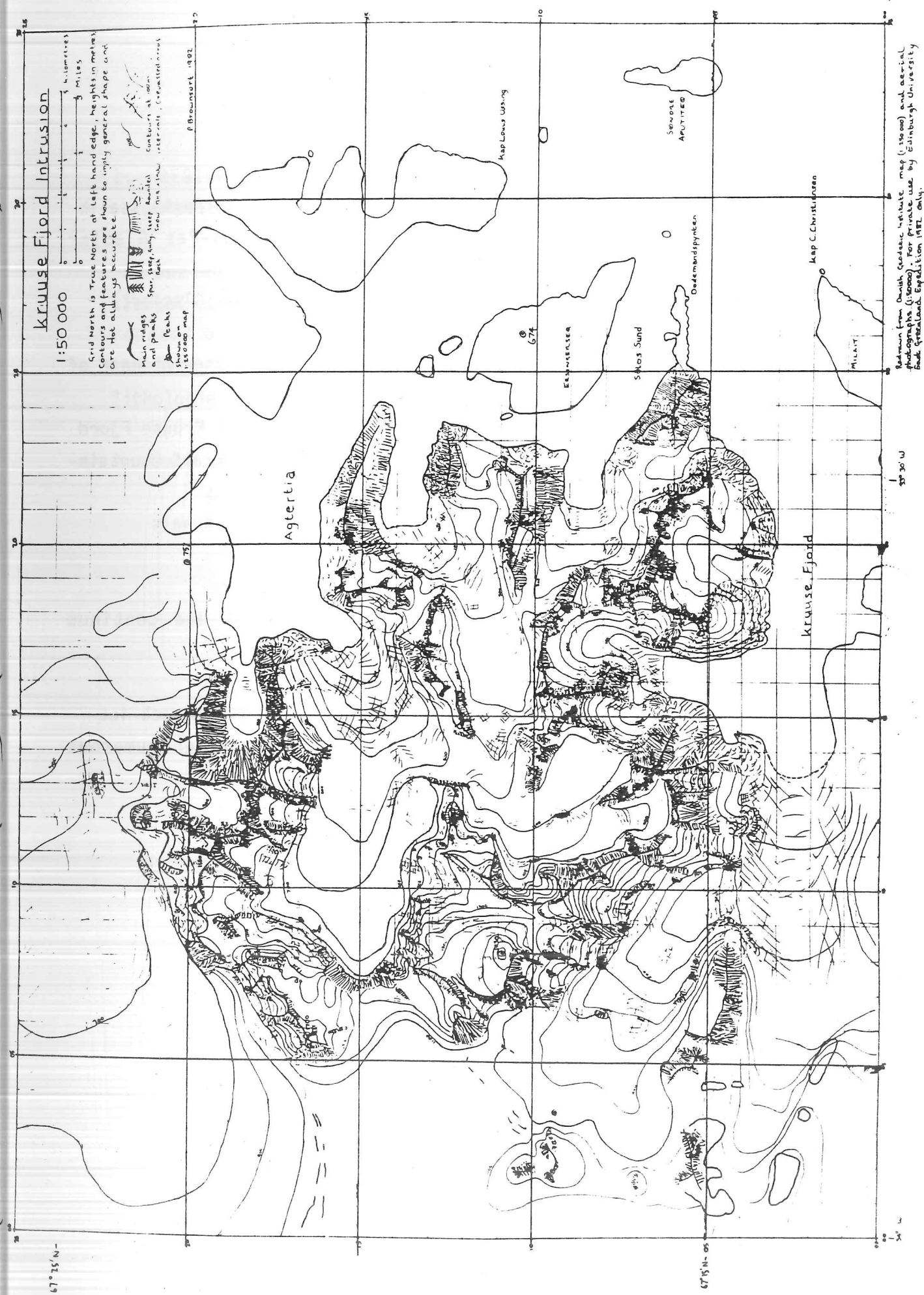
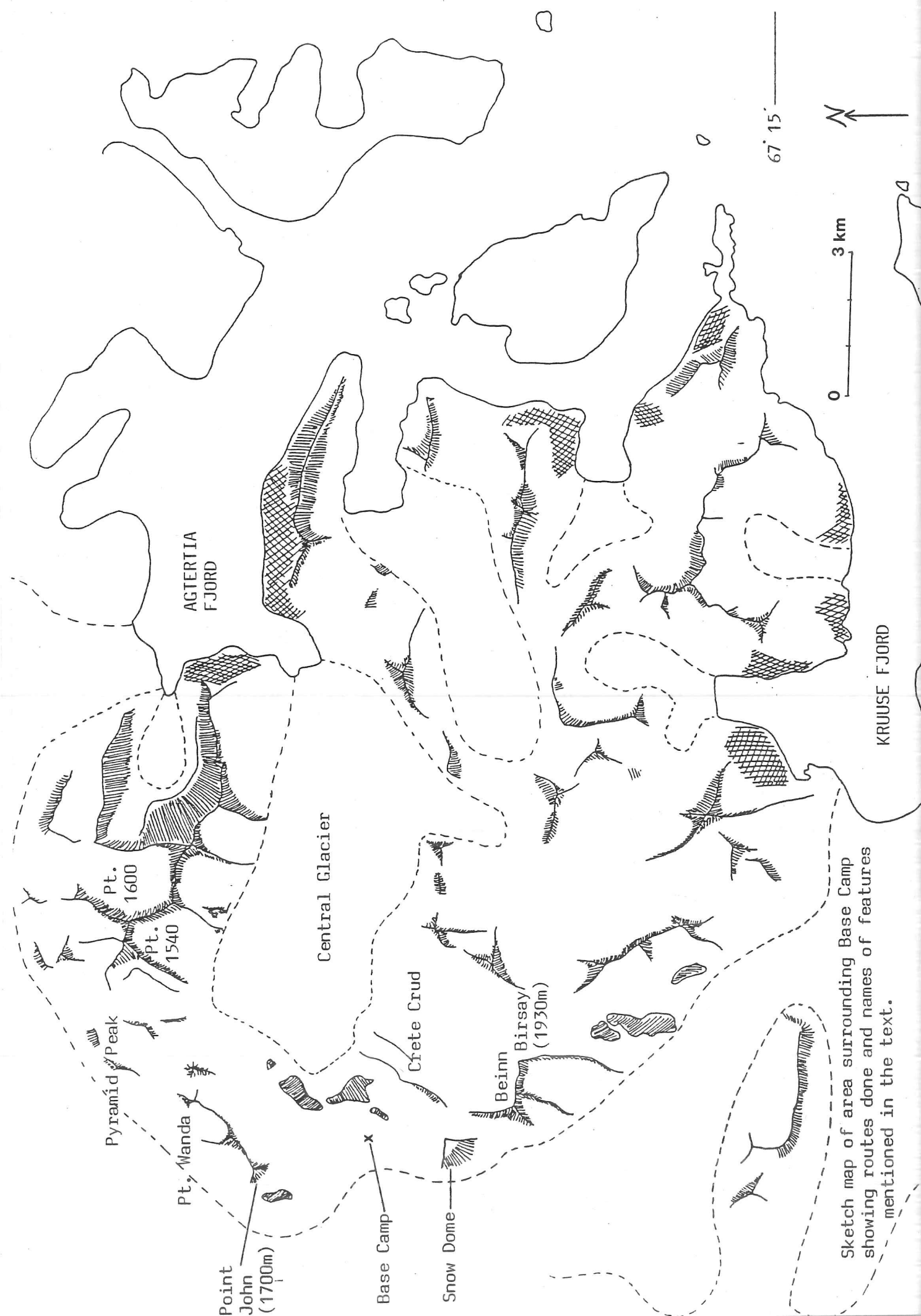
Having reduced our loads we were able to make quite good progress. Keeping up a fairly hard pace and exhausting ourselves as a result we managed to get within striking distance of Tasilaq. We had expected to have to sit out at least one more stint of bad weather, however this did not materialise and consequently we arrived with a day to spare. The last two days consisted of backpacking our gear down a small icefall and the final moraine strewn glacier to the Tasilaq campsite.

Arrival at Tasilaq was not the end of our problems. The Ulimaut had a desperate struggle reaching us due to the severity of the pack ice. However it suddenly appeared through the mist on the morning of the 26th August. We made ourselves at home in the converted fish hold where we sat out the long periods spent stuck between iceflows. These lasted up to 20 hours and resulted in a five day round trip which should, in a normal year, have taken only a day and a half.

We finally arrived back in town and lapped up local hospitality for a few days before setting off across the channel to the Kap Dan airstrip. Various American geologists unloaded their excess food on us so we pigged out in style during our two day wait for the flight.

I hope this section has given an overall view of how the expedition progressed. Return to normal life was a slight culture shock for all of us, which shows, how, even over a short period one can become intensely involved with the peculiar realities of expedition living. Most of us, given the chance, would be keen to return to Greenland at some time in the future, and perhaps one day the Kruuse Fjord will reveal some more of its secrets to those willing to persevere and reach it.





EXPEDITION DIARY

27 June 1982	Fly from London to Iceland
28 June	Fly from Reykjavik to Kulusuk
29 June	Fly by helicopter from Kulusuk to Angmagssalik
8 July	Helicopter flight to Pourquoi-Pas Glacier cancelled due to bad weather
10 July	Helicopter flight to Pourquoi-Pas Glacier; begin sledge journey
13 - 19 July	held up by crevasses and bad weather at head of K.I.V. Steenstrups Nordre Brae
19 - 26 July	Continue sledging to base camp at Kruuse Fjord
27 July - 2 August	Carry out geological fieldwork and mountaineering from base camp
3 - 8 August	Another storm brings activity to a halt
10 August	Start return journey
13 - 15 August	Blizzard buries tents
16 August	Abandon unessential equipment and continue sledging
22 August	Arrive at Tasilaq
26 August	Boat arrives - having been stuck in pack ice
29 August	Arrive back in Angmagssalik after numerous delays in pack ice
31 August	Boat journey to Kulusuk
2 September	Fly to Reykjavik
3 September	Fly from Iceland to London

GEOLOGICAL OBSERVATIONS

Dave Thompson

1. REGIONAL GEOLOGY BETWEEN THE POURQUOI-PAS GLACIER/TASILAQ AND THE KRUUSE FJORD

During the journey to and from the Kruuse Fjord, the Expedition sledged across glacier terrain which was, for the most part, surrounded by Archaean Gneisses. Several opportunities arose to study them at closer quarters, which allowed us to distinguish five main lithologies.

(a) Archaean quartzo - feldspathic and amphibolite/pyroxene gneisses:

These were by far the most common rock types observed and consisted of repetitive units of quartz-rich/poor feldspathic gneisses, interbedded with darker more homogeneous amphibole/pyroxene rich gneisses in huge sheet-like bodies. The degree of banding and the thickness of each unit varied considerably, being fairly intense and well defined along the northern side of the Pourquoi-Pas Glacier, but much more uniform further north.

Large scale structural deformation of these rocks appears to be absent, the layers being concordant and gently dipping, the dip increasing towards the coast. However on a small localised scale polyphase folding was commonly noted.

In some areas, especially on the southern side of the Pourquoi-Pas Glacier, bedding appeared to be absent, giving the rock the appearance of a large Granite Intrusion.

At $34^{\circ} 36'W$, $67^{\circ} 2'N$ an outcrop of the country rock was examined. It was found to consist of two feldspars, quartz and a pyroxene and was an excellent example of a granite gneiss. It had a granular texture with no schistosity, but was found to contain xenoliths of a schistose mafic material.

(b) Basic Sheet/Dyke Intrusions within the Archaean gneisses

A series of basic intrusions striking southwest to northeast were found throughout the region. They were mainly concordant to semi-concordant with the foliation of the country rocks, suggesting some structural control on their emplacement.

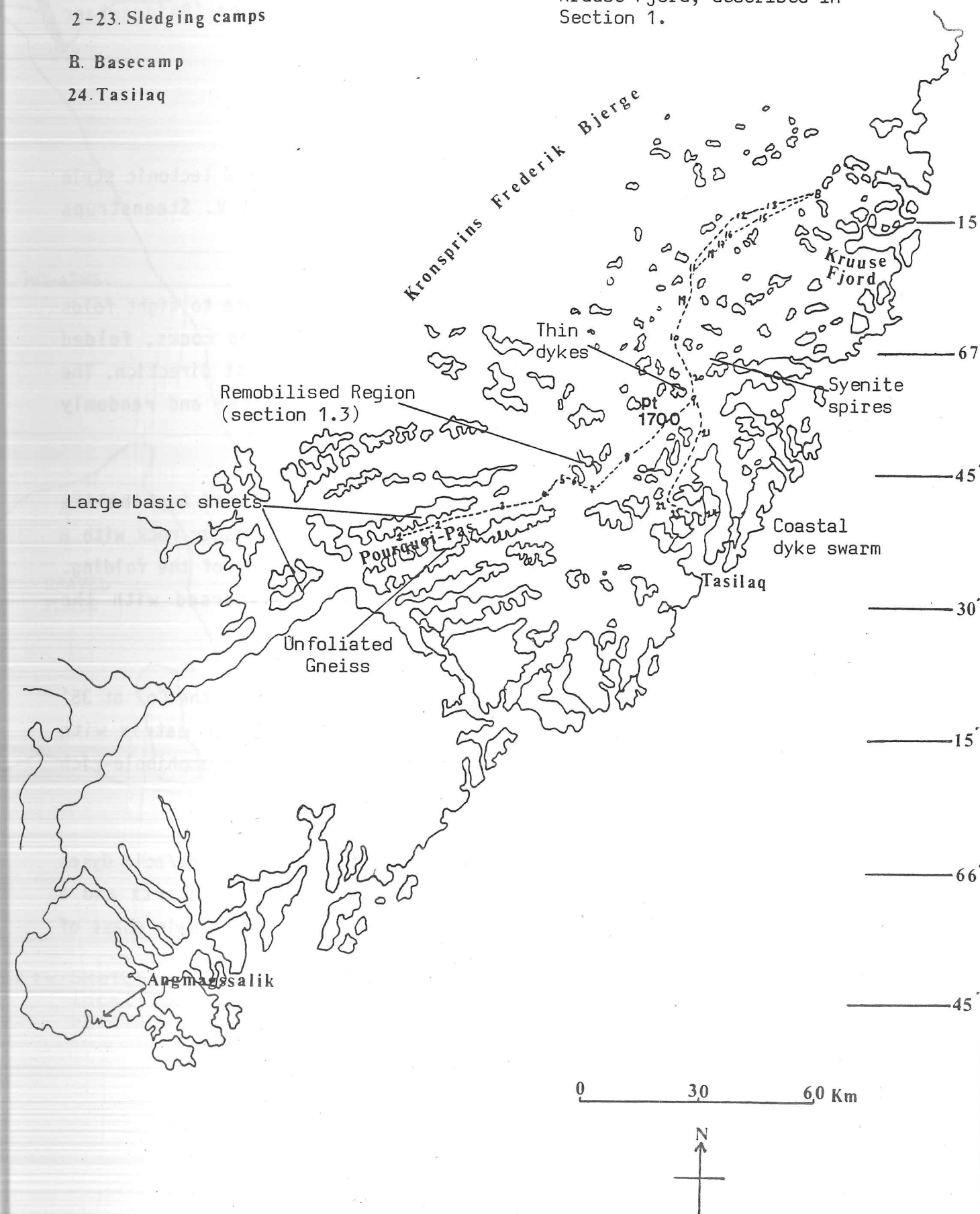
The most impressive of these layers was a steeply dipping sheet (approx. $50^{\circ}/130^{\circ}$ at $35^{\circ} 50'W$, $66^{\circ} 41'N$) on the northern edge of the Pourquoi-Pas Glacier. On closer study it was found to be a medium to coarse grained melanogabbro with augite (60%), feldspar and olivine (commonly iddingsitised). Weathered under-surfaces contained disseminated deposits of a metallic mineral (possibly arsenopyrite). This particular sheet was commonly up to 60m thick, although it frequently became broken up and interleaved with the surrounding country rock.

A similar sheet was observed from the helicopter, on our way to the drop-off point, along the northern side of the Midgardgletscher. It is possible that this is a continuation of the Pourquoi-Pas sheet, which would imply a length of at least 70km.

A similar sheet to the one just described was seen to the west of Tasilaq Col at $34^{\circ} 45'W$, $66^{\circ} 48'N$ (approx. 30-50m thick) and thin dykes observed at Pt. 1700m ($34^{\circ} 35'W$, $66^{\circ} 56'N$) which were cut and offset by later faulting were assumed to belong to the same group.

- 1. Drop off point
- 2-23. Sledging camps
- B. Basecamp
- 24. Tasilaq

Figure 1. Features observed on journey to Kruuse Fjord, described in Section 1.



These dykes and sheets probably belong to the suite intruded before and during the early Proterozoic deformation, that affect the Nagssugtoquidian Mobile Belt area (Bridgwater 1976 - Geology of Greenland).

(c) Nagssugtoquidian Deformation

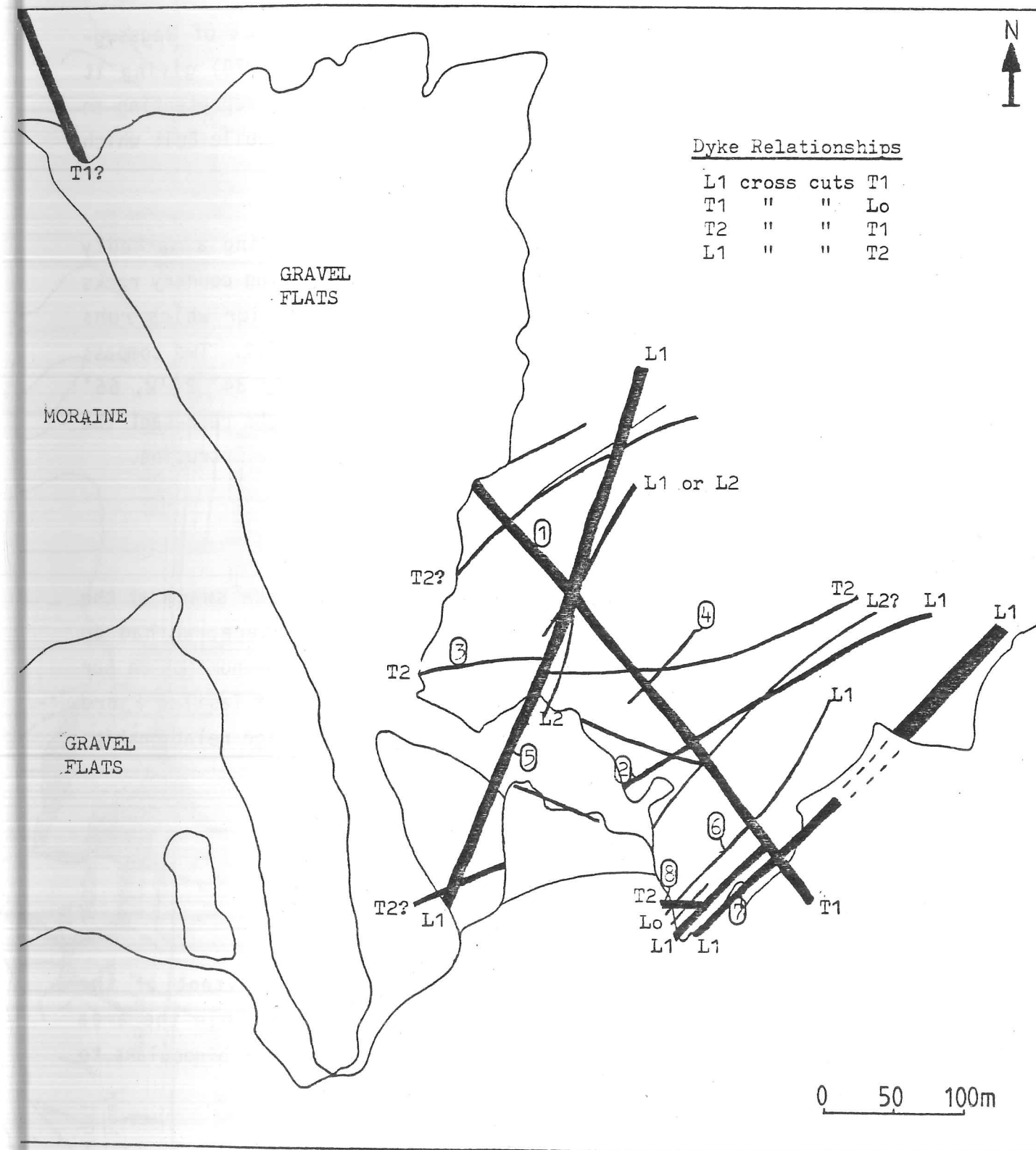
A region made up of a distinct rock type and tectonic style was found at the northwest end of the K.I.V. Steenstrups Brae, at 35° 5'W, 66° 47'N.

The structure consists of upright moderate to tight folds giving steeply dipping to vertically bedded rocks, folded around axes which trend in a roughly east-west direction. The folding is accompanied by a group of sparse and randomly spaced dykes parallel to the axial direction.

The most common lithology is a well foliated Amphibolite Gneiss, made up of an amphibole-quartz-feldspar rock with a good cleavage parallel to the axial direction of the folding. Darker amphibole rich bands are interspersed with the quartzo-feldspathic bands.

Another rock type found near the campsite on the Col at 35° 10'W, 66° 46'N consisted of a quartz-feldspar matrix with large alkali feldspar augens and flames of amphibole-rich material.

The whole area is criss-crossed by pegmatite veins/acid dykes containing: orthoclase, microcline, biotite, quartz and a green amphibole, which certainly post date the main phase of deformation.



1.2 :- Sketch map of the area around the Tasilaq campsite showing the local Tertiary coastal dyke swarm.

Specimens:- 1) T1-Main dyke
2) T2-or Linterm.
3) T2
4) L2-pyroxene rich
5) L1
6) L1-flow banded
7) L1
8) T2-pyroxene ?
9) Big feldspar dyke
10) Augen gneiss

Order of intrusives:- Lo,
T1,
T2,
L1,
L2?,

L2 probably occurs after L1, or could be contemporaneous with it.

This region probably corresponds to the area of Nagssugtoquidian remobilisation described by Myers (1979) giving it a time range of around 2700 - 1700 Ma, and representing an isolated block of the main Nagssugtoquidian Mobile Belt which outcrops further to the south.

- (d) An extremely impressive pair of spires showing a markedly different weathering pattern to the surrounding country rocks were spotted to the southeast of the glacier which runs northwest from Pt. 1700 at $34^{\circ} 25'W$, $66^{\circ} 59'N$. Two compass bearings put their location at approximately $34^{\circ} 24'W$, $66^{\circ} 59'N$. This pale unfoliated rock was assumed to represent the western margin of the Laubes Gletscher Syenite Intrusion.

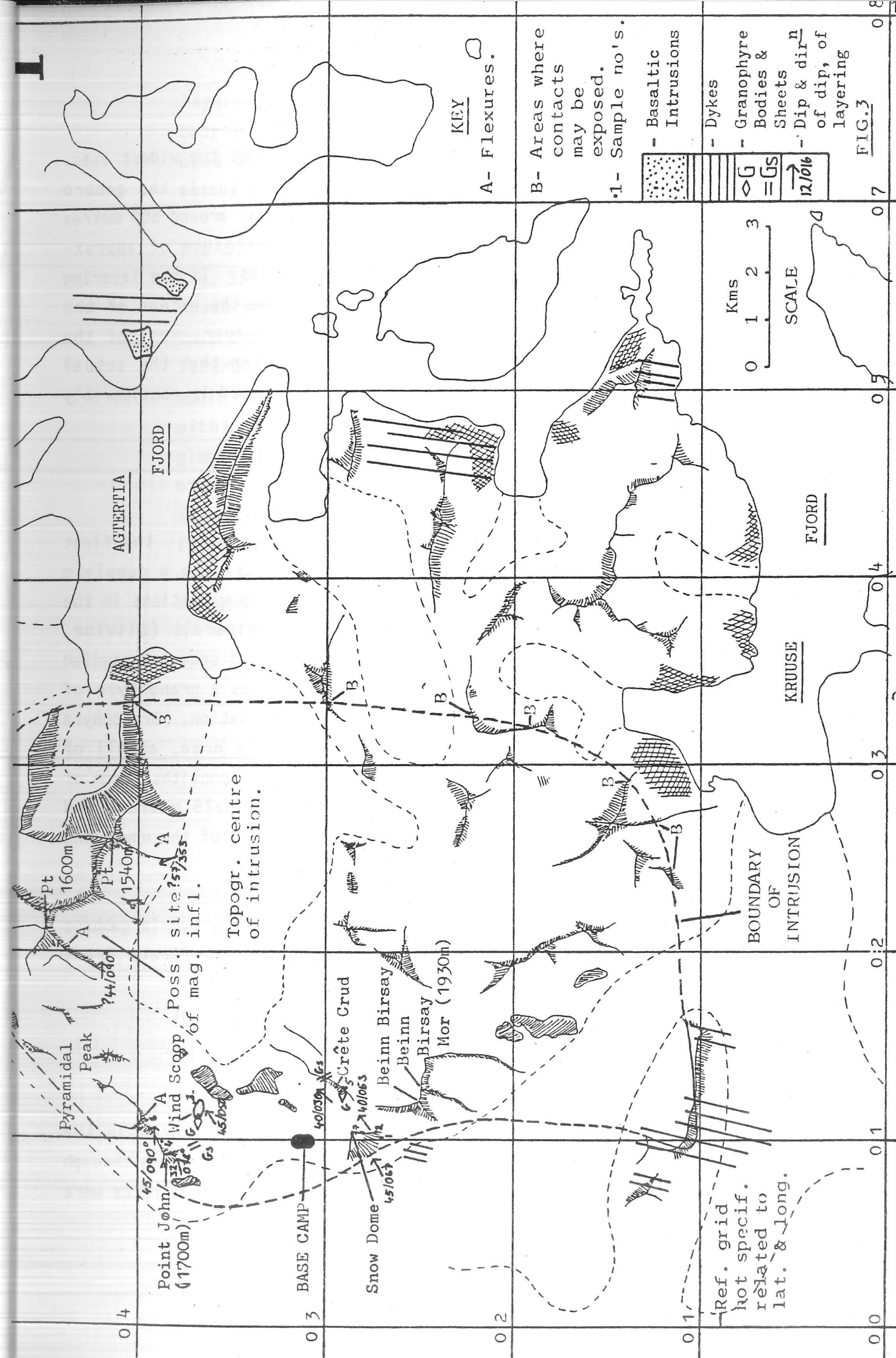
(e) Coastal Dyke Swarm at Tasilaq:

After being unable to study the costal dyke swarm at the Kruise Fjord which is known to be present there, we had an opportunity to have a look at a similar phenomenon on our return journey. This study was carried out at Tasilaq Fjord (see fig. 2) mainly to try to determine the age relationships between the dense local Tertiary intrusives.

2. THE KRUISE FJORD INTRUSION (Fig. 3)

2.1 Introduction:

The accompanying map shows the inferred extent of the intrusion. No direct contacts were found within the area studied, however contacts were observed through binoculars to the east and south.



The intrusion is 21km long and 13km wide at the widest axes. The highest point is 1930 metres (Beinn Birsay), the gabbro itself probably first becomes exposed at around 500 metres above sea level giving a rough vertical exposure of approximately 1500 metres for the layered series. If the layering was horizontal then this would also define the extent of the layered sequence that is exposed. However, most of the layered rocks dip at angles of around 45° so that the actual extent of the layered sequence is exposed is considerably more than this (around 2,150 metres).

2.2 Distribution of Lithologies

Only two major rock types were distinguished, the first being a variable iron-rich gabbro, usually with a cumulate texture developed but having considerable variations in the modal abundances of the main cumulus minerals (olivine, pyroxene and feldspar). The total exposed sequence studied the second major lithology that was found was a granophyre of which sample number 5 is a good representation. Granophyre was found at a number of localities in the area, at all of these it contained an abundant suite of xenoliths, some of which reached considerable sizes (up to 0.75 metres) and probably originated by the stoping effect of the upwelling granophyre.

Some unusual and varied rock types, possibly hybrid gabbros and gabbro breccias, were found along the ridge (Crete Crud) to the southeast of basecamp.

2.3 The layered Series - Overall Structure:

Layered gabbro made up the bulk of the exposed rocks in the area studied and distant viewing of the whole area through binoculars indicated that virtually all the exposed rocks were

layered, one possible exception being a large (50m high) body at the base of the Snow Dome, which probably lies at the base of the layered sequence. From above it appeared to be fairly homogeneous with no lateral and vertical variations.

The direction and angles of dip of the layers are shown in Fig. 3. On the western and southern margins where direct measurements were obtained, the layers were all found to dip inward towards the centre of the intrusion so that traced laterally they would form concentric rings. Therefore it would seem reasonable to suppose that the depocentre lay within the poorly exposed area containing a seaward flowing glacier that lay in the topographical centre of the intrusion. However, observations of an outcrop to the north suggested some northward dipping layers away from the centre. Thus one may postulate that there are several depocentres in operation and that the floor of the magma chamber may have contained hummocks (Fig. 4).

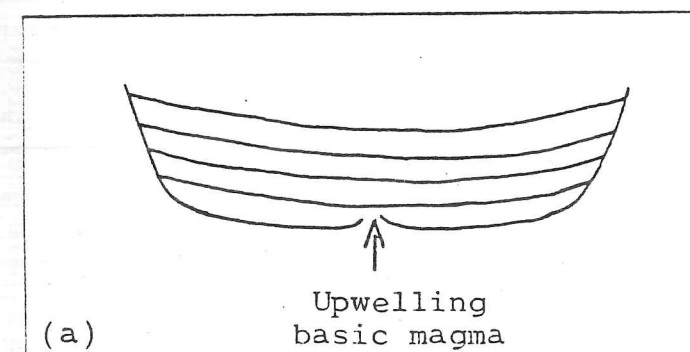


Fig. 4: (a) Sketch showing the proposed model for a flat floored magma chamber.

(b) Sketch showing the proposed model for the Kruuse Fjord, with a hummocked magma chamber floor.

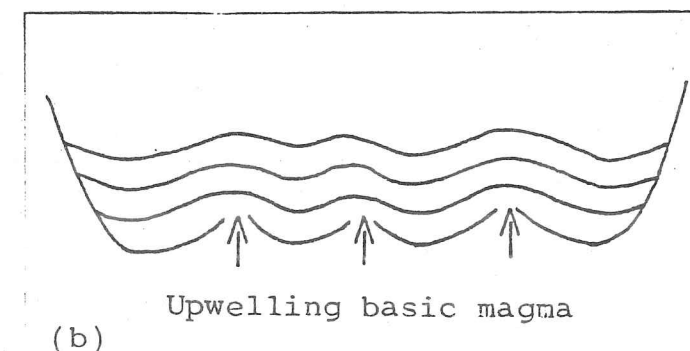
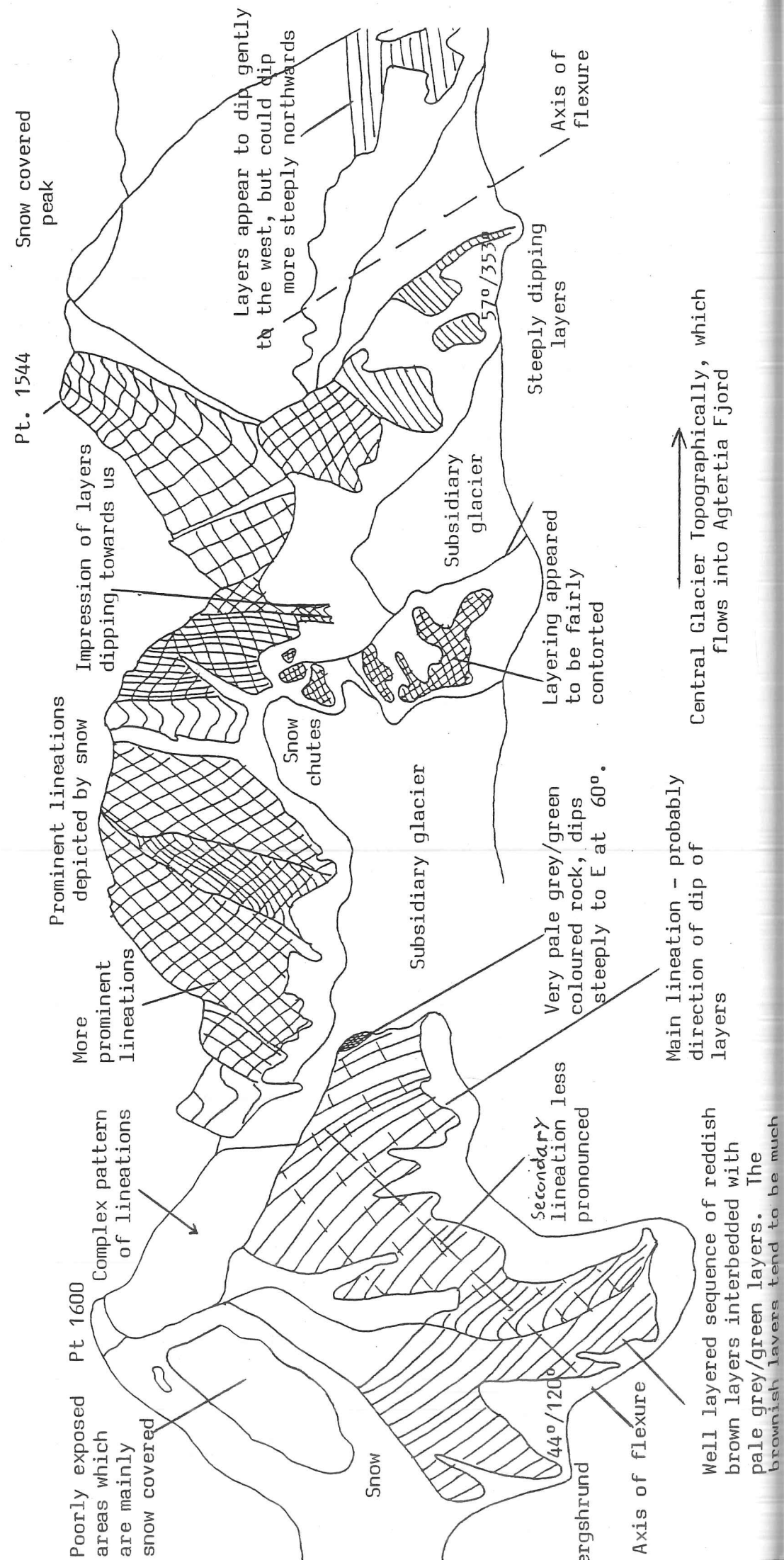


Fig. 5. A sketch looking approximately NE of the layering in Pt. 1544m and the surrounding ridges. Taken from GR. 01300315 (See fig. 3)



The dip of the layers ranged from 30° to 50° with 45° being a good average figure. This would seem to be high and widespread throughout the intrusion except possibly in the east, where dips appear to become shallower (Fig. 5). This could imply that the intrusion is tilted slightly towards the east. However, one must be careful since these are two dimensional observations and the layers could be dipping towards or away from us. The steep dips found in the west are comparable in steepness to those attained in the border group of the Skaergaard intrusion.

Another feature that is worthy of note is the occurrence of a large scale flexuring within the layering as shown in Figs. 4 and 5. This type of flexuring was observed at three localities, marked on the map (Fig. 3), and causes the layers to become more steeply dipping towards the centre of the intrusion. These flexures could be attributed to the formation of drag folds formed by gravitational collapse of layers in the centre of the magma chamber while still in a semi-liquid state.

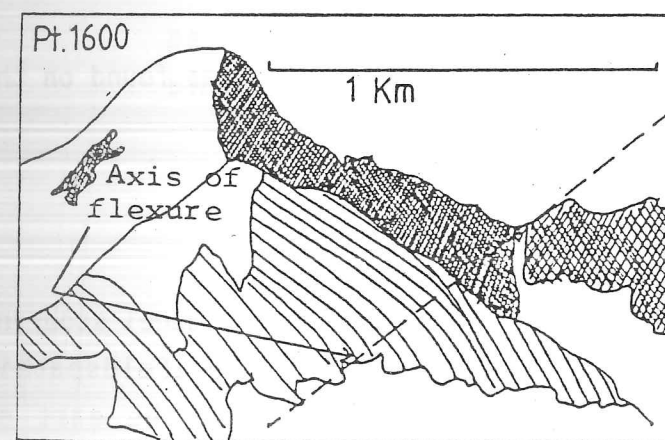


Fig. 6: Sketch of Pt. 1600m and neighbouring ridges showing the well defined flexure.

2.4 Layered Series - Small Scale Structures:

Some of the small scale structural features of the layering are shown in Figs, 7, 8, 9 and 10. Spectacular trough bands of the type found at Skaergaard were absent. Slump structures were seen at a number of localities, ranging from highly convolute forms to the more regular folds as shown in Fig. 7.

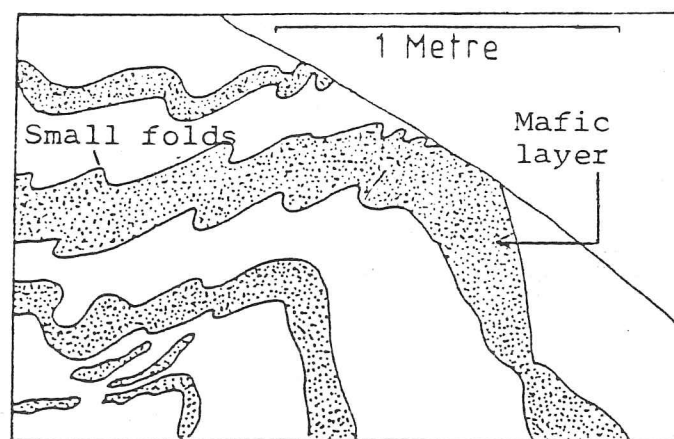


Fig. 7: Small scale folding of the layering which was reasonably common within the more finely layered units.

These are recumbent folds, the folds being defined by a melanocratic layer with smaller parasitic folds on the hinges.

Figs. 8 and 9 show channel scouring structures found on the south and east sides of the Snow Dome peak.

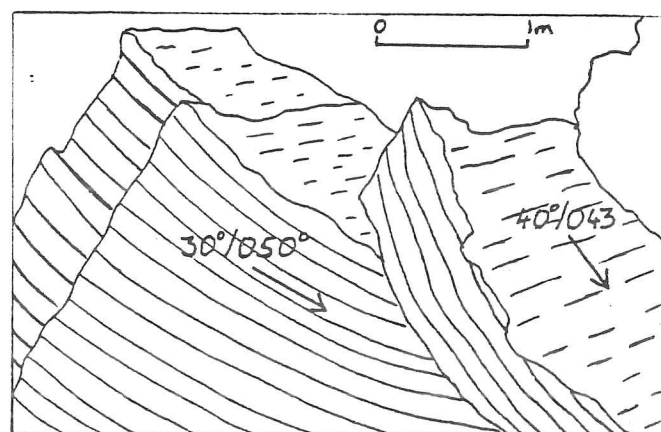


Fig. 8: Channel scouring feature in feldspathic gneisses to the east of the Snow Dome.

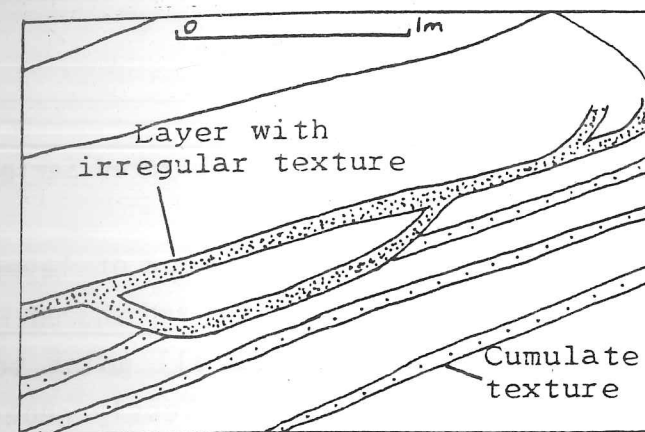


Fig. 9: Structure found on slabs on southwest face of Snow Dome

These structures consist of layers that appear to scour out and truncate the layers below, the two layers having different microtextures and mineralogy. Syndepositional faulting (Fig.10) which may be consistent with the high angle of the layering, was observed in several localities.

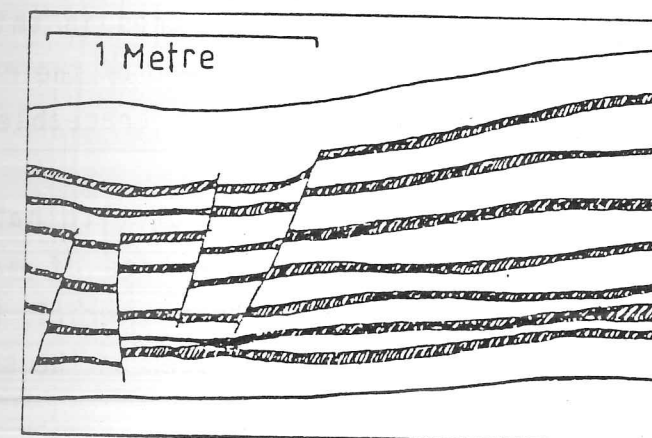
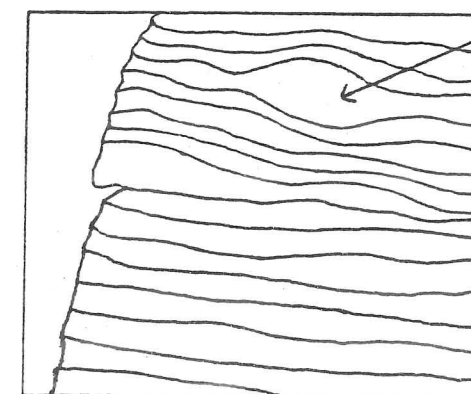


Fig.10: Syndepositional faulting of the layering as observed at the Wind Scoop.

Wavy layering and lenticular structures were well developed, particularly on the south faces of Point John, and Beinn Birsay (Fig. 11).



Large lenticular layer.

Fig. 11: Type of layering observed on the south face of Point John.

2.5 Lithological and Textural Variations in the Layered Series:

This study brought home to us the great variety of layering to be found in an intrusion of this type and showed it is false to assume that layered rocks are all going to be similar to the text book examples of endlessly repeated rhythmic units. During our study the following variations were found:

- (a) Layers without well-defined cumulate laminations suggesting that crystal settling was of little importance.
- (b) Uniform layers of mainly feldspathic mesocumulate giving monotonous uniform beds of up to 1.5 metres in thickness. Well developed at the southern end of the ridge running northwest from Point John and traceable to outcrops near the Windscoop.
- (c) Rhythmic layers with typical sequences of alternating light and dark bands usually with a base of mafic minerals grading up into more feldspathic material. On a scale of up to 25cms per layer well seen on the south face of Point John.
- (d) Pegmatitic layering, consisting of much coarser grained gabbro. Seen on the ridge to the northwest of Point John and at the Wind Scoop. A section of this ridge is illustrated below (Fig. 12).

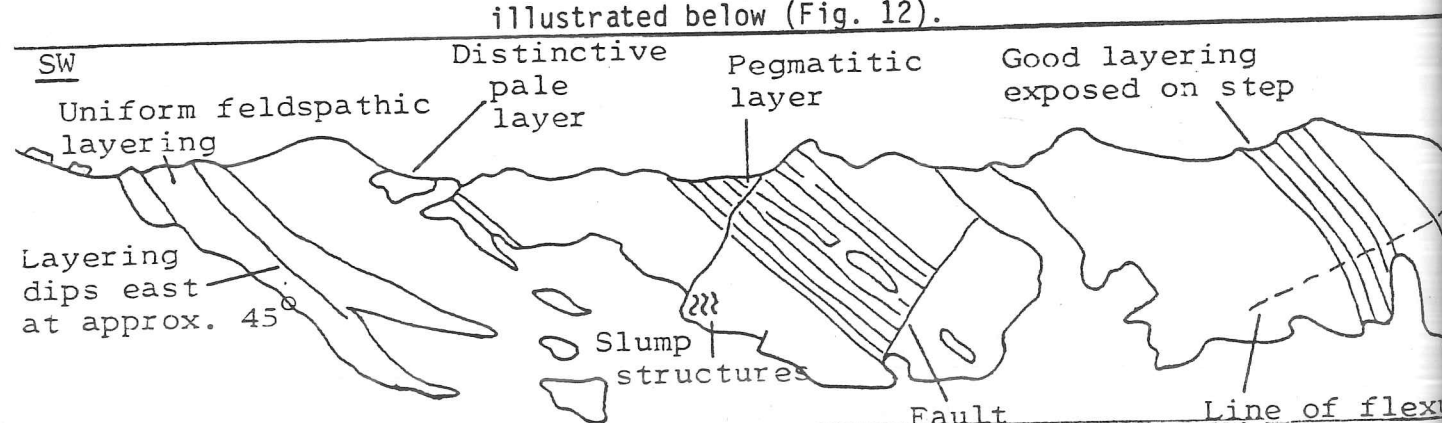


Fig. 12: Sketch of the ridge which runs northeast from Point John (GR.0090-0385), showing the layering and the flexuring of the layering.

- (e) Layering due to subtle changes in the abundances of certain minerals, essentially a type of rhythmic layering where no dominant cumulus phase can be identified. This type of layering was found to be very common.
- (f) At the northern edge of the ridge running northwest from Point John an interesting texture was observed, consisting of rafts of olivine crystals dispersed in a more feldspathic matrix.
- (g) Repetitive units, up to two metres in thickness, separated by weathering surfaces and containing smaller scale internal rhythmic layers. These presumably represent separate pulses of magma that have then undergone crystal settling, i.e. megacycles.

It is also possible to distinguish large scale variations in the character of the gabbro; careful mapping and logging along ridges would allow one to piece together a well-defined vertical stratigraphy which might then be correlated throughout the intrusion. Unfortunately time prevented us from doing this. However, it was observed that certain conspicuous large scale variations were present. For instance the south face of the Snow Dome had a break at 1/3 height, the darker layers below possibly being far more Fe-rich than the overlying lighter coloured ones.

2.7 Amphibole and Pegmatite Veins:

These were quite common, the best localities being shown on the map. Possibly two broad types may be defined - those that are clearly discordant with the layering and those that are possibly concordant with it and have simply brought about the replacement of the original mineralogy with late stage hydrothermal vein minerals, mainly amphiboles and feldspars. To the south of Point John some slabs were found which consisted of a heavily altered gabbro criss-crossed by leucocratic and hornblende veins, one of which was collected and contained a fibrous amphibole.

2.8 Eastern edge of Snow Dome:

Not only was veining a fairly common feature, but small scale fracturing (1cm across) cross-cut many of the units looked at. This was particularly apparent on the eastern edge of the Snow Dome (G.R. 01100285) where three sets of fracture patterns were observed:

(a) $80^{\circ}/224^{\circ}$; (b) $40^{\circ}/186^{\circ}$; (c) $6^{\circ}/324^{\circ}$

all of which had considerable spatial variations. The layering (1/4 - 3m thick) dipped at $41^{\circ}/036^{\circ}$, and consisted of medium-coarse grained gabbros with varying abundances of the primary phenocryst phases (olivine, feldspar and pyroxene). No evidence could be found to show whether or not the fractures offset the layers).

It was at this locality that one of the few basaltic intrusions were found, it being a 4-10cm thick dyke cross-cutting the layering and dipping at $30^{\circ}/305^{\circ}$.

2.9 Crete Crud:

This section (Fig. 13) consists of an illustration along a section of the ridge that runs northwest from the Snow Dome. It seemed to contain a complicated series of hybrid gabbro breccias. A strong fracture trending parallel to the ridge ($040^{\circ}-220^{\circ}$) was seen to transcend all units.

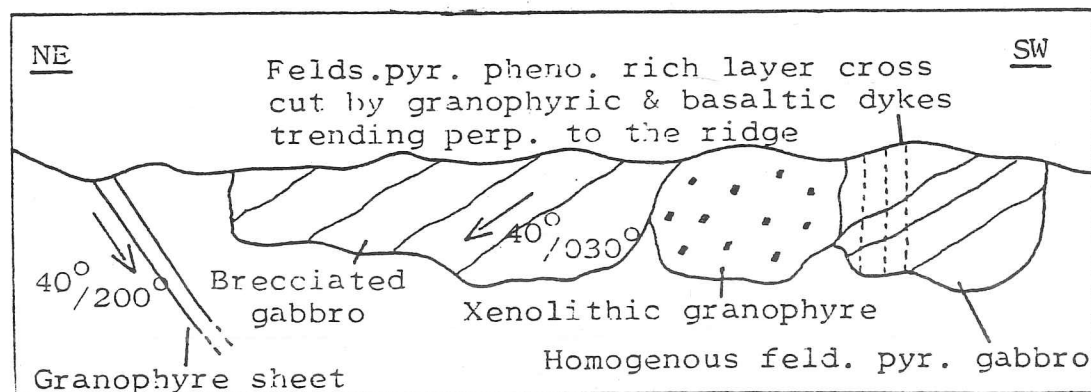


Fig. 13: Sketch of Crete Crud from Base Camp showing the cross cutting nature of the granophyre bodies.

Granophyres, containing rich xenolith assemblages, were found throughout the area studied. It occurred either in sheet form, sometimes semi-concordant with the layering, or as larger plug type bodies, truncating the layering. In the latter case the shape is obscured by the ice and it may be possible that the separate granophyre bodies link up into one mass.

2.10 Wind Scoop:

Some excellent examples of large xenoliths up to 0.75 metres across were found (Fig. 14) at this locality (G.R. 01150365).

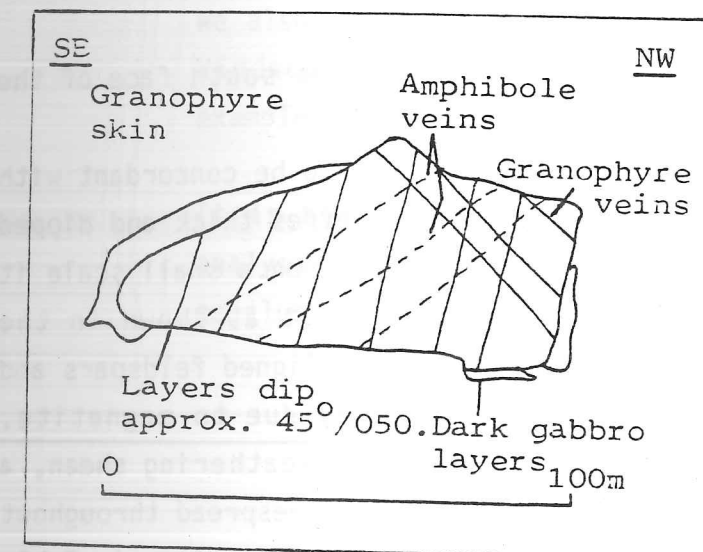


Fig. 14: Sketch of the outcrop exposed at the Wind Scoop (G.R.01150368) showing the relationships between the various vein systems.

A granophyre plug on the eastern edge of this locality was found to be quite inhomogeneous, ranging from pure white to dark grey in colour and possibly becoming hybridised with the surrounding gabbro at the outer margins. As well as containing the large nodules described above it also hosted a variety of smaller xenoliths up to 20cm long

2.11 Basaltic Intrusions and Dykes:

Basaltic dykes cutting the layered series were very rare, at least in the western part of the intrusion. Coast parallel dykes become progressively denser to the east but their age relationship to the intrusion is uncertain. Very large

irregular shaped plugs were seen exposed on the coast on the northern side of Agtertia Fjord.

A series of dykes striking northeast to southwest were found to the south of the Snow Dome and these were back veined and had caused baking of the country rock.

A dense dyke swarm was also seen to cut the peak at G.R. 0100 0105, especially on the western face.

2.12 Sample Collections

Only seven samples were retrieved from the Kruuse Fjord out of the hundred or so that were originally collected.

- (1) A sample from the dark band on the south face of the Snow Dome;

This prominent dark band appears to be concordant with the layering; it was roughly 2.5 metres thick and dipped towards the northeast (Fig. 15). On a small scale it was found to cut the layers beneath it as shown in the diagram below. It contained flow aligned feldspars and hand specimens were heavy, possibly due to magnetite. The surface had a peacock purple weathering sheen, a type of weathering that was fairly widespread throughout the intrusion. Major element analysis is given in Table 1 (KFC 3).

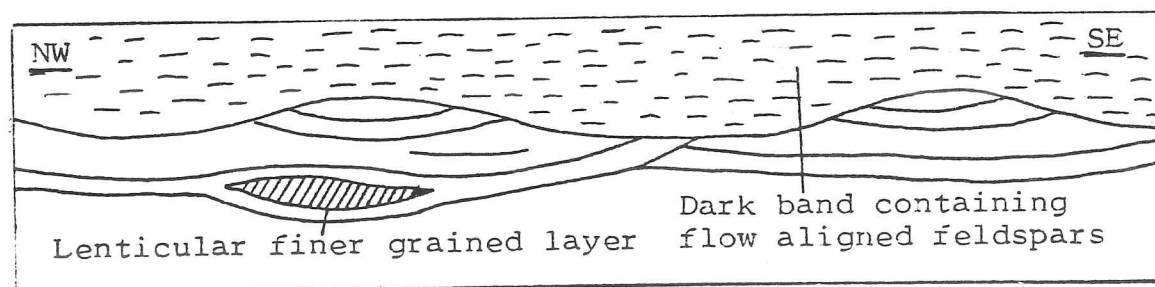


Fig. 15: Diagram to show the contact relations at the base of the dark band on the Snow Dome.

- (2) Small gabbro chip from the Snow Dome;
- (3) Leucocratic gabbro from the Wind Scoop; Major element analysis given in Table 1 (KFC 1);
- (4) Some granules of leucocratic gabbro from the southern end of the ridge that runs northwest from Point John.
- (5) Granophyre containing nodules of gabbro and basaltic material. Major element analyses given in Table 1 (KFC 2).
- (6) Gabbro sample (medium grained) from the ridge to Point John;
- (7) Granophyre from Snow Dome.

We also collected some samples of amphibole veins from the Windscoop and elsewhere, one of which contained an excellent example of a fibrous hornblende up to half a cm in length.

It is hoped eventually to have our few remaining samples analysed, after which a more comprehensive and hopefully conclusive report will be produced.

Table 1: Major element analyses of three Kruuse Fjord samples.

	Gabbro (from Wind Scoop KFC1	Granophyre KFC2	Meta-gabbro (from Dark Band) KFC3
SiO ₂	43.72	67.13	32.22
Al ₂ O ₃	12.13	14.85	7.05
Fe ₂ O ₃	20.30	4.73	33.51
MgO	5.46	0.86	15.05
CaO	10.49	1.99	6.67
Na ₂ O	2.92	4.99	0.87
K ₂ O	0.44	3.93	0.04
TiO ₂	3.65	0.86	4.60
MnO	0.27	0.11	0.28
P ₂ O ₅	0.03	0.15	0.02
Total	99.66	99.59	100.32

Bibliography

- Myers, Bridgwater and Gill, G.G.U. Progress Report 1979-80.
- Myers, (1979) - Earth Planet Sci. Lett, 46, p407-418.
- Escher and Watt (Eds) - Geology of Greenland - especially Chapters 2, 3, 5 and 15.

MOUNTAINEERING REPORT

Simon Durkin

Introduction

One of the main objectives of the expedition was to investigate the mountaineering possibilities in the Kruuse Fjord area. It was felt that this would be inevitably linked with the geological objective on account of the terrain.

In our first four days at base camp we climbed some of the obvious routes in the immediate vicinity. We climbed a total of five new peaks by six routes and although none were of great length or technical difficulty they provided some very enjoyable climbing. From these summits we were able to confirm, at least visually, the feasibility of access routes into other parts of the range. Also we sketched out routes for more challenging mountaineering objectives. Unfortunately, due to the onset of bad weather these objectives had to be shelved.

Brief descriptions of the routes we climbed and a discussion of the potentials of the region now follow.

Traverse of Point John (1700m) from West to East

The finest peak visible from base camp was Point John, an elegant pyramid lying about two miles to the north. On 28th July, our first day at base camp, four of us set out to climb it. Charlie and Hugh took the straightforward looking East Ridge while Pete and I chose an approach from the west.

From the corrie to the south of the peak we avoided the large bergschrund by climbing a steep snow pyramid. This led to an obvious snow shoulder which was followed by a fifty foot rock step where we roped up. The rock step (Grade II) led to a very steep snow pitch which Pete led. This took us onto the West Ridge which swept up

steeply from the main glacier. The ridge was followed on steep ice for about 450 feet to the summit (3 hours).

We were joined on the summit by Charlie and Hugh who had arrived by the East Ridge. We all descended by this route which was straight-forward snow although steep at the top.

The time for the traverse was 4 hours, the grade about AD-. The peak was named Point John after my brother who was killed in a road accident in 1978.

Traverse of the Crete de Crud

To the southeast of base camp an obvious ridge rose up from the central basin of the range and led southwest to drop down the outer edge of the range. The ridge was important from an access point of view as it barred a direct approach to the high plateau around Beinn Birsay (Point 1930m), the highest peak in the range. Also its northern end seemed the most reasonable route for a descent into the central basin.

On 28th July Nick and Dave investigated this ridge. They traversed onto it at its northern end and first descended a few hundred feet. The descent was not difficult although the snow was steep and the slope still convex when they turned around without getting a clear view to the bottom. The climb to the summit was first on steep loose slabs with some interesting geology, then on steep ice. The summit, at about 1500m, was a pleasant roof-top of snow. Descending first on snow they came to the last section, a horizontal ridge of very broken rocks which gave the whole ridge its name. Finally a descent was made to the col at the southern end.

Ascent of the Pyramid Peak (c.1500m)

On 29th July Pete, Hugh, Dave and I explored to the northeast of base camp to look at access routes and to climb a prominent peak that has become known as the Pyramid Peak.

We climbed through a wind scoop around a tooth of rock about a mile north of base camp to reach the hanging glacier beyond. We crossed this to reach the col at the end of a long ridge running northeast from point John. From here we had hoped to turn the northern end of the Pyramid Peak to reach the glaciers and peaks on the northern edge of the range. However a steep icefall plunged down to the northwest from the col and did not provide a route. Instead we climbed the peak itself, 500 feet of steep snow took us to a rock ridge which we scrambled up to the summit.

From the summit we could see the northern end of the Crete de Crud where it dropped into the central basin. It looked steep but was free of major crevasses and clear of any serac debris from the icefalls on either side. It appeared to be the only reasonable route through the icefalls on the southern slopes of the basin. The headwall of the basin looked a definite no-go area with steep rock overhung by seracs and confused icefalls. However, the icefalls flowing south from the northern peaks looked more approachable, although still awkward and we could sketch out plausible routes for some of them. In particular, the long snow ridge running southeast from Point 1600m, a very impressive peak, looked like a promising route.

We descended by the same route and skied back to base camp. The grade was about PD.

Traverse of the Wanda-John Ridge

On 30th July Nick and Charlie set off to traverse the long ridge running northeast from Point John. The ridge had a central peak of around 1600m and several minor peaks and appeared to be of geological significance.

They started from the far, northeastern end where they climbed up a small snowy col by mixed ground on the left. There was not enough time to climb a small snow peak further northeast so they turned southwest towards the main ridge. Passing through a gap between a huge cornice on the left and an overhanging serac face on the right they reached the central summit by 6.30am. This was followed by a long rock arete with occasional steps and snow sections. The rock petered

out as they rose towards Point John so they left the ridge and traversed the east face of Point John to reach its east ridge. The traverse was awkward and time consuming on steep and slushy afternoon ice.

The ridge was over 1000m long and the whole route took 16 hours, it was graded at AD.

Ascent of Beinn Birsay (1930m)

The highest peak in the range lay southeast of base camp beyond the Crete de Crud. It had a very spectacular Southwest Face and a fine, long South Ridge in which we were particularly interested.

On 31st July Dave, Hugh, Pete and I set off for the col at the southern end of the Crete de Crud. We traversed the Crete northwards to reach its summit in under two hours. We then headed southeast, first descending 50m to reach the northeast flanks of Beinn Birsay which we climbed easily on gentle angled snow. Apart from one deviation to avoid a bergschrund we kept to the heavily corniced ridge and reached the twin summits in another hour. There was no cornice at the summits and we could peer over and down the huge Southwest Face. The South Ridge rose over 1000m up from the glacier directly to the main summit. It was mainly rock which looked sound, particularly where it steepened towards the top. The only major obstacle on the ridge appeared to be a deep notch one third of the way up. We descended a few hundred feet to the southeast of the summit to get a profile view of the ridge and to look at the peaks and passes in the southern corner of the range, many of these looked quite reasonable.

We returned to base camp by the same route; the round trip took 7 hours and the grade was F. We named the peak Beinn Birsay in honour of our patron, Lord Birsay.

On 3rd August Nick, Charlie, Pete and I set off to climb the South Ridge of Beinn Birsay, prepared for a long day. But we abandoned the attempt before reaching the foot of the ridge in the face of an imminent storm. The storm lasted for five days and effectively put paid to our plans for further routes.

Conclusions

In the limited time available we had climbed all of the major peaks easily accessible from our base camp except for one: the Snow Dome (ca. 1800m) immediately to the south. However, the five peaks we climbed were but needles in a haystack and the Kruuse Fjord area offers many more fine peaks. Most of these would involve access via the central basin or via a traverse of Beinn Birsay to reach the southeasterly basins. They would therefore require a least one and probably two bivouacs.

Given more good weather we could certainly have accomplished some of these routes. But the routes we did accomplish were very satisfying and leave us with many happy memories. For me, the ascent of Point John by the West Ridge will always stand out as one of the most enjoyable mountain days I have experienced.

Further Mountaineering Notes

Character of Climbing in the Kruuse Fjord Area and Potential Further Afield

Pete Brownsort

If the peaks we climbed were as needles to the haystack of the Kruuse Fjord range they were as grains of sand on a beach compared to the peaks we flew over, sledged through or saw in the long views northwards towards the Watkins Bjerge.

That being said, the Kruuse Fjord mountains are very distinctive in several ways some of which are attributable to their geology. It was this distinction, the geology and the unexplored nature of the area that tempted us there in the first place.

To the north and west of the range are vast, low-lying glaciers while to the south is an area of complex turbulent glaciers and small peaks. While peak heights gradually increase with distance inland there is not a peak to match Beinn Birsay in height at a similar distance from the coast for thirty miles north or south. When viewed from inland the range presents its largest and steepest faces, a consequence of its invariably dipping layered rocks and the scouring action of the more powerful glaciers fed from the ice-cap. The peaks have simple but bold features and often a degree of symmetry. The enormous rock walls and ice faces of the range are absent from the mountains of the surrounding country which tend more towards pinnacles, ribs and covloirs. The rock itself when seen from a distance has a different tone being blue-black as opposed to the warmer, brown tones of the country rock.

Proximity to the sea, relative height and a direct exposure to the cold winds from the ice-cap may be factors that have combined to allow a greater build up of ice in the range than elsewhere in the coastal mountains. This contributed much to the character of our climbing as

the easiest routes on the peaks were climbed were mainly on snow and ice. On north-facing slopes the snow often lay extremely steeply and was generally hard green ice within about six inches of the surface. This gave excellent and exciting climbing well protected by good ice-screws. Snow and ice features such as cornices, bergschrunds and crevasses were of an impressive scale and the ice-falls above the head-walls of the central basin were continuously active. We avoided all these objective dangers.

We did little rock climbing and the rock, though inherently sound, was generally pretty loose as would be expected with such an active freeze-thaw cycle. Although there was much stonefall, there was none of an anthropogenic nature from above as is common in the Alps. But the sport of Boulder Trundling was often practised - a very satisfying and perfectly safe activity when you know exactly where everyone is within a fifty mile radius! The unhidden dangers particular to French belay ledges were thankfully absent.

Avalanches were not unknown - contrary to some information we had received. We saw evidence of wind-slab avalanches and there were continuous fresh snow avalanches off the steeper faces after the five-day storm. .

One of our stated objectives was to open up the area for future expeditions. While we have fairly conclusively demonstrated that one cannot wholly rely even on overland transport in areas as remote as this (let alone air or sea transport) it is worth commenting from a climbing point of view on the more interesting areas we passed through.

A mere eighteen hundred pounds will take you by helicopter in fifty minutes from Angmagssalik to the Pourquoi-Pas Glacier. Here there are many fine peaks of 2000m to 2400m but it is likely that some have been climbed - after all you could almost do a route in a weekend from London, so what can you expect. But the routes all looked excellent, and spread over a range of standards

Less easily accessible but as far as I know all unclimbed are the peaks around the head of the Laubes Glescher to the north of Tassilaq. These range from 1600m to 2000m and include some impressive rock spires and walls. It would take perhaps ten days to set up a base camp in this area after being dropped by boat at Tassilaq beach. There are also fine mountains all around Tassilaq Fjord which have been explored by several previous expeditions.

Towards the edge of the ice-cap, perhaps forty miles from the coast, there are a number of snow peaks 200m to 3000m high which we saw from our sledging route. These appeared to offer fairly straightforward climbs but their height and remoteness would give an exciting challenge perhaps to a strong ski-mountaineering party.

In addition to these more serious areas our return journey by boat showed us the limitless possibilities for climbing holidays among the beautiful islands and fjords all along the coast for sixty miles north east of Angmagssalik.

In considering climbing in areas as remote as those mentioned above one must always bear in mind that the journey to a peak will often be a greater challenge than the ascent of that peak. This certainly proved to be the case on this expedition.

PHYSIOLOGY

Charles Morton

Background

It is well documented that various periodic or cyclical parameters of human behaviour may be manipulated by environmental factors. Aschoff(1) showed that human volunteers living in isolation with no reference to time, or access to environmental clues such as the day/night cycle ie: under constant illumination exhibit a drift away from the normal 24 hour sleep/wake cycle and diurnal rhythm of renal function. The period reported in one experiment was one of 26 hours. Further, he demonstrated that the 'natural' period could itself be altered by varying the intensity of constant illumination. Mills(2) reported that a male subject living in isolation underground for 105 days likewise exhibited this drift of diurnal rhythms, the period being 24.5 hours. This was in spite of being in possession of an accurate watch, and thus being aware of 'real' time.

Objectives of the E.U.E.G.E.

On this expedition we were to experience continuous daylight. Owing to our relatively low latitude ($67^{\circ} 20'N$) there would inevitably be a variation in the intensity of light. Reports indicated that even at the darkest moments there would be sufficient light for full activity. This indeed was the case for the time of the experiment. In addition we planned to travel at 'night' when the snow was in its best condition, in other words we would be 12 hours out of phase.

It was decided to study the sleep patterns of all six members of the expedition in relation to:

1. A possible drift away from the 24 hour cycle. This might occur in a similar way to that reported by Mills above in spite of possession of watches and clocks.

2. The difficulty or otherwise of adjusting to the "out of phase" routine. This is known to be of relevance to industrial shift working and presumably also of importance in planning similar schedules on polar expeditions.

Methods

For the six weeks prior to departure all members kept a record of their sleep patterns to act as a control. On the expedition records of all members' sleep patterns were kept on charts.

Observations on the physical rigours of each day were made, and the difficulties of adapting to new routines recorded.

Results

When the results have been fully considered in the light of available literature they will be submitted to a suitable journal for publication. In the meantime further information may be obtained from the address below.

References

1. Aschoff, J. "Circadian Rhythms in Man" Science: 1965 : 148, pp 1427 -1432.
2. Mills, J.N. "Three Months Underground" J. Physiology: 1964 : 174, p217.

Further information regarding the medical or physiological aspects of the expedition may be obtained from:

Charles Morton
Woodcroft
The Avenue
March
CAMBRIDGE PE15 9PR

MEDICAL REPORT

Charles Morton

There are many reports by doctors on the planning and provision of medical aspects of the expeditions in which they have taken part. Medical planning for this particular expedition was much facilitated by these and by personal advice from other expedition doctors. The essence of such planning must be anticipation of events and their management, including the possible evacuation of casualties.

The medical equipment consisted of three small first aid kits (one for each climbing/sledging/camping pair) and one larger box.

The small kits contained:

Aspirin 300mg	10
Paracetamol 500mg	10
Codeine Phosphate 30mg	12
Sennakot tablets	5
Metaclopramide	5
Chloramphenicol "Minims"	2
Pentazocine 50mg	6
Pentazocine 30mg/ml. inj. 2ml	3
2 ml syringe with needle	3
Triangular bandage	1
Crepe bandage roll	1
Elastoplast 12cm x 3.8cm	
Melonin dressing - large	1
Melonin dressing - small	1
Roll of micropore tape	1
<Gauze swabs - pkt of 5	1
Mediswabs	3

These contents were packed in polythene boxes 7" by 4.4" by 2.5" and weighed 12oz. Instructions for use of the various items were included.

The larger box contained some stock of the above items, some antibiotics, some plaster of paris sufficient to manufacture a backslab and a suturing kit. In addition my own first aid kit contained Cyclimorph 15mg x 5 and a No. 2 plastic airway.

During the expedition medical problems were luckily negligible. A number of cases of diarrhoea occurred in storm bound camps doubtless due to poor personal hygiene. Codeine Phosphate was an effective treatment. There was one case of contact dermatitis from paraffin, our only fuel. This was effectively controlled with Clobetasone Butyrate ointment. Most of us found sleeping difficult on the return journey in spite of a state of increasing physical exhaustion; waking after 4-5 hours sleep and being unable to fall asleep again was the common problem. Temezapan 30mg proved to be ineffective and a longer lasting benzodiazepine would have been more appropriate.

As a general comment the small first aid kits were always far more accessible than the larger box. For instance on the one occasion when the suture kit would have been useful the medical box was buried under four feet of fresh snow! Steristrips in the small kits might be a more sensible alternative.

Further Reading

Illingworth R. "Medical Equipment on Expeditions B.M.J. 1981, 282, p202.

FOOD REPORT

Pete Brownsort

I was originally chosen to be food officer on account of my notoriously large appetite. Nick thought this would be the best way of ensuring ample food supplies and preventing me from complaining if there were insufficient.

Rather than get bogged in complicated food energy value calculations I decided to rely on my natural instincts in designing the rations. As a starting point I took the type of ration I normally take on winter climbing trips in Scotland and while these are usually supplemented with quantities of chips and beer they proved to be an adequate framework.

The resulting diet was based around simple carbohydrates: oats, biscuits, sugar, pasta and sweets as opposed to the more traditional pemmican, margarine, dried fish and dog of the Watkins era. We kept to some traditions, however, and commemorated the anniversary of Watkins' death by dropping to half rations as our food ran out at Tassilaq.

There were three major constraints to be considered in designing the rations. Firstly, and most importantly, weight; we originally intended moving everything ourselves overland. Plans for an R.A.F airdrop and the various luxuries that would allow came and went. Eventually we had to carry five weeks' supplies ourselves and two more were delivered by the helicopter on its visit. My original target weight was set at about one kilo per man day, I managed to get pretty close to this figure (c. 1.2kg) even including packaging.

The second major constraint was the ease of preparation of the meals. I felt that particularly on the sledging journeys, the quickest and easisest meals would be best. This led to the design of two types of supper menu; one for sledging rations using tinned meats and another for base camp rations using dried meat which would require

longer cooking and larger amounts of water, but which would be lighter.

The third constraint was the time delay between obtaining the food and its eventual use. This required all the items to keep for several months.

Two obvious and overriding factors were that the food should be generally liked by the team members and that we should be able to afford the rations I designed. We were helped with the last point by the generosity of many companies to whom we are very grateful. The final cost to us of the eight weeks rations that we bought in Scotland was slightly less than we would have spent in a similar period in Edinburgh.

The following lists give details of the various components of the rations.

Breakfast

Each breakfast box contained the following items and was designed to last two men (a tent/sledge pair) for a week. Each box weighed 5kg gross.

750g Scotts porage oats
 600g Pattersons oatcakes
 250g Muesli base
 1000g Sugar
 500g Stork margarine
 284g St Ivel 'Five-Pints' dried milk
 454g Either jam, marmalade, honey or peanut butter
 100g Nescafe (to last more than one week)
 Teabags (14)
 Salt, a small drum

Lunches

The lunches were aimed to provide a continuous supply of small snacks all through the day. The menus were similar throughout the expedition. Sledging lunches were packaged together with sledging suppers, the following items giving a six man day unit in a box weighing 5kg. The base lunches were packed separately as six man day units.

Protein base: Three small tins or packets of either sardines, various pates, corned beef, chopped ham with pork, Austrian smoked cheese or Kraft cheese slices.

300g Oatcakes

400g (2 packets) of sweet biscuits, either Fruit and Spice, Abbey Crunch, Fruit Shortcake, Gingernuts or Digestives.

250g (2 packets) Cheddars, cheese biscuits

Either 400g assorted dried fruits,

Or 6 x 25g packets of peanuts, fruit and nuts, etc.

Either 1 x 200g or 6 x 20g bars of Cadburys milk chocolate

6 bars: either Mars, Topic, Marathon, or Milky Way.

100g Boiled sweets or toffees.

Sledging Suppers

The following items were packed together with the lunches to make the six man day unit.

Soup: 6 packets of Batchelors 'Cup-a-Soup'

Protein base: either one large tin of ham or two standard (1lb) tins of one of the following, pilchards, haggis, mince and potatoes or beef casserole.

Carbohydrate: either 750g of various pastas or rice, or a 'sufficient' (see below) amount of instant potato mix.

Vegetables: one third of a catering pack of Batchelors dried vegetables, either cabbage, carrots, peas or green beans.

Puddings: only every other day. Either dried apple flakes plus instant custard mix or cheese-cake mix.

Base Suppers

The base rations were all dehydrated foods in catering packs and were packaged in roughly 42 man day units.

Soup: Erin dried soup mixes, various flavours.

Protein base: Batchelors 'Ready Meals', dried meats in a number of different recipes.

Carbohydrates: vegetables and puddings as for sledging rations.

Kitchen Sundries

We also had several boxes containing the following sundries.

Kellogs 'Rise and Shine' dried fruit juices		
Colmans 'Cook-in Sauces'	Tomato puree	Stock cubes
Flour	Mustard powder	Sugar
Salt	Mixed spice	Matches
Pepper	Tea bags	Candles
Mixed herbs	Coffee	Toilet roll
Garlic powder	Dried milk	Kitchen roll
		Tissues
		Detergent

Fuel

We used Primus stoves for cooking and took a fuel allowance of 1/4 pint of paraffin per man day. This proved to be sufficient even when we had to melt all our water from snow.

Overall the energy content of the rations appeared quite sufficient. None of us sustained any significant weight loss although for much of the time we were involved in strenuous exertions. However, the bulk was fairly low and we were often hungry. This was most noticeable when we were stormbound with nothing to take our minds off food.

In retrospect the distinction between sledging and base rations was unnecessary. The dried meats we used did not require great quantities of water, they could be cooked in the same time as the rice or vegetables and in the same pot. So we could have used them the

whole time and saved weight. However, on a future expedition I would still probably take some tinned meats as they provide better flavours and textures, do not have the devastating effect on the digestion that dried foods have and we were lucky enough to get to get most of our tins supplied free.

It is worth mentioning some of the more memorable and important points about particular items. The instant mashed potato was rather a failure, it was the only thing that ever leaked significantly, the fine powder getting everywhere. Also no matter how much we used it never seemed enough, rice and pasta are much more satisfying. The dried cabbage was pretty unpleasant but the dried green beans were excellent.

The Colmans 'Cook-in Sauces' were very good and made a lot of the other flavourings and seasonings we took superfluous. However, the Tandoori and Vindaloo flavours had to be banned quite early on: Toilet roll is difficult to judge and we took too much. We took one roll per day but only used about half, although we didn't lose any through dampness as I had expected to. We also took too much salt, 2lb would have been ample.

For drinks we took 1.5kg of Nescafe and about 800 tea bags most of which were used. We also had instant soups and 'Rise and Shine' fruit juices which were greatly enjoyed and gave us a supply of vitamin C.

We found that tins of Spillers 'Tyne Brand' beef casserole contained hardly any meat and were therefore unsatisfactory. In contrast the Grants Bs tins of haggis and mince and potatoes were both excellent. The dried apple flakes were also excellent and very easy to prepare, we wished we had taken more. The cheese-cakes were quite difficult to prepare but were usually worth the effort. The bags of flour were useful for making extra-filling snacks, we often cooked 'chipattis' and even some cakes.

Certain team members soon became fed up with large numbers of 'Cheddars' although some of us liked them. However, the oatcakes were perhaps the most sought-after commodity during the expedition. They became a kind of currency and were used for various exchanges and as payment for tasks performed.

While St Ivel 'Five-Pints' dried milk is itself very good, the uses to which the empty bottles were put made it an essential item. These uses ranged from milk mixing, storage and measuring of other foods and water, replacements for broken mugs and other culinary uses to the less obvious uses as paraffin bottle and the extreme use as a pee-bottle for use when stormbound; clear labelling was essential!

Packaging

All the food was sorted and packed in Edinburgh in May 1982. Many items were weighed out into portions and heat-sealed into polythene bags. When each box was packed it was numbered and also heat-sealed into a large, tough polythene bag.

We used three types of boxes. A flattish, tray-like box made of coated cardboard and supplied by Bowaters was used for breakfast boxes and sledging rations. Large cardboard boxes with an outer sleeve of coated cardboard provided by Thames Case were used for the base rations. Plastic boxes with snap-on lids from DRG Plastics were used for some lunches and all the sundries. We had no problems with this packaging, nothing got significantly damp although the stores were often left lying around in snow and rain and were treated roughly while sledging.

The packaging policy for the sledging rations was very convenient. Separate breakfast boxes for each pair were essential as we always had breakfast in bed. The food for the rest of the day was all in a single box so most of the sledge loads could remain undisturbed. The cook of the day preparing the meal then had everything to hand and already measured out.

Acknowledgements

I would like to thank the following companies for their help.

Food - supplied free of charge by:

Alliance Cash and Carry
Brooke Bond Oxo Ltd
Colman Foods Ltd
Grant Brothers (Meat Cannery) Ltd
Keen Cost Cash and Carry
Lyons Tetley Ltd
Pattersons Scottish Shortbread Ltd
Roots Wholefoods
St Ivel Ltd
A. & R. Scott
Spillers Foods Ltd
Tate & Lyle Refineries
United Biscuits Ltd
Van den Berghs & Jurgens Ltd

Supplied - at reduced cost by:

Batchelors Catering Supplies Ltd
McNabs Groceries Ltd

Packaging - materials supplied free by:

Mackinnon and Hay (polythene bags)
Bowaters
DRG Plastics
Thames Case Ltd

Polythene bag heat-sealer lent by the Botany Department, University of Edinburgh.

So with the help of these companies the catering was very successful and in retrospect the job of food officer was very satisfying. The standard of cooking was generally very high, particularly at base camp with its well organised kitchen. The memories of a good meal and comfortable seat (albeit cut from ice) on a warm afternoon surrounded by superb views will be with me for many years; although I suspect that the memories of the few culinary disasters such as the 'Tandoori Potato Soup' and the 'Ham a la Thixofix' might remain as long.

Equipment Report

Hugh Mackay

None of us had been on a sledging expedition to Greenland before so we chose our equipment on the basis of alpine and Himalayan experience, reports of similar expeditions and discussions amongst ourselves. Having returned we have gained an insight into the type of gear needed to survive and prosper in an arctic summer environment. I hope to highlight some of our successes and failures in this report so that future expeditions may benefit from the experience.

Personal Equipment

The expedition took place in July and August during the short arctic summer. The weather would be better described as alpine rather than arctic. Typically the daytime temperatures are high while at night they may fall a few degrees below zero. However storms were fairly frequent and during these virtually all conditions were encountered from persistent fog and drizzle to severe blizzards lasting several days.

Clothing worn on a cold sledging night would typically consist of thermal underwear, a wool shirt, polar jacket and a windproof/waterproof jacket of some description. For the latter thinsulate jackets were found to be ideal since they were robust and remained warm when wet, if necessary they could be combined with goretex or other waterproof cags.

Single alpine boots were quite sufficient for climbing and walking. For much of the time we wore nordic ski boots which can double as a lightweight walking boot. These were found to be cold on occasion.

Other essential items were spare gloves, snow goggles and high factor suncream.

Transport

Virtually the whole expedition was spent on travelling across snow covered glaciers. We decided that the best way to travel on this type of terrain was by using skis and man-hauled sledges. For most of the journey this combination worked very well, the skis provided adequate traction and only had to be removed on steep uphill sections with a hard surface.

Before we left we had experimented with various types of ski, including waxed and non waxed nordic skis and mountaineering skis with skins. We finally decided on Trak Telemark non waxed nordic skis. They are light, have steel edges, are easy to put on and the bindings have few moving parts to go wrong. Non skiers found them easy to use and they required no attention. The last thing one wants to do on emerging from a tent at 11pm on a freezing night is to start fiddling with waxes. The only disadvantage of nordic skis is that one must carry two pairs of boots, one for skiing and the other for climbing.

We used three ex Royal Marine Pulka sledges, with two people hauling each sledge. The pulka sledge is essentially a 5' by 2' tray with three 1" wide steel runners screwed directly onto the 1' base. The sledges were inexpensive but were not really the best design for the high and heavy loads that we put on them (around 180kg). As a result they were rather unstable. They were however very strong and held out to the end despite constant use and some spectacular crashes. Some minor repairs were carried out involving rescrewing some of the runners.

Unfortunately there is a great shortage of sledges available for this type of expedition. We tried to obtain Nansen sledges (which would have been ideal) but the cost of these was prohibitive (about £500 each) and it is difficult to find suppliers. Most of the types of stretcher sledge used in mountain rescue are unsuitable and again expensive. The best solution in future might be to build ones sledges basing the design on a modification of the dog sledges commonly found in Angmagssalik and seemingly of simple build.

The sledges were hauled by ropes attached to padded hip belt harnesses which we designed and built ourselves. The point of attachment of rope to harness had a quick release device so that one could free oneself if a sledge ran out of control or fell down a crevasse.

Accommodation

We had two Vango "Force tens" and one Ultimate "The Tent". The Vangos had to be specially adapted for glacier camping by sewing a 45cm wide nylon snow valance around the perimeter of the flysheet. A snow valance is essential as pegs will not hold down the tent securely, especially in soft snow; it also completely seals the inner tent from wind and spindrift. Bamboo garden canes were found to penetrate deeper and have more securing power than normal tent pegs.

Two snow shovels were carried and were used for both digging in and digging out. At base camp we dug deep pits for them so that the main force of any wind would pass over the top.

9mm Karrimats provided barely adequate insulation from the cold ground.

Arsenal

There was a remote possibility that we would meet a Polar Bear and so a .308 calibre hunting rifle was taken to deal with this. As it turned out polar bears were most noticeable by their absence, and the gun was rather heavy. It is worth noting that one can buy rifles in the supermarket in Angmagssalik for £20 upwards which is much cheaper than buying an expensive gun and license in Britain.

A selection of pinpoint and smoke flares were also carried and were used for attracting the attention of helicopters, boats etc.

Radios

We are indebted to Plessey Avionics who lent us all our radio equipment. We could not possibly have afforded to buy our own.

We took the following equipment:

- 2 x Clansman RT 320 Manpacks
- 2 x Hand generators (for recharging batteries)
- 2 x 1 ah batteries
- 2 x Whip antenna
- 2 x Dipole antenna
- 2 x Dipole mast
- 2 x Handset
- 2 x Earth

Two of everything was carried in case one broke down.

Using this equipment and the Dipole antenna we were able, on occasion, to communicate with Angmagssalik, from our base camp at Kruuse Fjord, a distance of some 160 miles. The quality of reception and transmission were dependant on weather conditions; if the weather was bad we could not communicate at all. However during clear conditions reception was extremely good.

As far as radios are concerned one thing became clear, that is except in cases where first class equipment is being used by expert hands they are not to be relied upon. We found that their effectiveness was at best sporadic. The message is simple, an expedition of this sort that relies heavily on radios as a crucial part of its planning is flawed from the start. Although it is still important to carry some means of communication as a safety measure.

The Blue Tube

One of the main problems of the coastal ice cap environment was the lack of running water. The only two methods of obtaining water were by melting snow on the primuses or by using the heat of the midday sun to melt water for us. For the latter case we developed an efficient method of melting snow using a length of dark blue polythene tubing. About ten metres of tubing was used one end was tied off, and snow shovelled in the other end. Once full, the open end was also tied off so that the snow was completely sealed in. After about three or four hours the tube would contain two to four gallons of water. This method was quite effective even on overcast days and we reckoned that it may have halved our paraffin consumption.

Equipment List

Personal: Ice axe, ice hammer, crampons, climbing harness, deadman descender, two slings, prussik loops, helmet, boots, gaiters, ski boots, skis, ski sticks, sledging harness, gl dubbin, 3 pairs wool socks, 2 pairs mitts, 2 pairs gloves, 1 set of thermal underwear, 2 pairs Y fronts, 1 wool shirt, 1 Thinsulate jacket, 1 pair overtrousers, karrimat, sleeping bag, scarf, towel, toothbrush, stationary.

Per Sledge: Teachest, 10 litre plastic jerry can for parrafin, primus stove, billie set, wooden spoon, meta tablets, first aid kit, geological hammer, rope, bamboo canes, candles, binoculars, 1 smoke flare, 1 pinpoint flare, toilet rolls, food boxes.

Miscellaneous: Spare crampons, spare ice axe, spare ice hammer, spare ski sticks, spare ski bindings, spare goggles, tent spares and repair kit, primus spares and repair kits, tool kit, spare primus, spare meta fuel, rifle and cleaning kit, 50 rounds of ammunition, 2 two gallon dixies, 2 snow shovels, ice saw, plastic basin, 2 smoke flares, 2 parachute flares,

3 pinpoint flares, blue water tube, main first aid kit, fishing tackle, heliograph, mapping equipment, geological hammers, collecting bags, drawing paper, ski wax, radio equipment (described elsewhere).

Climbing Equipment: Were were uncertain as to what to expect in the way of style and difficulty of climbing. Consequently we took more than we actually needed, particularly rock climbing gear.

11 ice pegs, 40 krabs, 14 screw gate krabs, 12 extension slings, 24 pitons, 6 deadmen, 9 assorted chocks, 4 friends, 3 x 9mm and 2 x 11mm ropes, abseil tape, harnesses, helmets, descenders, crampons, ice axes and hammers.

Acknowledgements

The following companies supplied equipment to us at reduced rates.

Alpine Sports (Blues) - Edinburgh

Berghaus

Clog Climbing and Safety Equipment

Black and Edgington Sports

Thermawear Ltd

Helly Hansen (UK) Ltd

Karrimor International Ltd

Kodak Ltd

Plessey Avionics and Communications Ltd

Graham Tiso Ltd

Finance

The cost of the expedition escalated rapidly as time proceeded. The rule of thumb that suggests taking the maximum estimated cost and then doubling it seems to work quite well. It is also essential to begin financial planning at an early stage, in order not to miss the deadlines of the grant giving organisations, some of which are in the autumn of the previous year.

The fund raising activities consisted of printing a prospectus and sending this to a selection of companies and organisations, along with a covering letter. We found the response very encouraging and it showed that there is considerable scope for raising money for this type of venture despite the harsher economic climate.

The main financial constraint on expeditions to Greenland is the high cost of internal travel. For instance we bought two hours worth of helicopter flying time at £930 per hour and chartered a fishing trawler for five days at a cost of around £20 per hour.

The accounts shown below give a fairly detailed breakdown of our expenditure, and perhaps illustrate how the bills for what might be thought of as peripheral items rapidly mount up.

Income

Industry

	£
Mobil North Sea Ltd	250.00
Scottish Grain Distillers Ltd	25.00
Charles Openshaw and Sons Ltd	50.00
ABC Chemical Company Ltd	50.00
Bank of Scotland	100.00
RTZ	100.00
BP General Education Charity	100.00
Marconi Space and Defence Systems Ltd	350.00
Reed Stenhouse UK Ltd	100.00
Christian Salvesen Ltd	100.00

Grants

University of Edinburgh	100.00
Edinburgh Geological Society	200.00
Lothian Regional Council (Countryside Award)	200.00
Gino Watkins Memorial Fund	400.00
Mount Everest Foundation	650.00
Royal Geographical Society	250.00
Scottish Mountaineering Trust	200.00
Edinburgh University Mountaineering Club	75.00
Augustine Courtauld Trust	250.00
Gilchrist Educational Trust	150.00
Scottish Sports Council	200.00

Private Donations	120.00
Members' Contributions (£875 each)	5,250.00

TOTAL 9,270.00

Expenditure

Equipment:

	£
Climbing equipment	78.00
Sledging harness	50.00
Snow valances	38.00
Flares	19.00
Meta fuel	31.00
Sledges	50.00
Gun and ammunition	262.00
Medical supplies	131.00
Film	86.00

Administration

Stationary and stamps	140.00
Maps	55.00
Phone Bills	42.00
Petrol	24.00
Bank charges	33.00
Gun license	25.00

Food	384.00
Crates and cases	133.00
Insurance	648.00

Travel

Air fares to Greenland	2,208.00
Freight to Greenland	436.00
Helicopter transport in Greenland	2,000.00
Boat charter in Greenland	2,175.00
Additional expenses	<u>134.00</u>

TOTAL 9,182.00

Some Notes on Expedition Planning

1. Permission

Permission to go ahead with the expedition was sought from the Ministry for Greenland in Copenhagen and the application took the form of a questionnaire. Permission was received in March 1982.

2. Shipment of Equipment

Needs to be arranged well in advance, the first boat arrives in Angmagssalik around 1st of July, but if the ice is bad this may be delayed.

3. Personal Travel

Several travel agencies are able to offer discount air fares to Greenland which work out cheaper than dealing direct with the airlines themselves. Two companies worth approaching are Twickenham Travel, (Twickenham) and Regent Holidays (Shanklin, I.O.W.).

4. Internal Travel

This is very difficult to arrange in advance - there are two methods. Firstly, helicopters - which are very expensive and of dubious reliability. Secondly, there is boat charter, however boats are usually busy during the short summer season and are again fairly expensive, especially if you get stuck in the pack-ice.

Of course the best answer is to have your own independent travel: Canoe/raft/inflatable/lilo etc. But we are unable to give any advice on this.

5. Summary

The most important advice that can be given about planning an expedition to Greenland is as follows:- Don't believe anything anyone tells you, unless it is first hand knowledge. For instance the helicopter payload and other details were obtained from Greenlandair's Head Office and they turned out to be completely inaccurate.

Acknowledgements

We would like to thank the following for their help, given either as advice or as direct assistance:

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Douglas Anderson

Dr C K Brooks

Dr T F D Nielsen

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The Late Mrs Merylees

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