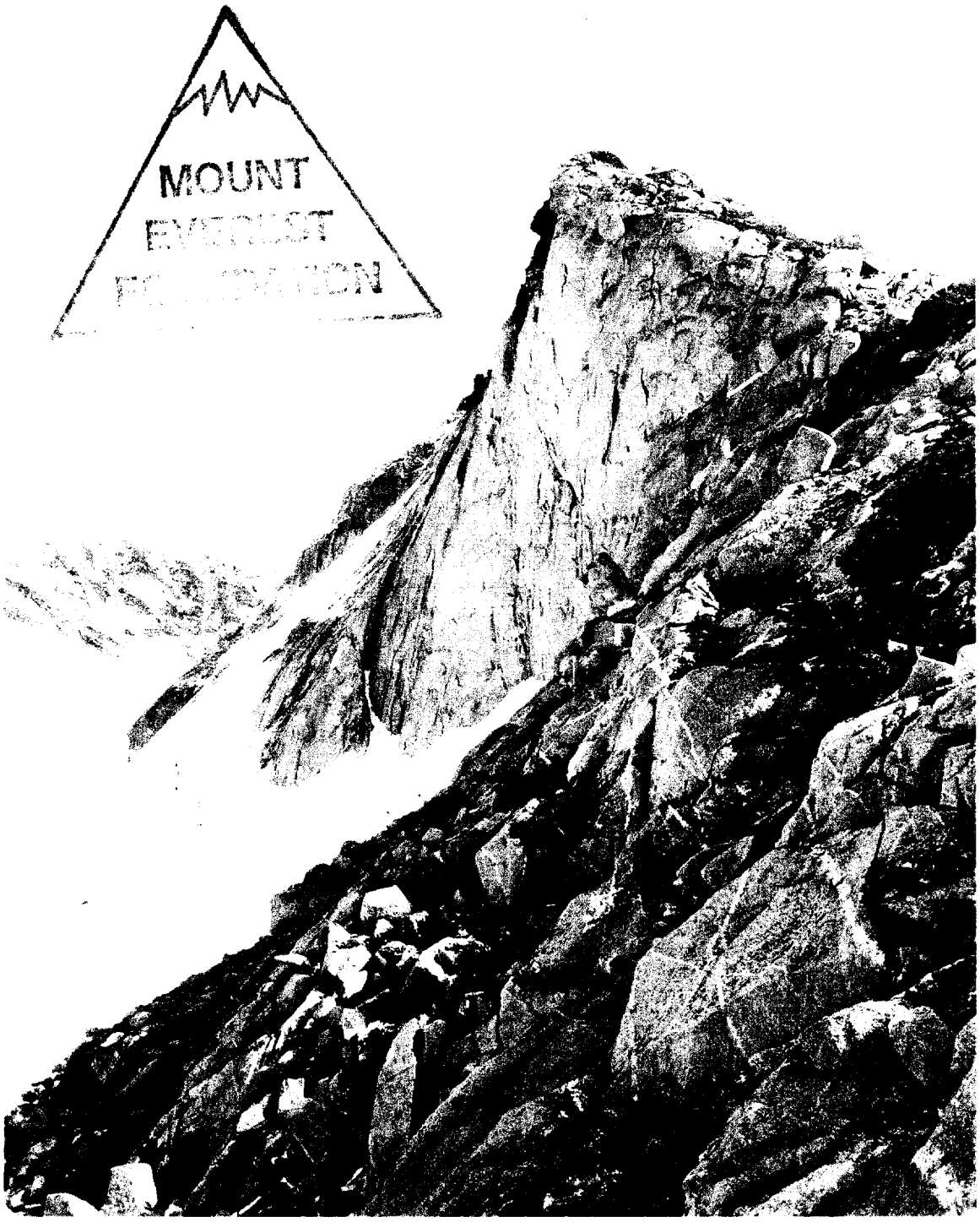
CAMBRIDGE GREENLAND GLACIOLOGY EXPEDITION 2002: FINAL REPORT



LOUISE BOYD LAND, NORTHEAST GREENLAND

4th July - 28th August 2002

Glaciological investigation into the mechanics of Arctic glacier confluences

Improved geological mapping

6 mountaineering first ascents

200 km ski tour

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1 INTRODUCTION

The Cambridge Greenland Glaciology Expedition 2002 visited a previously untouched area of Louise Boyd Land at 74°N, 28°30'W in Northeast Greenland. The expedition involved glaciological and geological research, alongside mountaineering and skiing objectives. The expedition was the product of over 18 months' planning and preparation, including physical training and the organisation of the scientific research programme. The expedition's aims, once in location, were to carry out a programme of field research into the glaciology and geology of the area; to attempt first ascents on four 2000 m summits close to the base camp; and to trek 200 km south to the fjords, for a boat journey back to civilisation. All these aims were eventually carried out successfully. The team overcame initial problems on arriving in Greenland, when it was revealed that some of the most essential freight (fuel containers, tents, some food) had gone missing in transit. Replacement of these with borrowed items luckily meant that the expedition could still go ahead.

Science

The main scientific project undertaken by the expedition was to investigate the mechanics of an Arctic glacier confluence. Interest in glacier confluences emerged during the planning period, after discussions with Dr. Ian Willis (Department of Geography) and Dr. Hilmar Gudmundsson (British Antarctic Survey) in Cambridge. The investigation involved daily surveying work while at the expedition basecamp, in order to measure surface ice velocities.

A secondary project was a detailed geological mapping investigation of the area surrounding the base camp. Two team members had just finished MSci Geology and were experienced in geological fieldwork. Despite severe time limitations, the expedition increased the detail of helicopter mapping by the Greenland and Denmark Geological Survey (GEUS) from the late 1990s.

Mountaineering

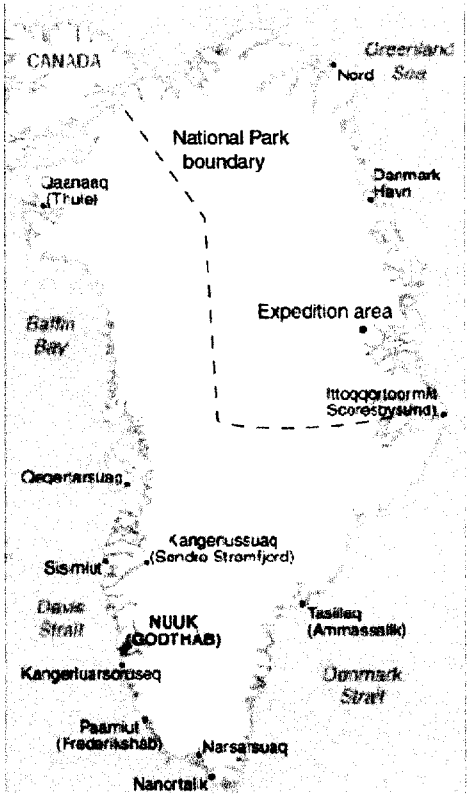
All members of the team are keen mountaineers and the main attractions of visiting the Greenland National Park were the remoteness of the area, and the possibility of climbing peaks and exploring areas that were totally untouched, and where no-one had been before. The team set out planning to climb four main summits, with the possibility of several others, depending on how the glaciology progressed. The alternative base-camp that was chosen also allowed several climbing and ski-mountaineering trips, and in the end six new climbs were completed.

Ski trek

For the remaining part of the expedition the team skied 200 km from Louise Boyd Land to Dickson Fjord further south, man-hauling pulks weighing up to 85 kg. The team passed along the edge of the Greenland Icecap, and then returned towards the coast down into the fjords. The team was picked up in small, semi-inflatable motor boats from Dickson Fjord, one of the most impressive of all the fjords in that region. From there the whole group returned by boat, via Ella Ø to Mesters Vig.

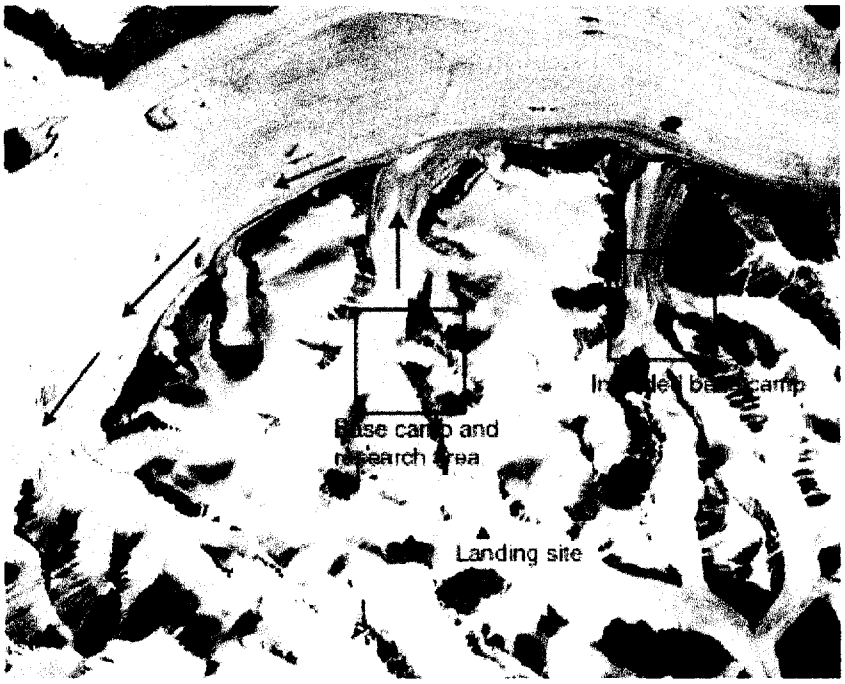
2 LOCATION AND HISTORY

Louise Boyd Land is at 74°N, 28°30'W in northeast Greenland, and is separated from the Greenland Icecap by a range of nunataks. It is approximately 250 km north-northwest of Mesters Vig, a Danish military outpost, and well within the Artic Circle (defined by the line of latitude at 66°N). The area is also inside the Greenland National Park.



Louise Boyd was an American explorer who was inspired to explore large areas of Greenland and the Arctic, after a cruise trip to Arctic regions in 1924. Throughout the 1930s Louise Boyd explored the fjords of Greenland's northeast coast, taking depth soundings and studying Arctic plant and animal life. She later became, at 68, the first woman to fly over the North Pole.

The team spent three weeks at the location outlined in the aerial photograph below. They then trekked out from Louise Boyd Land, heading south and west onto the Greenland Icecap, and then turning back towards the coast to reach the fjords.



Left: Aerial photograph showing the expedition's landing site and basecamp, and also the intended basecamp. This proved to be inaccessible with pulks. Red arrows mark the route taken at the beginning of the ski trek.

3 THE TEAM

Chris Lockyear (Team Leader)

Chris (23) graduated with MEng from St. Catharine's College, Cambridge. He is now working as a Field Engineer for Schlumberger (an oilfield services company). He anticipates many opportunities to travel overseas during his work, and is also very keen to continue exploring while he is on leave. In the future he hopes to return to university to do a PhD.

He has already taken every opportunity to travel, both within Britain and further afield. He was part of an expedition to Tanzania in 1997, where he worked with local communities and also managed to climb Mt Kilimanjaro. In 1999 he travelled around India, and in 2000 he travelled to Gabon and Equatorial Guinea in West Africa, while working for Schlumberger.

In 2001 Chris attended the BMC-run Conville course on Alpine safety and spent several weeks in the Alps. His activities there included climbing Mont Blanc and trekking the Haute Route from Chamonix to Zermatt. At the time of writing he has already taken the opportunity of furthering the skiing skills he acquired whilst in Greenland, spending 10 days cross-country skiing in Norway.

Chris is a proficient canoeist and an instructor in abseiling. He is also a keen cyclist and rower.
Contact: **chrislockyear@yahoo.com**

Madeleine Humphreys (Logistics Officer)

Madeleine (23) graduated with MSci (Geology) from St. Catharine's College, Cambridge. She has now started a PhD in Igneous Petrology at the University of Bristol. She is currently investigating the importance of volcanic degassing, in Montserrat, West Indies and Kamchatka, Russia. She has already done fieldwork in Montserrat, and is looking forward to visiting Kamchatka, Bolivia and Chile in the coming year, as part of her studies.

Her geological interest has already taken her on field trips around the world. She has done extensive fieldwork all round Britain and Northwest Scotland, and in recent years has also visited the Pyrenees, the Sierra Nevada in southern Spain, and central Greece. She also enjoys travelling outside geology and has spent time in Germany, Italy, Czechoslovakia and Switzerland.

In 2001 Madeleine also attended the Jonathon Conville course in the Alps, and climbed the Aiguille du Tour. Later in the summer she trekked the Haute Route (Chamonix to

Zermatt). She enjoys rock climbing and mountaineering within Britain too, and is now based in Bristol, where there is excellent local climbing. She is looking forward to participating in and organising more challenging polar expeditions in the future.

Madeleine is also a keen sports player, involved in rowing, running and badminton (in which she is a qualified coach).
Contact: **madeleine.humphreys@bristol.ac.uk**

Natalie Clegg (Treasurer)

Natalie (24) graduated from Clare College, Cambridge with MSci (Geology). Through her course she gained much fieldwork experience, working in the Lake District, Scotland, Greece and New Zealand, where she was mapping in the Seaward Kaikoura Ranges. She is currently taking a year out and is spending 5 months in Northern India from March 2003, teaching English. Afterwards she will be going to law school for two years before joining Ashurst Morris Crisp with the eventual aim of doing Environmental Law.

In the summer 2001 Natalie walked the Annapurna Circuit in Nepal and completed the Jonathon Conville course on Alpine Safety. She has previously travelled in Europe, Asia, Australia and New Zealand.

In her Gap year Natalie was a Short Service Limited Commissioned Officer in the Royal Logistics Corps. During that time she organised summer adventure training in the Bavarian Alps and attended a two-week ski-mountaineering course. She is an experienced and proficient skier and competed in the Army Divisional Championships in 1999. Her other interests include rowing and chocolate! She, too, hopes to return to the polar regions to undertake more challenging expeditions.
Contact: **n.m.clegg.98@cantab.net**

Derek Marshall (Medical Officer, Publicity Officer)

Derek (23) is now in his final (4th) year studying Electrical and Information Sciences at Corpus Christi College, Cambridge. An organisational mastermind, he is also President of the Corpus May Ball Committtee 2003 and is frequently involved with the Corpus Christi Playroom theatre as a technician. He is also an accomplished singer.

Derek is the only member of the team with previous experience in the Arctic. He was a member of the 1998 BSES expedition to North East Greenland, which was based around

Mesters Vig and studied the glaciology of that area. The first results of this research have just been published in the journal *Hydrological Processes*. Together with his previous expedition experience, Derek is well trained in First Aid. He attended a 3-day course in Mountain First Aid at the BMC Mountain training centre at Plas-y-Brenin, and a Wilderness Medical Training course, in preparation for the 2002 expedition.

During the summer 2001 Derek spent two weeks climbing in the Austrian Alps and a month teaching Japanese students in Cambridge. Derek created the expedition's website, using images from his 1998 expedition as a basis. He also maintains his own personal site, which contains many images of Greenland from both expeditions.
Contact: **derek@twintrees.demon.co.uk**

Sam Harrison (Mountain Leader)

Sam (22) graduated in 2001 with BA(Hons) in Philosophy from Queen's College, Cambridge. He spent the year 2001-2002 doing various temporary jobs, and enjoyed six months working in a non-technical post at Glenmore Mountain Lodge in the Scottish Highlands. There he was able to do lots of climbing in his spare time, and also attended a course in ski-mountaineering.

Sam travelled extensively around the Himalaya during his vacations from university, trekking in China, Tibet, Nepal and Northern India. In the summer 2000 he worked on a small rural farm in Ladakh, helping take in the harvest and learning more about the language and culture. He also climbed two 6000m peaks.

In the summer 2001 Sam also attended the Conville course on Alpine Safety. He stayed in the Alps for several weeks and a highlight for him was climbing the Chere Couloir on Mont Blanc du Tacul. Sam is a keen winter climber, leading Scottish grade V. He is currently living in the French Alps for the winter season, climbing and skiing, with the intention of gaining experience to work as a field assistant for the British Antarctic Survey.
Contact: **hamsarrison@hotmail.com**

4 PATRONS

Prof. Peter Friend (Department of Earth Sciences, University of Cambridge)

Peter Friend has been based in the University of Cambridge throughout his geological career. He has recently gone into 'retirement' but remains actively involved with the University, where he is still based in the Department of Earth Sciences and is an Emeritus Fellow of Darwin College. Early in his career he also worked in the Scott Polar Research Institute (SPRI) at the University of Cambridge.

His first major research programme involved seven summer expeditions in Spitsbergen, followed by three in East Greenland. These were all self-contained, light-weight expeditions using sledges, small boats and camps. His more recent areas of fieldwork have included the Middle East, the Himalayas (Pakistan and India) and the Pyrenees and Sierra Nevada of Spain. For a number of years he chaired the Cambridge Expeditions Committee and was a member of the Screening Committee for the Mount Everest Foundation. He was President of the Arctic Club in 2002 and is on the Screening Committee for the Gino Watkins Memorial Fund. He is currently also Chairman of the Trustees of CASP (the Cambridge Arctic Shelf Programme), which carries out geological research in many different parts of the world.

Prof. Mike Hambrey (Director, Centre for Glaciology, University of Wales, Aberystwyth)

Mike Hambrey was at the University of Cambridge for fourteen years, becoming Senior Research Associate in the Department of Earth Sciences and an Associate of the Scott Polar Research Institute, working on Arctic geology and the Earth's ancient glacial record. He moved to Liverpool John Moores University in 1991 as Head of Earth Sciences, before joining the Centre for Glaciology in Aberystwyth, becoming its Director in 1998 and Professor of Glaciology in April 1999.

For shorter periods he has been Guest Scientist at the Alfred Wegener Institute for Polar and Marine Research and President of the British Branch of the International Glaciological Society. He was awarded the Polar Medal by HM the Queen in 1989. His fieldwork has been primarily in Svalbard, Antarctica, Norway, East Greenland, the Canadian Arctic, the Andes and the Swiss Alps. His current research interests include the Cenozoic evolution of the Antarctic ice sheet, involving field work in the western Ross Sea region and Antarctic Peninsula, as well as the structural glaciology of Arctic and Alpine valley glaciers.

Mr. David Hempleman-Adams OBE

As a teenager, David Hempleman-Adams was initially inspired by the Duke of Edinburgh's Award Scheme to take up mountaineering and exploring. While a student at Manchester and Bristol, he visited Mt. Everest, and with Steve Vincent reached the summits of Mt. McKinley (Alaska, the highest peak in North America) and Mt. Kilimanjaro (the highest summit in Africa).

With polar trekking as a new challenge, in 1992 he led the first ever team to the Geomagnetic North Pole after abortive attempts on both the Geographic and Magnetic North Poles. During the next three years, he reached the summits of Mt. Everest, Mt. Elbrus, Mt. Aconcagua, Mt. Vinson and the Carstenz Pyramid, thus reaching the highest points in Asia, Europe, South America, Antarctica and Australasia respectively, and becoming only the third Briton ever to reach the highest point on every continent. In 1995 he received the MBE.

In 1996 he reached the Geographic South Pole after a 680-mile solo walk, and within a month had also reached the Magnetic South Pole by boat. In May 1996 he led the Ultimate Challenge team to the Magnetic North Pole, and after another abortive attempt, finally completed an unsupported expedition to the Geographic North Pole, reaching it with Rune Gjeldnes in 1998. He became the first man in history to reach the Geographic and Magnetic North and South Poles as well as climb the highest peaks in all seven continents, and was awarded the OBE.

5 EXPEDITION TIMELINE

TIME PERIOD	ACTIVITY
October 2000	Decision is taken to mount an expedition to Northeast Greenland
October 2000 to March 2001	Background investigations, discussions over possible research programmes. Visit to the RGS-IBG Expedition Advisory Centre. Important time for making contacts.
March 2001	Team is chosen, patrons agree to be involved with the expedition. First applications for grants are made.
March – June 2001	Logistical preparations continue.
Summer 2001	Team training in the Alps; all members of the team increase their mountaineering experience. Financial applications begin in earnest. Applications are submitted to the RGS and other organisations for approval.
Autumn 2001	Logistical arrangements are 'finalised'. The team receives official approval from the Cambridge Expeditions Council and receives Charitable Status. Letters are written to companies asking for goods to be donated to the expedition
January 2002	Team training on Ben Nevis, Scotland. Ideal opportunity for testing equipment, techniques, teamwork and food menus.
March 2002	Amongst other things, 18kg porridge and 300 cereal bars are collected from Jordans in Biggleswade. More food trips… and more food trips…
April 2002	The team decides to be picked up by boat at the end of the expedition – this will be a spectacular way of ending the expedition even though it demands last-minute changes to the logistical arrangements. More trips to buy and collect food…
11th – 16th May 2002	The team spends the entire weekend packing food and other equipment – in total over 1 million Kcal that will be consumed in just under two months…The 33 boxes are driven up to Paul Walker in Cumbria who is looking after the expedition's freight.
28th May 2002	The team attends a rifle training course in Cambridgeshire
25th June 2002	The team does sponsored skydives in order to raise money.
28th June 2002	Graduation from university for three team members!
1st July 2002	The team departs the UK, bound for Iceland
4th July 2002	Transfer from Reykjavik to Akureyri, Iceland.
5th July 2002	Fly by Twin Otter to Constable Pynt and Mesters Vig, Greenland. Collect freight at both places… But the team discovers that the tents and some food boxes are missing… After borrowing replacement tents, the team flies off to Louise Boyd Land.
6th July 2002	Try and reach the intended base camp area but it seems inaccessible with pulks. After all the delays, time is short and the team decides to find an alternative basecamp, which is reached on 7th July.
8th – 30th July 2002	Glaciological and geological research in Louise Boyd Land at the alternative base camp. During this time the team also achieves 6 first ascents on summits in the area.
31st July – 20th August 2002	The team leaves Louise Boyd Land behind and starts on the 200km ski trek to Dickson Fjord further south.
22nd August 2002	The team is picked up by boat from Dickson Fjord
24th August 2002	The team arrives back in Mesters Vig – and enjoys hot showers!
27th August 2002	Fly back to Reykjavik
28th August 2002	Return to London.

6 TRAINING

The team was chosen as a cohesive unit of people who got on well together, but who also had complementary skills in different areas. However, each member of the team had at least one Alpine season and a basic understanding of first aid. In addition, further training was undertaken in the lead-up to the expedition.

Medical training

All members of the team attended basic first aid courses in preparation for the expedition. In addition, the Medical Officer attended the BMC's Mountain First Aid course at Plas-y-Brenin, and the Wilderness Medical Training course, jointly organised by Wilderness Medical Training and the RGS Expedition Advisory Centre.

The Rescue and Emergency Care (REC) course at Plas-y-Brenin is a three-day course covering basic First Aid procedures and extending them for use in the mountain environment. The emphasis is on confidence-building and simple techniques. There is a significant practical content. Sessions are interspersed with specialist topics related to travel in the outdoors. The course covers a good level of practical first aid, to which all expedition members should be trained.
Plas-y-brenin, National Mountain Centre, Capel Curig, Gwynedd, Wales, LL24 0ET, Tel: 01690 720 214, **www.pyb.co.uk**

Due to the potential long delay before evacuation in case of an emergency in Greenland, the team decided that the Medical Officer should also receive some basic medical training. This was taken through the RGS-IBG Expedition Advisory Centre and Wilderness Medical Training. The emphasis of this two day course is on working in remote environments without immediate professional medical support. The course covers the use of basic drugs (antibiotics and painkillers amongst others) and provides a framework for diagnosis of common problems. It is broadly theoretical in nature, although practical sessions on life-signs and physical examination are scheduled as breaks in the programme. The course book is detailed and well presented and is designed as an on-site manual detailing symptoms, diagnoses and possible treatments. The course complements the REC first-aid course and is ideal training for Medical Officers who may be involved in long-term care and drug dispensing.
Royal Geographical Society - Institute of British Geographers **www.rgs.org**
Wilderness Medical Training, The Coach House, Thorny Bank, Skelsmergh, Kendal, Cumbria, LA8 9AW, **www.wildernessmedicaltraining.co.uk**

Mountaineering/ campcraft

Four team members attended the Jonathon Conville Alpine Safety course, which is run by the BMC and subsidised for students. The course is based in the Chamonix Valley, costs £40, and includes three days' training in a group of 3 with a guide. The course covers all aspects of Alpine Safety, including general Alpine skills, crevasse rescue, weather/ avalanche awareness etc. Details are available on the BMC website.

In addition, the whole team spent a week in Fort William, Scotland over New Year before leaving for Greenland. This was privately organised. The team had a rapid re-introduction to skiing, in order to remember downhill techniques. Following this the team camped on Ben Nevis, and spent a few days practising techniques for crevasse rescue, ice climbing, rope-work and camping in snow. The week also provided a good opportunity for testing food menus and equipment.

Expeditions Advisory Centre, RGS, **eac@rgs.org; www.rgs.org/eac**
Jonathon Conville Memorial Trust **www.thebmc.co.uk/safety/train/conville.htm**

Ice climbing on Ben Nevis (left)

At the top of the Ledge Route, Ben Nevis (right)

7 SCIENCE - GLACIOLOGY

INTRODUCTION

Detailed investigations into the mechanics of glacier confluences are rare and have focused on glaciers in the European Alps. As far as we know, our study is the first of its kind this far north. The aim is to compare the difference in behaviour between Arctic and Alpine valley glaciers of a similar size and to test existing theories on Arctic glaciers.

Scientific investigation in very remote areas such as northeast Greenland brings problems aside from the obvious one of carrying out prolonged, static work in cold temperatures. The main drawbacks are the extent of logistical planning, the cost necessary to transport expensive monitoring equipment to very remote locations, and the necessity for self-sufficiency while in the field. The expedition therefore wanted to test whether employing a 'low-tech' approach was viable, alongside trying to obtain useful and interesting data. The aim was to carry out a survey, together with all associated measurements, every day over a three week period.

Left:
Chris working on the Total Station, during one of the daily surveys

METHODOLOGY

Seventeen 2 m stakes, of inside diameter 19 mm, were drilled into the glacier surface to a depth of around 1.7 m, thus leaving a short section of the stake extending above the surface. The stakes were arranged so as to create a series of triangular cells that covered the confluence area of two glaciers. Glacier motion was monitored by repeatedly measuring the distance, and azimuthal and vertical angles of the stakes, from a fixed observation point, using a Leica Total Station (TC403L). Sighting prisms were attached to the stakes using handmadewooden fixtures and metal washers. As weight was an important consideration, the stakes used were made of polypropylene rather than the traditional wooden dowel or steel and no backing boards were used. To make the stakes more visible without backing boards, they were sprayed with fluorescent enamel paint.

In addition to the stakes that were free to move with the glacier, two fixed points were placed on the valley walls. These prisms were mounted with wooden fixtures and then fitted into cracks in the rock. The object of these fixed points is to provide a reference to

a point that we knew could not move. The position of each of these points was measured both before and after each survey. This provided the basis for a thorough error analysis of the results and can be used to account for changes in atmospherics or in the positioning of the Total Station during a survey.

Further, the position of all free and fixed prisms were measured via two GPS systems to allow the plotting of relevant points on a topographical map on return, for visualization purposes.

Finally, to be able to account for changes in rate of movement of the ice over a period of time, it was necessary to record the weather accurately over the duration of the project. This was done using a small handheld Silva weather station, to record temperature and windspeed, and a raingauge to measure precipitation. On a weekly basis the length of stakes protruding from the ice was measured, this was used to produce a record of the ablation at the seventeen points across the glacier.

APPRAISAL OF EXPERIMENTAL METHOD

In total 18 surveys were made over a 21 day period. Three days were missed due to poor visibility. The majority of the experimental techniques and equipment performed well, however there were a number of small problems that were overcome in the field and could be avoided in the future. The homemade prism mounts performed well. The polypropolene stakes froze into the glacier and held their position well, though without the fluoresent paint they would have been nearly impossible to find. Placing markers in the snow helped to locate the stakes over long distances. The main problem with the stakes was their bending stiffness. This became more of a problem as the survey went on, when a greater proportion of the stakes protruded above the snow as ablation progressed. The weight of the prisms then tended to pull the stakes over. Thus the position of the prism (to which the survey was taken) did not accurately represent the point of the glacier where the stake was inserted. In the field this was accommodated by measuring the direction and magnitude on this "lean", thus creating a suitable correction factor. Ideally more rigid stakes would have been used to avoid this problem. Depending on weight restrictions the traditional wooden stakes would be more appropriate, or a stronger lightweight alternative, for example aluminium, though this would significantly increase the cost.

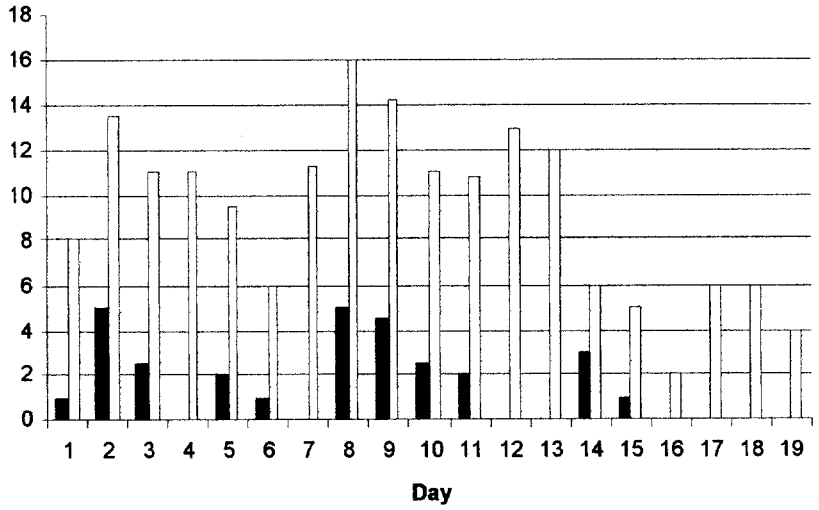
Ideally a continuously logging weather unit would have been taken to record atmospheric properties, however the cheaper, lightweight Silva "Windwatch" performed well on daily spot readings. A consistent measure of precipitation was achieved by using a conversion factor to account for the difference in volume of snow and water collected in the rain gauge.

RESULTS AND METHOD OF ANALYSIS

A large amount of data for the glacier confluence was collected over the three week period. Typically the stakes moved at rates between 2 cm and10 cm per day, depending on their location on the glacier and recent weather trends. The figures below show a

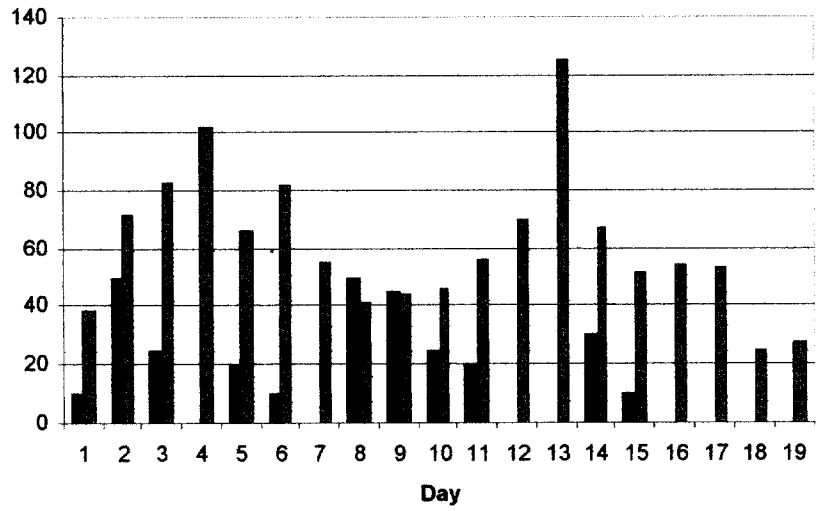
correlation between the recorded temperature, ablation rates and the rate of motion of the glacier.

Chart to show the effect of local temperature variations on the rate of ablation on the glacier surface



This first figure shows that following/ with a rise in local temperature the rate of ablation (decrease in level of snow/ice on the glacier surface) increases. Red columns represent ablation; cream represents daytime temperature.

Chart to compare the ablation of the glacier suface at a specific point to the rate of motion at that point



This second figure shows that following an increased rate of ablation we witnessed an increase in motion on the glacier. Again, red columns represent ablation, blue columns represent measured glacier motion. The aim now is to correlate the two over the whole confluence area to help build up a picture of its motion as a whole.

In order to obtain a thorough analysis of the results, several techniques are being employed. The measured positions of the stakes (after correction for any observed lean), are corrected for drift in the data over the period of the survey. This includes changing atmospheric conditions and relies on the accurate measurement of the fixed points on the valley walls. The most likely *actual* positions of the stakes, accounting for errors at each individual location, is then determined using a Least Squares analysis. The merits of two pieces of software for use in analysing this data are currently being determined. These are the 'GAP' (General Adjustment Programme - City College, London) and 'LSQ' (a Cambridge University Engineering Department Least Squares adjustment programme). The resulting coordinates will then be applied to a programme to determine the stress and strain over the surface of the confluence region. Significant modifications to the code will be required for use with this particular data set.

These results will then be compared with similar surveys carried out on European Alpine glaciers, in order to assess the contrasts in behaviour of such similar systems in very different locations. This work is still ongoing.

8 SCIENCE - GEOLOGY

The main body of previous geological work on Louise Boyd Land consists of 1:500 000 scale mapping done by GEUS in the 1990s. This involved camps at the edges of two fjords to the south and east of Louise Boyds Land, together with some spot landings and helicopter mapping. We planned to complement this mapping with more detailed work from the ground. Unfortunately we were unable to use the planned location as our basecamp because of its inaccessibility. Our work in the original area (Area 2) was therefore limited to one two-day visit. However we were still able to complete a more detailed map. The actual basecamp (Area 1) was geologically less interesting but increased our understanding of the regional structure of Louise Boyd Land. See the aerial photograph in the Location section, for details of the two areas. The information gathered is currently being added into the geological map.

GENERAL GEOLOGY

Most of the rocks in Louise Boyd Land are within the 'Upper Thrust Sheet' as defined by GEUS. Metasediments are from the Mesoproterozoic Krummedal succession, and are cut by a variety of younger (930 Ma) granites, some Caledonian (425-425 Ma) granitic sheets, and (in the eastern areas) some thick, folded metadolerite dykes (A.K.Higgins, personal communication, 2001).

In Area 1, rafts of metasediments occur within a large granitic body, on a variety of scales from small, usually ductilely deformed blobs several 10s of cm across, to large chunks up to 100m across and several hundred m long (figure **6.1**). The large chunks of metasediment are usually only lightly deformed in a ductile manner, but brittle deformation was also observed. Some areas of metasediment exhibit complex folding on a small scale compared with that of the raft itself. Other rafts may be very coherent; in other words the deformation of the metasediments is very variable. In Area 2 the metasedimentary rafts are much more extensive and form continuous sheets in places. There is a general trend of lessening dominance of the granite from west to east. Deformation of the metasediments is considerable across Louise Boyd Land. In addition the whole area is characterised by low intensity, late-stage folding on a broadly N-S axis.

Area 1

The area is dominated by a probable S-type granite, containing large rafts of metasediments. A gentle antiform strikes N-S along the study glacier; the change in dip is visible in the metasedimentary rafts.

Metasediments

The metasediments comprise interbanded psammites and pelites. They have a distinct foliation defined by compositional changes. Pale, qz rich, psammitic bands are interspersed with dark bands containing biotite, tourmaline and garnet. Alignment of biotites and tourmaline (up to 2.5cm length) are parallel to foliation. Garnets (1-3mm in size) are distributed evenly throughout, suggesting that these may be post-deformational.

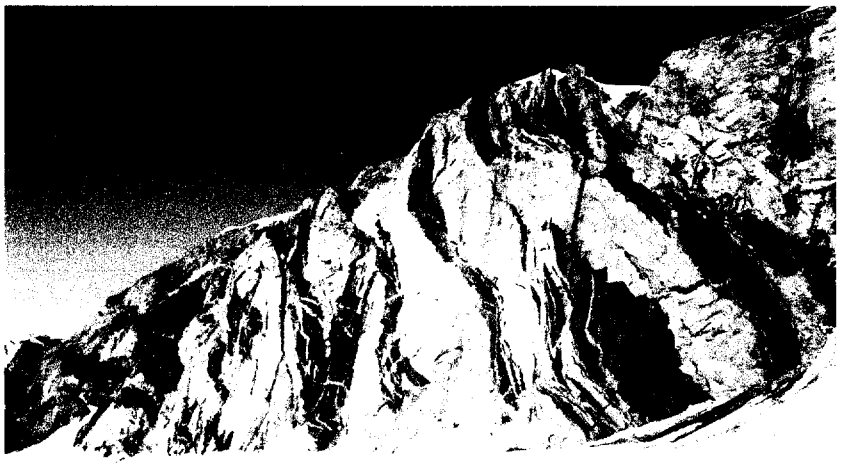


Figure 6.1
Cliff showing large metasedimentary rafts (dark brown) surrounded and intruded by granite. Deformation includes larger scale ductile folding, as well as smaller scale brittle cracking.
Scale: cliff is 500 m high; horizontal field of view is 1.5 km

The foliation in the metasediments probably represents primary depositional features. This is supported by excellently preserved ripples (Figure **6.2**) and possible flame structures . Ripples are well preserved in one particular locality and are generally cusp-shaped and fairly symmetrical in profile, occasionally bifurcating. The side profile is asymmetric. The ripple index ≈ 5, which suggests a wave dominated environment though the shape of theripples is more suggestive of a current dominated environment.

Figure 6.2
Cusp-shaped ripples well exposed in dark, pelitic metasediments within the granite batholith in Area 1.

Deformation
Some of the psammitic layers are affected by boudinage on scale of ≈ 20 cm. In these areas the edges of the boudins are rimmed by micas parallel to the edge, while the ends contain patches of coarsely crystalline quartz. Folding and kinking is common. There are at least two periods of deformation within the metasediments (see figure **6.3**).

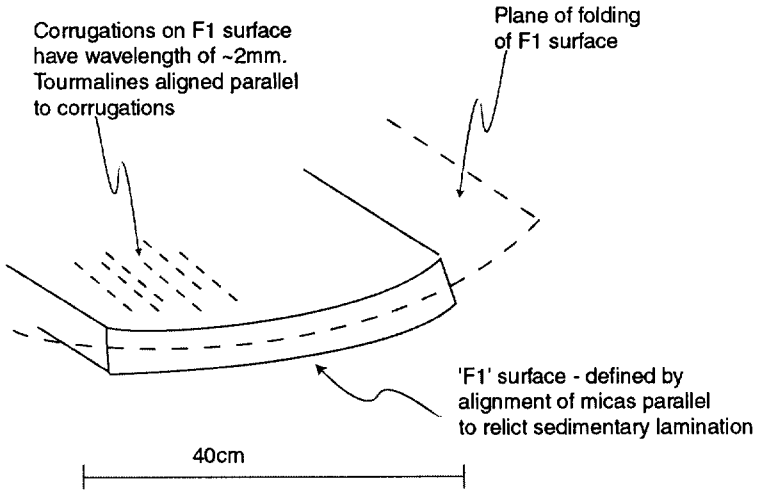


Figure 6.3

At least two stages of deformation have affected the metasediments in Louise Boyd Land (Area 1).

There are many different (cross-cutting) generations of veins in the metasediments. Most are apparently granitic in composition, and in variable states of deformation. The scales of the veins varies between 1 cm and several metres; it is difficult to distinguish between granite and an impure psammite in some cases.

Granite

The granite in Area 1 is variable in colour, grainsize and modal proportions of mica; it would be impossible to ascertain whether more than one generation of granites were present without some geochemical analysis. Tourmaline is commonly found within the granite and is also concentrated in pegmatitic veins, often in fan structures. This is probably the Caledonian granite.

Area 2

This eastern part of Louise Boyd Land is dominated by coherent regions of metasediments, intruded by large granite sheets. Two different types of granite are present. The first is similar to that in Area 1, and occurs towards the structural top of the area. The second is a foliated granite containing large 'augen' feldspars. The foliation is defined by alignment of biotite or phlogopite mica. Shearing resulted in the formation of C-S fabrics on the scale of 1 m (figure **6.4**); the shear sense is roughly Top-to-the-North. The tops and bases of the shear bands are marked by coarsely crystalline, subhorizontal bands of apparently unfoliated granite, several cm to 10s cm thick. (figure **6.4**). This is thought to be the older, Grenvillian granite and is found only at the structural base of the area.

The interbedded psammites and pelites are similar to those in Area 1. Pale layers containing quartz, feldspar and clumps of red-brown biotite are interbanded with dark, pelitic layers. The scale of the interbanding varies between small lensoids of roughly 2 cm x 10 cm, to large bodies several metres long. A weak, planar foliation within the psammitic bands is defined by the alignment of biotites. Deformation is similar in magnitude to Area 1 and involves isoclinal folding, shearing and boudinage of sandy lenses. In some areas the rock has a distinctive pink colouration. This is thought to be due to the presence of orthoclase feldspar, possibly suggesting a different source composition.

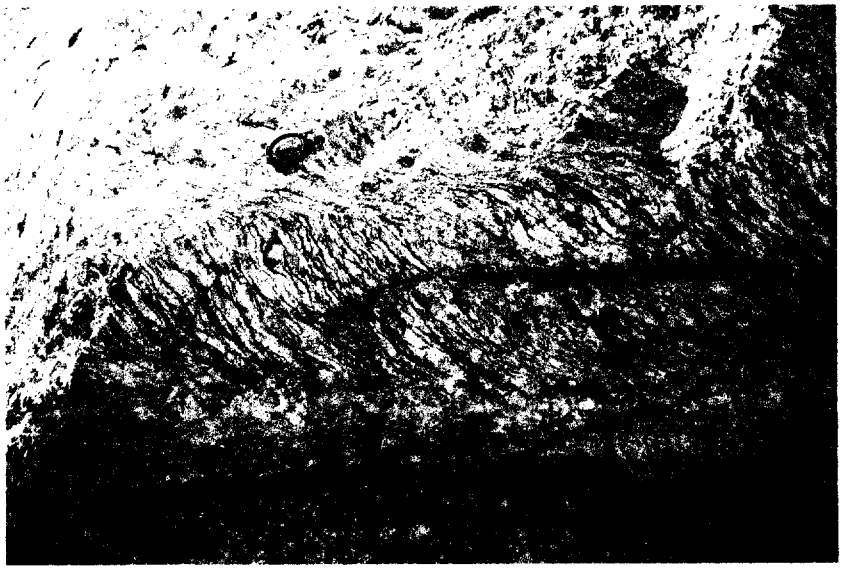


Figure 6.4
Sheared, Grenvillian augen granite outcrops at the base of cliffs in the northeastern part of Louise Boyd Land. Shear fabric can be seen cutting down to the right in the photograph.

9 SCIENCE - MORAINE SAMPLING

The team carried out sampling of moraines from various of the large Arctic glaciers during the ski trek south. These samples will form part of a large, ongoing project at CASP to study sediment transport in the Norwegian - Greenland Sea. Successful hydrocarbon exploration requires an understanding of sediment dispersal patterns. In the case of the Norwegian - Greenland Sea, sediment was supplied from Greenland to Mid-Norway at discrete times during the Jurassic to Paleocene, between 200 and 60 Million years ago. Confirmation of this sediment supply will help to predict times at which westerly sourced reservoir sands were deposited on the Norwegian shelf.

The project is expected to take up to 2 years to complete. The main objectives are:
(i) To identify and understand sediment transport paths in the Norwegian - Greenland Sea region, prior to the onset of sea floor spreading.
(ii) To understand the role of Greenland as a source of sediment to Norwegian basins.
(iii) To combine provenance information from Mid-Norway and East Greenland.

The research will be based on detailed geochemical analysis of the samples, involving analysis of heavy minerals and dating of zircon grains in selected samples.

Details of this ongoing project are available on the CASP website, **www.casp.cam.ac.uk**.

10 SCIENCE - POLLEN TRAP

INTRODUCTION

The pollen trap at Mesters Vig is part of a long term project to investigate the fallout of pollen from the air in Arctic latitudes. The trap was set up in summer 1999 and has previously been emptied once in 2000. It is the furthest north of a network of pollen traps which are feeding data to the Pollen Monitoring Programme (PMP), a research initiative sponsored by the International Quaternary Association (INQUA). The PMP aims to monitor modern pollen fallout using a standardised methodology. Pollen deposited in a trap from local vegetation can be distinguished from that which has drifted in from other areas. The results are fed into a data bank which is kept at Oulu University, Finland.

Analysis of ancient pollen trapped in sediments, such as peat, is frequently used to infer the vegetation history of a particular site. It is a tool used by many scientists, including archaeologists, climatologists, botanists and geographers. However, interpretation of the pollen record for a site is made problematic because some pollen may be the result of long distance aerial transport, rather than being locally produced. The PMP aims to shed light on this problem by quantifying the amount of local and long distance pollen fallout at a variety of sites with different vegetation characteristics. This data can be used as analogues in the interpretation of fossil pollen diagrams, thus enabling a greater degree of precision to be achieved. The Mesters Vig trap is particularly important because European vegetation during the last ice age may have been similar to the present environment in Greenland. The trap therefore provides results which enable fossil pollen diagrams from former cold periods in western Europe to be better understood.

METHODOLOGY

The trap at Mesters Vig comprises a polythene tub buried in a meadow away from potential sources of contamination. Pollen entering the trap sticks to a layer of glucose in the bottom of the tub and is thus prevented from leaving. In order to prevent the tub filling with rainwater, the trap is fitted with a plastic lid. The trap is left to collect pollen for a season or more (in this case, two seasons) and the resulting pollen grains analysed.

RESULTS

The 1999 - 2000 season recovered 135 pollen grains, all but two of which were from vegetation present at Mesters Vig. However, 2 were of Hornbeam (*Carpinus*) which must have originated in North America or Europe and must therefore be the result of long distance transport.

The trap contents from 2000 - 2002 are dominated by Arctic Willow (*Salix arctica*), which accounted for 92% of the pollen counted. *Saxifragaceae* (saxifrage) pollen amounted to 4% of the total pollen; the majority of grains are are *S. granulata* and a few are *S. oppisitifolia.* Other, minor pollen types represented (at <1% of total pollen) include *Oxyria* (mountain sorrel), *Empetrum* (probably *E. nigrum*, crowberry), *Urtica urens* (small nettle), *Silene vulgaris* (probably *S. uniflora*, bladder campion), *Poaceae* (grass, which at this location was probably *Leymus* - lyme grass or *Elytrigia*, couch grass). These

results concur with those from 1999-2000, which were also dominated by willow and saxifrage.

A surprising find was one grain of *Alnus* (alder) pollen, which must have originated considerably further south, and been blown in by the wind.

One major difference from the 1999 - 2000 results is the total pollen influx. For the 2000 - 2002 season, the total influx was 19,000 grains/cm^2/year, compared with 332 grains/cm^2/yr for 1999. The reason for this is clear from the trap contents. Some insects have got into the trap and carried in the large amounts of willow pollen; they appear to have been feeding on willow prior to entering the trap.

Analysis was carried out by Heather Tinsley, University of Bristol.

11 MOUNTAINEERING

The opportunities for climbing in the northern region of Louise Boyd Land are boundless, with summits suitable for both ski-mountaineering and technical alpine ascents, and rock-climbing ranging from easy moving-together to the hardest possible aid climbing. On closer inspection, the original site proposed as a base for studying and climbing held many technical alpine ascents, though other mountainsides were commonly scree-covered giving fairly inaccessible summits. The newly selected site turned out to be ideal for our experience-level and the time that we had available to complete the climbing programme.

Our campsite was directly below a granite ridge that ran up about 800 m, before turning into a snow ridge leading to a snow dome summit. This ridge had two prominent pinnacles at about 400 m in height above the glacier. To gain confidence, we initially climbed the easy saddle-back ridge, moving together; later we returned to climb two pitched face routes to the summits of the two pinnacles. The saddle-back ridge was used as a descent route. The time in descent of the ridge was greatly reduced on these occasions, indicating our greater assurance and familiarity with the surroundings. An abseil using two pitons was reluctantly employed on descending the second pinnacle, after 2 hours' searching for a route leading over to the first pinnacle and the descent ridge.

Below are brief descriptions of each climb; please see the following pages for route sketches.

Climb 1: 'The First Granite Pinnacle'
Date: 12/07/02
Grading: PD with moves of III; 450 m
Moved together up the north west ridge - a saddle-back mostly composed of broad arêtes and low angle flakes. The granite on the upper two thirds was of good quality though much of it was still extremely loose. Getting onto the summit block was awkward but subsequently a small tunnel was found leading to the top. 1 and 1/2 hours to summit and 3 and 1/2 in total (up and down).

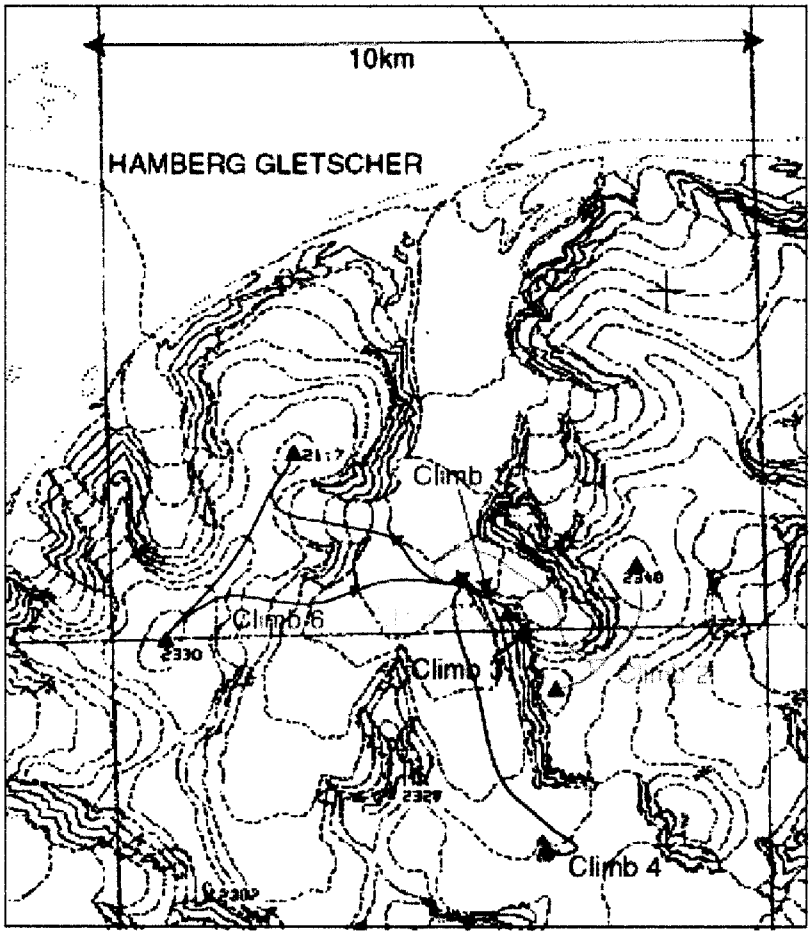
Climb 2: Points 2200 m and 2340 m
Date: 19/07/02
Grading: F; roughly 7 km skiing distance
Skied to bottom of northwest-facing col between the two summits. Ascended steepening snow and ice on skis and then on foot in crampons for 200 m, then skied up to both summits. 6 hours to first summit, 11 hours in total. In reality the side of the col was too steep for us on skis, requiring kick turns on a very exposed slope. This was further compounded by the top layer of powder snow freezing to our skins, thus removing any grip that they provided. We therefore had to remove our skis and change to crampons in a very exposed position. On the descent, only crampons were used.

Climb 3: 'Patience Peak' (West Face of 2nd Granite Pinnacle)
Date: 20/07/02
Grading: IV; 350 m
6 pitches of delightful granite becoming steadily more solid as height was gained. Generally not steep but fairly exposed. Tricky route finding led to moves of III for two pitches. Pitch 3 was a chimney system, consistently IV. Pitch 5 involved moves up a thin flake system - great IV. Moves of III+ led to an easy scramble among huge summit boulders to the small and extremely exposed summit. Descent required one 60 m abseil, followed by a traverse across an unstable scree-filled gully, up onto the descent ridge (the saddle-back ridge of the First Granite Pinnacle). 6 hours to summit, 10 in total. This was the highlight of the climbing programme.

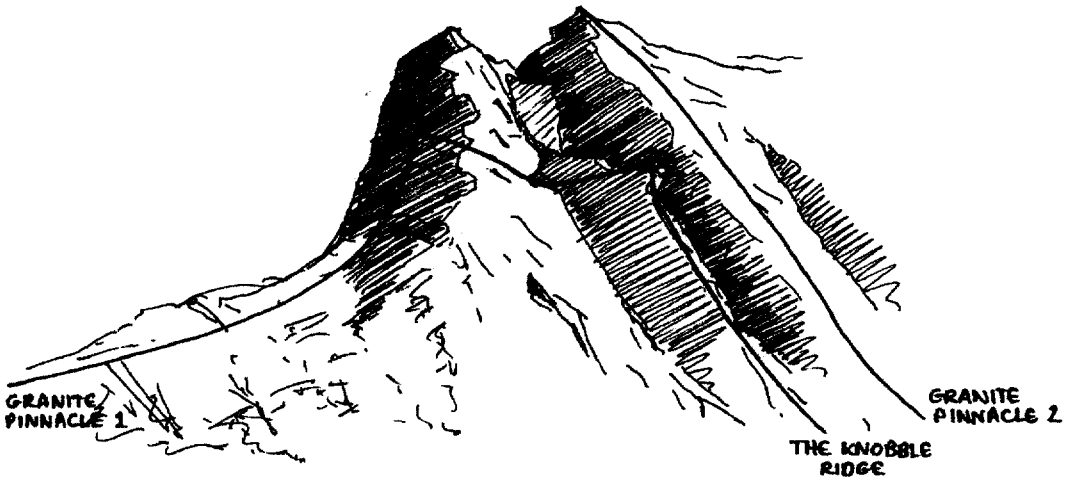
Climb 4: 'Landing Site Nunatak' (2000 m)
Date: 22/07/02
Grading: F; 200 m
150 m snow slope led to an easy but loose ridge to the summit with great views of the surroundings. 1 hour in total.

Climb 5: 'The Knobble' (West Face of 1st Granite Pinnacle via Knobble Ridge)
Date: 26/07/02
Grading: IV to Knobble; 180 m
2 pitches of increasing difficulty (III) led to the third and crux pitch (IV) with an initial steep crack leading to exposed moves up to the Knobble. A fourth short pitch (III) saw us on top of the Knobble, from where we could move together to the summit of the 1st Pinnacle. 3 hours to Knobble, 3 hours 40 mins to summit of the First Pinnacle, 4 hours 20 mins in total.

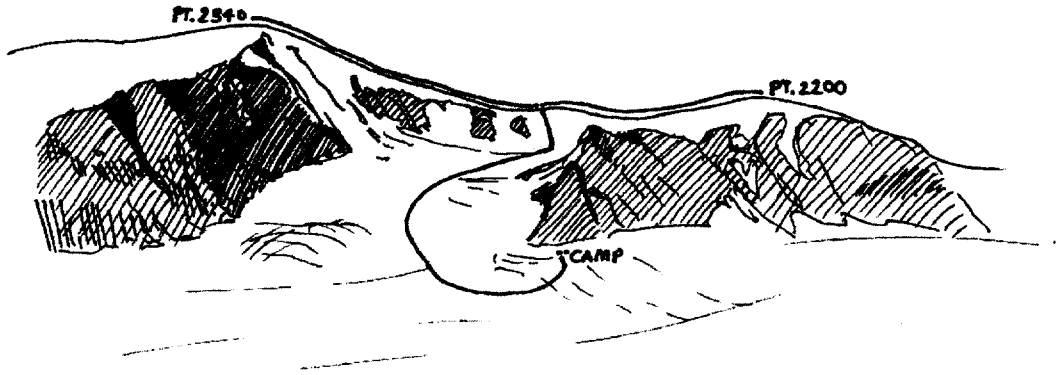
Climb 6: Points 2117 m and 2330 m
Date: 27/07/02
Grading: F; roughly 11 km skiing distance
Crossed the main study glacier, then skied up glacier on East Face of Pt. 2117, using ski crampons, to summit. Descended to wide, flat col between the two high points, then skied up to Pt 2330. Descended on foot the glacier on the East Face of Pt 2330 and skied back to camp. 3 hours to first summit and 7 hours in total.



Map of the northern part of Louise Boyd Land, showing the route of each climb. Scale: one grid square equals 10 km. Red triangles represent summits reached

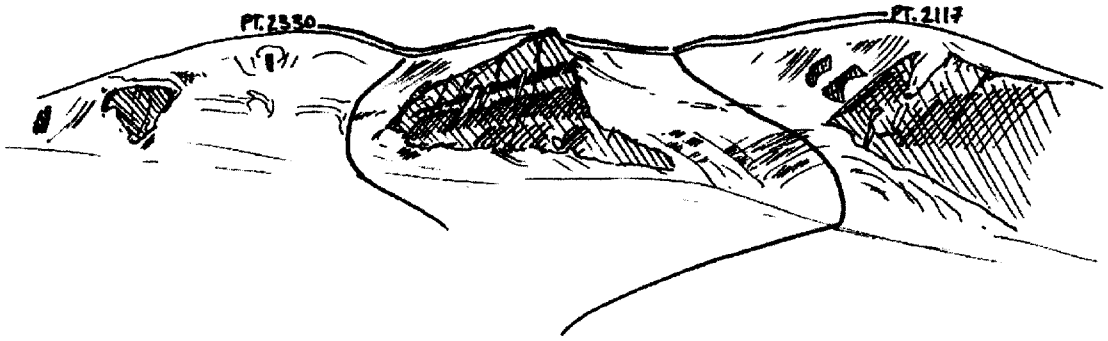


Climbs 1, 3 and 5: 'The First Pinnacle', 'Patience Peak' ('the Second Pinnacle') and 'The Knobble' (looking SE)



Climb 2: Points 2200 and 2340 (looking SE)

Climb 4: The Landing Site Nunatak (looking SSW)



Climb 6: Points 2117 and 2330 (looking W)

12 SKI TREK REPORT

The ski-trek was an integral part of the expedition. For logistical and financial reasons, we decided to make our way as far south as possible before being picked up to go back to Mesters Vig! We were also looking forward to the trek in its own right, however. We trekked 200 km over 21 days, and arrived 100 km south of our base camp, for our boat pick-up from Dickson Fjord. The route initially took us north and west out of Louise Boyd Land onto the Hamberg Gletscher, before heading south along the impressive Victor Madsen Gletscher. We headed out onto the ice-cap, then turned back inland via the Verena Gletscher and passing close to Shackleton Bjerg. After crossing Concordia Plads, we passed through Gletscherland before descending to Dickson Fjord via the Langenthaler Gletscher. See Appendix 7 for a map of the route. The terrain was extremely varied, and included snow-covered glaciers, frozen lakes and rivers. The worst conditions were large, stagnant areas below the snowline, as these were dry glaciers riddled with small streams and covered in ice pools. This terrain caused huge problems with the pulks as the coarse, sharp ice fingers and undulating terrain wore through the fibreglass hulls.

Day 1 – Wednesday 31st July 2002
Area: Base Camp to Hamberg Gletscher
Grid reference at start of day: 73°40.71'N 028°06.36'W
Grid reference at end of day: 73°40.42'N 028°11.32'W
Distance covered: 8.5 km
Weather: Clear, cold start; warming throughout the day.
Terrain conditions: Passing down through the snow.
We got up at 7.30 am as we had planned the previous evening. Visibility was unlimited, which would be helpful for navigation, but it meant that the morning was bitterly cold! The aim was to get away as fast as possible, but our morning routine for the trek was as yet unpractised. Our routine was for the girls to take down their tent with the help of Chris and Derek, while Sam cooked the breakfast. We then all ate breakfast before taking down the boys' tent and finishing off the packing. The rocks that had been used to hold down the tents over the last week or so were thoroughly frozen in and took a long time to knock out. We eventually got away at about 10 am. Progress was initially very slow as we were roped up and rapidly zig-zagging around crevasses. Ski skins and pulk harnesses were problematic and slowed progress further, requiring considerable patience.

We knew that crossing the confluence area to the Hamberg Gletscher could be problematic and had chosen to visit it a couple of weeks earlier to assess a likely route. We knew that there was an area of relatively smooth ice (or "the runway" as it was known!) leading down to the junction of the two glaciers. Getting onto this area quickly would save time, energy and equipment. We had also found that there was only one spot in several hundred metres along this junction where we could safely cross onto the moraine at the edge of the Hamberg Gletscher. This was a solid ice bridge over a fast-flowing river between the two glaciers. With the use of GPS, we managed to navigate our way down the runway and over the ice-slope. From here we had to relay our equipment, carrying it up a scree slope of moraine, then over around 500 metres of twisted ice structures to a river. To keep track of all the equipment the relay was done in stages, only

moving on to the next step when all the equipment had reached the end of the previous one.

Our first significant river crossing provided the last challenge of the day. It was only about knee deep but icy cold and running at about 3 m/s. Pulks were partially emptied so that they would float and we therefore needed a couple of relays to move all the equipment across. We wore the outers of our ski-boots with crampons to provide a safe but very uncomfortable mode of crossing, resulting in severe bruising of shins and feet. After the river crossing we decided to push on until our basecamp was well out of view. At 6pm we stopped, set up camp and made dinner.

Day 2 – Thursday 1st August 2002
Area: Hamberg Gletscher
Grid reference at end of day: 73°33.67N 028°11.32W
Distance covered: 10.5 km
Weather: Fine, but cold and windy
Terrain conditions: Undulating ice to thin layer of soft snow covering ice pools and small rivers.
Another tough day. The going was initially quite quick, but the undulating terrain meant straining work. Small ice ridges of a couple of feet meant straining hard to move the pulk upwards. The rigid traces then tended to throw you in the air as the pulk tried to catch up! The terrain deteriorated further after lunch, and at several points the pulks had to be lifted over moraine. Later, care was needed over soft snow covering fragile ice structures which collapsed under your weight. There was significant damage to Chris' pulk, due to impact when colliding with the far side of a small river. We all felt that 10.5 km was a good result after such a tough day!

Day 3 – Friday 2nd August 2002
Area: Hamberg Gletscher
Grid reference at end of day: 73°33.23'N 028°40.87'W
Distance covered: 12 km
Weather: Clear and cold
Terrain conditions: Smooth firm snow leading to dense crevasse field
After an initially tough section, we soon reached a large area of flat firm snow. Several medium sized river and lake crossings were made without drama, and skiing was quick and relatively easy. Unfortunately by late afternoon it became clear that we were in the

middle of a large crevasse field, and we zig-zagged up steep slopes to an early finish. Luckily a quick reconnaissance revealed a likely escape route for the morning.

Day 4 – Saturday 3rd August 2002
Area: Hamberg Gletscher leading on to Victor Madsen Gletscher
Grid reference at end of day: 73°32.85'N 028°45.73'W
Distance covered: 9.5 km
Weather: Clear and cold
Terrain conditions: Good snow initially, followed by braided rivers and hard ice.
The route discovered the previous night proved successful, although we had to ski over several frozen rivers and lakes, sometimes with only a thin covering of ice. Coming over the brow of a steadily rising hill revealed a good view of what lay ahead for the next few days. A steep slope of sharp flaking ice which caused everyone several hard falls when descending (except Natalie!). Following this the second significant piece of damage to a pulk occurred, when the rivets holding Sam's traces into his pulk sheared off. This resulted in lengthy repairs every day or so. As the terrain deteriorated we passed into an area of braided streams. These were mostly less than 3 feet wide but had steep banks up to 3 feet high. Repeated crossings soaked our clothes. Later Natalie's, Madeleine's and Sam's traces (again) all broke within a very short space of time. Soon it became obvious that proper repair jobs would be required to stop wasting valuable time. We had to stop in the middle of a entire network of rivers, cold, wet, with no idea of how to get out!

Day 5 – Sunday 4th August 2002
Area: Top of Victor Madsen Gletscher
Grid reference at end of day: 73°25.91'N 028°46.93'W
Distance covered: 5 km
Weather: Snowfall and mist (visibility <500m)
Terrain conditions: Braided rivers littered with ice-covered pools of freezing water.
At 4.30 pm, we hit another river. This river was by far the biggest we had come across, at more than 10 m across, with vertical banks about 2 m high and obviously running for kilometres in either direction. It was obvious that we were going no further today.

Today the terrain really began to take its strain on the pulks. The hulls of both Chris's and Sam's pulks had been worn right through by the ice in some sections, leaving long gouges down the side. It became clear that there was no way we could continue in this state. The girls took their (still solid) pulks, and we carried as much as possible in rucksacs. The aim was carry everything forward in two loads and to try to find the best route through. Slowly the mist thickened, and with still worsening terrain the girls took to floating their pulks down stream beds to provide an easier passage. This proved effective until they started to take on water –when all of a sudden it didn't seem like such a great idea!!

Day 6 – Monday 5th August 2002
Area: Top of Victor Madsen Gletscher
Grid reference at end of day: 73°25.91'N 028°46.93'W
Distance covered: 0 km (6 km of relaying)
Weather: Heavy fog and snow
Terrain conditions: same as day 5.
Before we thought about crossing the river we had to get the rest of the kit. We had marked the location using our two GPS, so finding it again was fairly straight forward, and the trip back proved uneventful if unpleasant. The afternoon was spent making two failed attempts at crossing the river. The first used Derek's undamaged Snowsled pulk, but this sank immediately. On the second we lashed together the Fjellpulken with skis and various bits of rope. This was just buoyant enough to get Natalie (the lightest member of the group) across, but not back without a considerable effort! We needed a new design!

Day 7 – Tuesday 6th August 2002
Area: Victor Madsen Gletscher
Grid reference at end of day: 73°25.86'N 028°47.06'W
Distance covered: 100 m
Weather: Fine and sunny, occasional strong breezes
Terrain conditions: River.

It took us all day, but eventually we all got across safely with all the equipment. The second raft was rebuilt using two empty jerry cans between the pulks to increase the buoyancy. Setting up a pulley system, we ferried our equipment bit by bit, ensuring we had tents erected at either side – just in case of an emergency!

We had travelled only about 100 m, but it meant a lot more: we had crossed a huge obstacle, and hoped that it might signal a change in our luck.

Day 8 – Wednesday 7th August 2002
Area: Victor Madsen Gletscher
Grid reference at end of day: 73°24.23'N 028°49.19'W
Distance covered: 3.2 km
Weather: Clear and cold
Terrain conditions: Mixture of crevassed, messy ice and moraine.
After a late night reconnaissance (one of the advantages of a midnight sun) to plan the morning's route, we had a late start. The fairly modest distance reflects a difficult couple of kilometres ferrying equipment (including carrying the pulks) to get ourselves into a position for what we hoped would be a good following day.

Day 9 – Thursday 8th August 2002
Area: Victor Madsen Gletscher
Grid reference at end of day: 73°18.56'N 028°53.93'W
Distance covered: 10.5 km
Weather: Overcast, improving throughout the day
Terrain conditions: Passing up through the snowline into crisp snow.
Initially there was only a slight let up in conditions. Navigation was made difficult by large ice mounds and river channels. However, after a long detour to avoid another major river crossing, we passed slowly through the snow line. Initially the snow itself was difficult as it was soft, so that the pulks sank and provided lots of resistance. But we could see that over the next few days the conditions would not get any worse. What's more, we knew exactly where we were, and the going was by far the fastest it had been throughout the whole trek!

Day 10 – Friday 9th August 2002
Area: Victor Madsen Gletscher
Grid reference at end of day: 73°09.68'N 028°58.94'W
Distance covered: 16.7 km
Weather: Very cold
Terrain conditions: Firm flat snow.
What a day! The snow was much firmer after a cold dry night, and the pulks seemed to glide up the glacier. Somewhat unexpectedly, we now seemed to be well up the glacier.

Day 11 – Saturday 10th August 2002
Area: End of Victor Madsen Gletscher
Grid reference at end of day: 73°02.54'N 029°22.11'W
Distance covered: 18.2 km
Weather: Cold wind and light snow
Terrain conditions: Hard blue ice.
Another record-breaking day, mainly on smooth ice with only one problematic patch in the middle of the day. Camp was set up at the edge of the icecap.

Day 12 – Sunday 11th August 2002
Area: Ice cap
Grid reference at end of day: 72°54.13N 029°26.12W
Distance covered: 17.2 km
Weather: Windy – lots of spin drift with decreasing visibility (-15 °C, 20 knots)
Terrain conditions: Patches of hard snow and soft snow drifts.
The day was spent out on the icecap. We maintained a steady pace throughout the day, partly because, with no shelter around, the bitter wind made stopping unpleasant. We stopped in the evening just as the winds were really picking up, whipping up snow, making it bitterly cold and creating a race to put up the tents. With old zips on the Himalayan Hotel, it did an incredibly poor job at keeping out the snow!

Day 13 – Monday 12th August 2002
Area: Ice cap
Grid reference at end of day: 72°51.22'N 029°22.53'W
Distance covered: 5 km
Weather: White out, wind and snow.
Terrain conditions: drifting snow.

A small but significant improvement in the weather overnight, coupled with an ever increasing pressure on time prompted us to get moving when otherwise we would have sat tight. However, by lunchtime it was futile, in whiteout conditions with no horizon or sun, our senses of direction proved to be wholly inadequate.

Chris, who was leading, found it impossible to ski in a straight line, and with rapidly decreasing confidence in where we were, we decided to pitch camp at lunchtime and try again the next day.

Day 14 – Tuesday 13th August 2002
Area: Nordenskiold Gletscher
Grid reference at end of day: 72°48.97'N 028°57.59'W
Distance covered: 14.5 km
Weather: Clearing quickly turning fine and sunny
Terrain conditions: Flat snow.
Shortly after starting the skies cleared and a warm sun emerged. In soft snow, through some difficult crevasse fields and increasing topography, the going was tough but satisfying. We spent the night with the magnificent view of Shackelton Bjerg.

Day 15 – Wednesday 14th August 2002
Area: Verena Gletscher
Grid reference at end of day: 72°44.23'N 028°32.62'W
Distance covered: 16.3 km
Weather: Fair to howling wind.
Terrain conditions: Areas of deep snow and patches of blue ice.
Thankfully a fairly uneventful day, and a pleasant plod among some magnificent scenery.

Day 16 – Thursday 15th August 2002
Area: Appenzeller Nunatak
Grid reference at end of day: 72°41.58'N 028°11.85'W
Distance covered: 12.3 km
Weather: Strong winds, calming throughout the day
Terrain conditions: Rapidly undulating snow drifts and areas of dense crevasses.

Overnight the winds really picked up, and we woke in the morning to drifts up the side of the tent. What's more, where our pulks were once parked stood a large mound of snow! Not a good start to the day as it took the best part of an hour to dig them out. The terrain was again challenging, but by this time we were beginning to get used to it and practiced in how to handle it.

The highlight of the day was a set of Arctic Fox tracks, the first sign of any wildlife in over two weeks – it meant that we were nearing the fjords and the fertile lands at their banks!

Day 17 – Friday 16th August 2002
Area: Rig Nunatak – Concordia Plads
Grid reference at end of day: 72°40.12'N 027°55.74'W
Distance covered: 9.5 km
Weather: Damp and overcast
Terrain conditions: Heavy crevassing and rough terrain.
We were all beginning to get very tired by now and really willing the end to arrive. When we realized that our target point to get off the ice was a lot further than we anticipated and that we were not in fact heading in the correct direction, morale took a big hit. What's more, the terrain we had found ourselves in was equal to the worst so far. An unexpected ferry of equipment over a large band of moraine took up more valuable time. We ended the day thoroughly exhausted, damp, and by now with very sore feet and with little motivation. A reconnaissance was needed to make an important decision about whether to head out around a large crevasse field, or whether a direct method was safe. We decided to go for the direct method.

Day 18 – Saturday 17th August 2002
Area: Gletscherland
Grid reference at end of day: 72°40:14'N 027°42.72'W
Distance covered: 6 km (plus 8 km of ferrying)
Weather: Fine and pleasant
Terrain conditions: Gravelly ice, essential flat, onto rock.
Fortunately we made the right decision, the going was fast, and rocks of Gletscherland approach rapidly. A couple of kilometres of rough, hard ice wasn't going to stop us, driven on by our desire to get on to some firm ground – and by lunch time we were very happily on dry land. Three relays of our equipment saw us camped by a magnificent lake, with all the luxuries that come with camping on dry rock.

Day 19 – Sunday 18th August 2002
Area: Gletscherland
Grid reference at end of day: 72°40.14'N 027°42.72'W
Distance covered: 0 km (24 km of relays)
Weather: Clear

Terrain conditions: Scree and mossy grass.

To complete the last stage of our trek we had to relay our equipment with rucksacs over the rock and tundra of Gletscherland, before reaching the mini-icecap on the other side of the region. Relays took around 5 hours, and three were required. On completion of the first, by amazing coincidence we bumped into the British Shackelton Bjerg expedition led by John Thorogood and Ian Steen. Having already trekked in the other direction, from Dickson Fjord through Gletscherland, they very kindly provided us with a set of GPS coordinates to help navigation down the very steep and crevassed Langenthaler Glacier.

Day 20 – Monday 19th August 2002
Area: Gletscherland – Langenthaler Gletscher
Grid reference at end of day: 72°42.91'N 027°20.81'W
Distance covered: 17.3 km
Weather: Clear and very cold
Terrain conditions: Soft snow leading to dry glacier with dense crevassing.
After one final relay, and we set off across the snow of Gletscherland. The point to whcih we had chosen to relay could have been better. We found ourselves on a steep hillside that proved very difficult to negotiate and took a lot of caution, and consequently a lot of time. We finished the day half way down the Langenthaler Gletscher, at the edge of a severe crevasse field.

Day 21 – Tuesday 20th August 2002
Area: Langenthaler Gletscher to Dickson Fjord
Grid reference at end of day: 72°48.77'N 027°15.62'W
Distance covered: A couple of kilometres!
Weather: Clear and warm
Terrain Conditions: Very steep and crevassed glacier leading to soft steep tundra.
The coordinates given to us by John and Ian proved invaluable, as negotiating the steep convex slope was difficult and resulted in many tumbles. However the amazing views of Dickson Fjord drove us on, and through our final challenge of lifting the pulks of the glacier and relaying the equipment down to the fjord.

We had a two day wait at Dickson Fjord before we were picked up by Clive Johnson and Izzy Ryder of CASP using semi-inflatable boats. They took us back to Mestersvig over two days via an over night stop at the magnificent Ella Ø. The trip took us up through the fjords and around icebergs and past a pod of narwhal.

13 LOGISTICS

Danish Polar Centre (DPC)
The Danish Polar Centre coordinates all expeditions within Greenland, and is extremely helpful with queries. As a general rule, the more information you can give the staff there, the easier it is for them to help you. Our contact was Hauge Andersson (**ha@dpc.dk**). They have an excellent website with a large section of information for people planning expeditions.

Our expedition was based inside the Greenland National Park and we were therefore required to have a valid entry permit. This can be applied for at the Danish Polar Centre, and the application must be received no later than 3 months prior to departure of the expedition (6 months for biomedical projects). Firearms permit and radio permit application forms are provided by the DPC; the deadline for these is three weeks prior to departure. They must also have an insurance statement by this time. The DPC requires expeditions within the National Park to have adequate Search and Rescue insurance worth DKK 1,000,000, (see later) and to carry an EPIRB (personal locator beacon). An official list of participants, together with addresses and dates of birth, should be provided before you go. It is also worth providing Fridrik Adolfsson (AirIceland, see later) and either Constable Point or Mesters Vig (depending on where your freight is going) with a full inventory of the freight boxes.
Danish Polar Centre, Strandgade 100H, DK-1401 Copenhagen K, Denmark
Tel: 0045 3288 0100 **www.dpc.dk**

Insurance
The DPC requires Search and Rescue insurance for the expedition as a whole, of DKK 1,000,000 for expeditions within the National Park. In addition, each individual must have air ambulance cover of DKK 280,000. The DPC must be provided with document certifying that each member of the expedition is adequately insured. We arranged our insurance through Paul Walker (Tangent Expeditions) using *Govier & Ault Limited Insurance Brokers, Kinder House, Lombard Street, West Bromwich, West Midlands, B70 8SD.*

Other companies that can arrange appropriate cover are:
1) AON Risk Services, Richmond House, College Street, Southampton, Hants, SO14 3PS
Tel: 01703 225616. They have a special expeditions insurance scheme for those expeditions approved by the RGS.
2) The British Mountaineering Council, 177-179 Burton Road, Manchester, M20 2BB
Tel: 0161 445 4747, **www.thebmc.co.uk**. The BMC also has a special expeditions insurance scheme, however their SAR cover may not be sufficient to meet the DPC requirements - check before you go ahead.
3) Harrison Beaumont (linked to West Mercia Insurance), *2 Des Roches Square, Witan Way, Witney, Oxon, OX8 6BE*
Tel: 01993 700200, **www.hbinsurance.co.uk**

Freight

Our freight arrangements were made with Tangent Expeditions. We delivered our freight to Paul Walker in Cumbria, and he sent it off with all the rest of his freight. This cost us £2 per kg, which seemed reasonable. Tangent is not the only travel company that can help with freight – try also Nonni Travel, based in Iceland. Alternatively, some reliable freight companies are:

1) Walden Export, Convent Drive, Denny Industrial Centre, Waterbeach, Cambridge, CB5 9QT, UK, Tel: 01223 861460, **www.waldex.co.uk**

2) Samskip, The Maltings, Silvester House, Silvester Street, Hull, HU1 3HA, Tel: 01482 322399

3) Eimskip (UK agents are MGH Ltd, Middle Platt Road, Immingham, South Humberside, DN40 1AH, Tel:01469 571880)

Most freighting companies will need to know the volume of your freight in cubic metres. As a rough guide, we had a total of 33 boxes and the majority of these were roughly 50 x 40 x 30 cm, making the total volume around 2 m^2. We used double-walled cardboard boxes for all our freight; these worked very well and were probably the cheapest option. They did disintegrate when the got wet during the expedition, but as they were cardboard we could burn them easily. Blue plastic barrels or plastic boxes are also a good option but would be more expensive. We got our boxes from Viking Direct and the high street chain Mailboxes.

It sounds obvious, but make sure that each box is clearly labelled with the name of the expedition, a contact name and telephone number (a member of the expedition and a contact in Iceland/ Greenland), box number (e.g. 3 of 21), and the destination of the freight. It is a good idea to send a full inventory of the contents of each box, to the DPC and also to the handler in Iceland.

www.viking-direct.co.uk

www.nonnitravel.is *(UK Consultant is Bernard Lockett, Tel: 01303 226050)*

International Flights

Flights between the UK and Iceland are expensive and currently only available from Icelandair or British Airways. We bought the cheapest option available, which was inflexible, non-returnable, non-refundable. This cost £512 per person. Depending on the planned itinerary, it may be worth considering spending slightly more on a more flexible ticket. 'Go' used to fly to Keflavik, though they have cut back this year. Their tickets used to cost only £120 return, so it would be worth checking whether this service has been started up again.

Icelandair, 172 Tottenham Court Road, London, W1P 9LG, Tel: 0207 874 1000
Go 0870 6076 543

Chartering an aircraft, usually a Twin Otter or a helicopter, is really the only realistic way of getting to anywhere remote in Greenland. This is also the most expensive part of any expedition, with charter costs in 2002 being £1430 per hour out of Mesters Vig (more for a ski-equipped Twin Otter, as the payload and range of the plane is reduced by the weight of the skis, which have to be fitted in Iceland). We managed to *share* a Twin Otter flight

on our way into the field, with an expedition run by Paul Walker (Tangent Expeditions). The Twin Otter took our group into the field and dropped us off with our equipment, and then went on to collect the Tangent group on their way home. This saved us a lot of money, and it would be well worth trying to share a flight in this way. Fridrik Adolfsson (Flugfelag Islands) may also be able to help with sharing flights. He works for both Paul Walker and AirIceland (who coordinate all charter flights to Greenland) and knows everything that is happening!

Left:
The team unloading the Twin Otter aircraft after landing in Louise Boyd Land

The payload of a Twin Otter is around 1000 kg. This was easily enough for the five of us and all our equipment. The payload of the new Bell 222 helicopter is around 700 kg and its charter costs are also higher, around £1800 ph. However, it has the advantage of being able to land almost anywhere.

Paul Walker, Tangent Expeditions International, 3 Mill Beck, New Hutton, Kendal, Cumbria, LA8 0DB, England, Tel: 0044 1539 737757
paul@tangentexp.demon.co.uk
www.tangent-expeditions.co.uk
Fridrik Adolfsson, Flugfelag Islands, Akureyri, Iceland, **fridrik@flugfelag.is**
Tel: 00 354 460 7080 (office) or 00 354 894 5390 (mobile)

Iceland: Accommodation and internal transport

Iceland is expensive. However unless you are very lucky you will have to stay in Iceland for at least a day en route to Greenland, especially if you want to take advantage of cheaper flight options. We stayed for two days in Reykjavik at the self-catering Salvation Army Hostel. This was very convenient as we had one room for all five of us. This cost us about 1800 ISK (£14) each per night. The hostel is close enough to Reykjavik Domestic Airport to be able to walk there even with all our baggage, thus saving us an otherwise hefty taxi fare. We did not book the hostel in advance and still managed to get spaces despite turning up at 2.30 am!

The airport bus service was fairly expensive but very efficient, transporting travellers from Keflavik International Airport to their individual hotels in about an hour. A single ticket cost about 1000 ISK (£7). Tickets can be booked in advance but you can also buy them on the bus.

Internal flights in Iceland are organised through Air Iceland (Flugfelag Islands) and are ticketless and generally very hassle-free. The transfer from Reykjavik to Akureyri takes about an hour and a half. Our return tickets between Reykjavik and Akureyri cost about £50 each. Be prepared for unexpected delays travelling out of Akureyri. The area is often beset by fog, and in fact we were delayed by a day because of mechanical problems with the aircraft in Greenland.
Air Iceland (Reykjavik) 00 354 570 3030 (Akureyri) 00354 460 7000
www.airisland.is
Airport Bus Service (Reykjavik) 00 354 562 1011
Greenland Tourist Board: **tourism@greennet.gl**
Salvation Army Guest House, Kirkjustraeti 2, Tel: 00 354 561 3203

Radios and communications
The DPC issues a statement that you will need: "an emergency radio beacon (EPIRB) capable of transmission on 121.5 MHz and/or 406 MHz with a 121.5 MHz homing device for continuous transmission using an internal power supply for at least 24 hours, at an ambient temperature down to –20 °C." The new style is impossible to set off accidentally – you have to screw on the aerial AND pull the pin out in order to transmit. We borrowed an EPIRB from CASP; however other firms do hire EPIRBs:
Premium Liferaft Services, Liferaft House, Burnham Business Park, Burnham on Crouch, Essex, CM0 8TE Tel: 0161 784858

We also borrowed our HF radio from CASP. We made our own powering set-up so that we could run it from the same battery packs as we used for our scientific equipment. These were 12 V, 7.2 Ah closed cell battery packs and could be recharged using our solar panel. The radio had pre-programmed channels which meant that we didn't have to re-tune every time we used it. We could also pick up BBC World Service and its American equivalent.
Clive Johnson, Logistics Manager, CASP, 01298 25405
Radio Administration, PO Box 1002, DK-3900 Nuuk, Greenland, Tel: 00299 323120

We hired a satellite telephone from Mobell. This was a good back-up in case of emergency, as radio reception to Mesters Vig can be very variable depending on the location. It also meant that we could coordinate our boat pick-up (we had no radio reception at all by the fjords) and call the UK with weekly progress updates. Mobell kindly offered us half-price line rental, which cost us £270 for the two months.
Simon George, Mobell Communications Limited, The Winding House, Walkers Rise, Rugeley Road, Hednesford, Staffs. WS12 5QU
www.mobell.com

Firearms

Expeditions within the Greenland National Park are required by the DPC to have firearms and polar bear deterrents, and a firearms licence is mandatory. Licences are issued by the Chief Constable in Nuuk and are free unless you have an automatic or semi-automatic weapon. We borrowed a Remington .308 bolt-action rifle from CASP. This was stored in Mesters Vig, which meant that we avoided any complications at customs! Fridrik Adolfsson bought our ammunition for us in Iceland. In the end, though, he was unable to get hold of expanding rounds. We borrowed 8 expanding rounds from CASP, and in addition had 40 full jacket rounds for shooting practice. Expanding rounds are vital for shooting polar bears, and we kept the rifle loaded with the expanding rounds. The risk of us seeing a polar bear was extremely low, since we were so far inland, but it was still essential that we took the rifle with us.

Chief Constable, P.H.Lundsteensvej 1, PO Box 1006, DK-3900 Nuuk, Greenland
Tel: 00299 321 448, Fax: 00299 324 194

Equipment

Our full equipment list is given in a separate section (Appendix 1), with details of manufacturers and comments on equipment performance. However some pieces of kit are much harder to obtain than the usual climbing gear. For example, we spent a lot of time and energy trying to obtain five pulks for the expedition. We tried to borrow them from BSES (British Schools Exploratory Society) but theirs were all in use. Paul Walker will hire out pulks but you need to get in quickly! In the end we hired two from a company called Arcturus Expeditions, bought two second hand, and borrowed one from a private contact. The Arcturus pulks were made by the Norwegian company Fjellpulken, and the others were made by Snowsled. See the separate equipment report for details of how the different makes performed.

Arcturus Expeditions (contact: Kathy Cartwright), PO Box 850, Gartocharn, Alexandria, Dumbartonshire, G83, 8RL Tel: 01389 830204
www.arcturusexpeditions.co.uk
BSES, 1 Kensington Gore, London, SW7 2AR Tel: 0171 584 1701
Fjellpulken: **www.fjellpulken.no**

Navigation

We initially bought the original 1930s maps from Stanfords in London (0171 836 1321). These are reasonably inaccurate, especially against GPS readings, but do have the advantage that the series covers the whole of the east and northeast Greenland coast. The are produced by the Dansk Geodaetisk Survey and are at 1:250 000 scale. We were also lucky to be given black and white photocopies of some excellent 1:100 000 scale maps used by the Greenland and Denmark Geological Survey (GEUS). They also provided us with a large scale map covering our whole route.

Aerial photographs can be purchased from the National Survey and Cadastre. We were lucky enough to be lent a full set of the 1975 aerial photographs at 1:150 000 scale by Anders Nielsen (Senior Cartographer, Map and Chart Division, National Survey and Cadastre), and a set of larger scale photographs of our study area by GEUS. It is

definitely worth while taking both aerial photographs and maps. We made a montage of the photographs but even so, there was quite a lot of distortion at the edges, where flight paths overlapped and the lens distortion was maximum. It is a good idea to laminate any photo montages and maps, to prevent them from disintegrating.
We had two GPS, a Magellan and a Garmin. Both worked well and we always had good satellite coverage. Magnetic declination is at present 35°W in northeast Greenland. Current values of magnetic variation at various latitudes are available from Natural Resources Canada.
GEUS, Øster Voldgade 10, DK-1350 Copenhagen K, Tel: 0045 381 42000
National Survey and Cadastre, Rentemestervej 8, DK-2400 Copenhagen NV,
Tel: 0045 358 75050
Natural Resources Canada, **www.geolab.nrcan.gc.ca/geomag/e_magdec.html**

Stoves and fuel
We took two MSR stoves, a Whisperlite and a Dragonfly. We had been intending to take Coleman Fuel from the drums at Constable Point, but since our jerry cans were lost in the freight, we had to take Jet A1 fuel from Mesters Vig. The main problem with the Jet fuel is that it is fairly heavy fuel, so the stoves could get quite sooty during priming. We found that both stoves needed a lot of priming as it was quite cold. The Dragonfly was extremely reliable and versatile, while the Whisperlite did not burn well on the A1 fuel, often giving a large, sooty flame. It also had no flame control. We took maintenance kits for both stoves, which were very useful as they included cleaning equipment. One further problem we had with the MSR stoves was that the plastic pump mechanism that attached to the fuel bottle seemed to be very weak. Perhaps the plastic became brittle in the cold, but both the pumps broke and had to be held together with cable ties (luckily this did not result in any loss in pressure). We needed a 3 L pan to cook in, but found a 1.5 L or 2 L pan quicker for boiling water.

We took 70 L fuel for the 56 days we were in the field. This was allowing for having to melt snow the entire time, as we weren't sure what the conditions would be. In the end, because we found running water at our base camp, this turned out to be far more than we needed. We also found that it was well worth digging down a foot or so with an iceaxe in order to find denser snow. A fuel consumption guide would be (for two stoves, five people):

- With running water, 1.5 L lasts 3 - 4 days
- Melting granular, recrystallised snow/ ice, 1.5 L lasts 2 - 3 days
- Melting soft snow, 1.5 L lasts 1 - 2 days

Remember to add a little water to the bottom of the pan when melting snow - otherwise it burns!

14 FINANCIAL REPORT

Financial Strategy

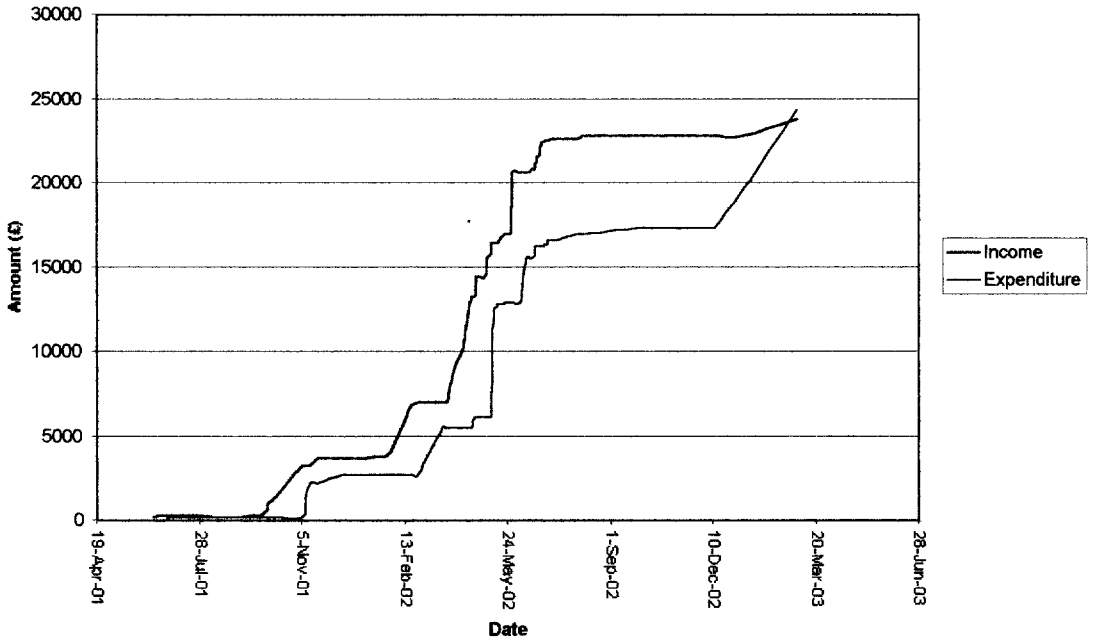
Constructing a budget

We started by basing our budget on that of previous expeditions. Then, as we began ordering equipment and arranging the finer details of the logistics, a more accurate budget emerged. Our major costs were the international flights and Twin Otter charter.

Raising the money

Other than our personal contributions we identified three possible sources of funding: Corporate Sponsorship, Fund and Awards, and Personal Donations. In terms of corporate sponsorship, our best responses came when we had a contact in the company who could personally recommend us. In these cases it was best if we could offer something in return for the money such as wearing the sponsor's logo, or giving talks and slide shows on our return; however some companies did not require any major return from us.

The Cambridge University Expeditions Society provided a useful list of sources of funding, but our most useful reference was the RGS website: **www.rgs.org**, under the 'grants' section. We applied for all the funds that were related to what we were doing, ensuring that each application was directed at the specific aims of each award. This required a substantial amount of work, but was our biggest source of funding. The 'Directory of Grant-Making Trusts' is also a good source of reference, and copies are found in public libraries. We employed a blanket approach with this, and received a couple of good responses from a couple of hundred letters sent. We were lucky enough to receive a reasonably substantial amount of funds from friends and family who had heard about the Expedition. This was helped by publicity in local newspapers and a sponsored skydive event.



The figure shows how our bank balance fluctuated over the course of the preparation period (the idea is to keep expenditure always below income!).

A Note on Publicity

Our largest individual contribution came as a result of Michael Kobold (Kobold Chronographs, **www.kobold.com**) spotting our website and offering to support us. The website was extremely useful for keeping people updated on progress prior to departure, and was also useful when asking for sponsorship. All our sponsors' logos are displayed on the website. General awareness of what we were doing was raised by us wearing expedition T-shirts around the university, and at home, which played a part in the contributions received by friends and family.

The Budget deficit

We succeeded in raising the basic amount required, but not all of the minimum 10% contingency. Some of our expenses were not due until our return and we agreed that if we needed the contingency money, we would raise the required funds individually.

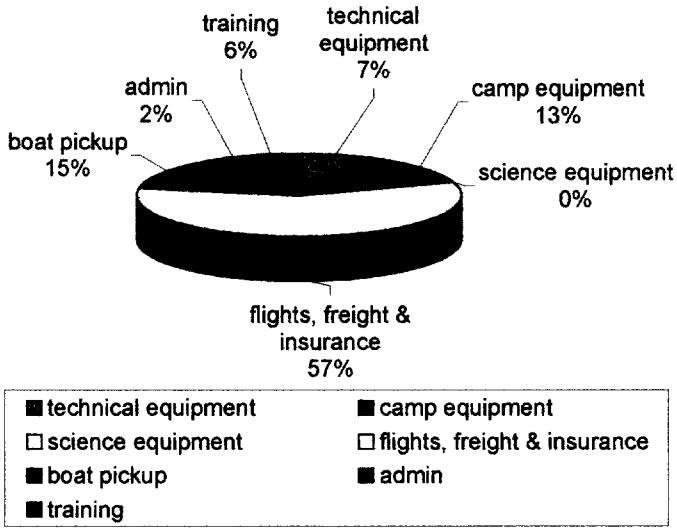
Sources of Income

All our donors are listed below. Some specific sums are not published, at the request of individual donors.

£1000 - £2500	Kobold Precision Chronographs
	CASP
	Dr. Nicky White
	Royal Geographical Society (the M.R.Mill Trust Fund)
	Gino Watkins Memorial Fund
	Enterprise Oil
	The Dennis Curry Charitable Trust
£500 - £999	Cambridge Expeditions Fund
	Corpus Christi College
	The Eagle Ski Club
	Fluor Ltd.
	The Mount Everest Foundation
	Augustine Courtauld
	Shell
£250 - £499	St. Catharine's College
	The Royal Society of St. George Expedition Award
	The Malthus Trust
	Sponsorship for Sky Dive
	Mr. and Mrs C. Coates
£100 - £249	The Alpine Ski Club
	St. Albans High School for Girls (Old Girls' Association)
	The Charles Parkin Award (Clare College)

	The Donald Robertson Award	
	Dr. R. Daniel and Dr. P. Brewis	
	Mr. and Mrs. Rugman	
£0 - £99	The Rotary Club of Bungay	
	Mr. and Mrs. J. Roberts	
	Mr. P. Tattersall	
	Swaffham Lions	
	Mr. and Mrs. Clegg	
	Mrs. Hinkley	
	Clive Johnson	
	Mr. and Mrs. J. Marks	
Other donations	The North London Parachute Centre donated 4 Skydives.	
Personal Contributions at £1200 per member		
TOTAL		**24 351**

Summary of Expenditure (a detailed breakdown is available in Appendix 4)



15 SPONSORSHIP

The financial report has already dealt with the corporate sponsorship that we managed to raise. This was undoubtedly a huge boost for the expedition planning. Another extremely important factor in achieving our target budget was the degree of support we had from companies in the form of 'sponsorship-in-kind'. In this way we obtained much of our equipment, including food, at greatly discounted rates, through the generosity of many smaller companies.

A full description of the items obtained is given below.

Company	Item(s)	Rate	Contact
Tesco, Cambridge	Food	Money off food bill	Local store
Unilever Plc	Peperami	Free	Nick Partridge
Soreen	Malt Loaf and Plum Loaf	Free	Roger Woodward
Agfa	Slide and print film	40% discount	Philip Miller
Jordans Cereals	Crunchy cereal, porridge and Frusli bars	Free	Amanda Halliwell
Mobell Communications	Satellite telephone rental	Half price	Simon George
Lyon Equipment	Beal Cobra double ropes Julbo Cham Altitude Arc glacier glasses Charlet Moser S12 crampons	Discounted gear	Simon Tulley
Venturesport	Mountain Equipment Ultrafleece salopettes MSR Drangonfly stove Helly Hansen long johns Lowe Alpine thermal tops Thermarests Bod Harnesses Petzl Ecrin Rock helmets	Discounted gear	Neal
Rab Carrington Ltd	VaporRise tops Survival bags Latok Goretex pants Guide Kinder Down jackets	Discounted gear	Paavo Lane
Allcord	Titanium ice screws Belay plates Hexes Pitons Gaiters Tricams	Discounted gear	Colin Westwood
Vango/ AMG Outdoor Ltd.	Phoenix Glencoe 1100 (5 season) down sleeping bags	Discounted gear	
Cairngorm Mountain Supplies	Ski-mountaineering skins Ski-boots Accessories	Discounted gear	
DMM	'The Fly' ice axes Deadmen Quickdraws Slings (various sizes) Lynx screwgates Boa screwgates Wallnuts	Discounted gear	Chris Rolands

16 ENVIRONMENTAL REPORT

Background

During its time in Greenland the expedition travelled 200km in three weeks, after having lived in one place for a similar period of time. Managing the environmental damage under either of these conditions is difficult. We needed to make sure that we were leaving behind us only the most minimal trail. Our concern was not with the environment in the atmospheric sense. The fuel we burned in the jet and chartered ski-plane flying to our location dwarfed the quantities of fuel and waste that we burned during the expedition. We were instead concerned with the local environment: maintaining the previously unvisited glacier surface at the state it was in before we arrived. Several members of the team had some training in what to look for and with what to pay special attention, and we were also given some guidance by the Danish Polar Centre (DPC) at Mesters Vig and elsewhere.

Rubbish

We made up our own ration packs and therefore generated a large quantity of rubbish from food. The majority of this was foil-backed plastic wrappers. Initially another great source of waste was our cardboard freight boxes and packaging, which rapidly became waterlogged. At the end of our stay in our science area we also generated some waste as we packed to leave.

In the science area, where appropriate, we were able to reduce the quantity of rubbish by burning. A deep fire-pit was constructed with a sandy base to prevent fuel leakage, and fires set infrequently (twice weekly) containing the rubbish and toilet-paper bag (see Medical Report). The ashes and unburned foil pieces were left in the pit and further fires set on top in order to reduce previous waste.

During the trek phase we were unable to burn rubbish and it was sorted, bagged, and carried to Mesters Vig where it was disposed of. The toilet-paper bag was carried with us until it could be safely burnt, on two occasions during the trek when we were near rock.

Fuel

We had rationed over 1l of fuel per day, anticipating that we might find no running water and could be continuously melting snow. Since we had found water at our science camp, we were left with several litres of fuel excess to requirements before the trek began, even allowing for well over a litre a day for the remainder. There seemed little point in carrying this to Mesters Vig and so we decided to burn the excess. Two methods for this were attempted. Burning on rock was little problem - the fuel was sprinkled onto our existing fire a little at a time, the aim being to burn as much as possible without allowing it to soak in. This took a long time to complete since for safety reasons only a small amount of fuel could be poured on at once. First attempts at this were less successful since too much fuel was allowed to soak in to the ground. The majority of this fuel will have later burned off through the wicking action of the sand.

An attempt at burning fuel on ice was unsuccessful. Only the more volatile components of the fuel were able to burn since the ice cooled the fire, and some unburned fuel escaped and pooled elsewhere. The resulting mix of heavier oils, soot and water was removed from the site and allowed to evaporate on the fire pit. The remainder was covered in fine sand (to prevent the fuel leaking into the glacier's hydrological system). It will in time degenerate in the air.

Camps

We made sure to return camp sites to as close to their original condition as possible, replacing rocks we had moved and removing the dams we had constructed for washing facilities at our science camp.

Science equipment

The surveying project required us to drill seventeen 2m by 19mm polypropylene tubes into the glacier surface to a depth of 1.8m (around 20cm showing). The tops of these tubes were sprayed in fluorescent orange enamel paint to improve visibility. We had thought it would be possible to remove these once the project was finished but soon found that they had frozen in below a depth of 10cm. Whilst good news for the scientific results, this meant it was impractical to attempt removal of all stakes. A test extraction took 2 hours to remove a 70cm portion, using boiling water and the ice-drill to remove the tube. The rest of these tubes remain embedded in the glacier surface and we felt that any attempt to disguise them by cutting the top portions off would be meaningless since the next melt season may expose them to a greater extent.

Summary

The environmental impact of the expedition was minimised by careful disposal of rubbish and a successful team ethic of low impact. It is unreasonable to assume that the only thing we left behind was human waste but we were able to minimise our long-term impact on the local environment. Once the snow has settled once again over our tracks the glacier will be broadly unchanged after our visit.

17 MEDICAL REPORT

Background and Training

The Medical Officer (MO) joined the expedition with some experience of medical, hygiene and safety procedures in the North East Greenland National Park, gained on the BSES Greenland 1998 expedition. This was improved by participation in a leadership training course with sessions on camp layout, hygiene and medical issues. In addition the MO also attended the Rescue and Emergency Care (REC) course in Mountain First Aid at Plas-y-Brenin, and the Wilderness Medical Training course, jointly organised with the RGS-IBG Expedition Advisory Centre (see section on Training for details).

Expedition members also attended basic First Aid courses. They were advised by the MO on medical issues through a briefing document compiled from experience, old BSES documentation, and advice from the other courses. This consisted of first-aid notes and precautions as well as general expedition advice on hygiene and safety. The purpose of this document was to raise awareness of safety issues before the expedition.

Medical Kit

Once approved by the Cambridge Expeditions Committee, the expedition benefited from the Cambridge Expeditions Medical Scheme. During an interview with a consultant at the Cambridge Occupational Health Centre a medical kit-list was drawn up and ordered. The scheme made this process simple and cheap and provided a basic medical kit containing courses of antibiotics, painkillers and a useful selection of dressings. The kit also contains useful non-medical items such as insect repellent. Please see Appendix 2 for a full listing of the contents of the kit. The medical officer was also supplied with a small manual, providing basic instructions and diagnoses in tabular form. This manual was taken on the expedition and was found to be useful although a little concise, concentrating only on major problems and not the minor ailments encountered. Some work comparing the two manuals before departure was useful for gaining an appreciation of the core ideas and auxiliary topics.

All expedition members brought an individual first-aid kit containing a selection of dressings, enough to manage any personal accident in the field without recourse to the main medical kit. The main kit was then reserved for serious incidents, illnesses and mid-term care. Personal medical or wash kits also included quantities of sun-cream, essential for prolonged exposure to Arctic sunshine on snow, and lip salve/ sunblock, which was also ideal for protecting the underside of noses and ears. To protect against dried-out and cracking fingers due to the cold dry air we took moisturising cream or Vaseline according to choice. Personal hygiene was left up to individuals and a small supply of off-the-shelf painkillers and indigestion relief tablets were taken according to personal preference.

In retrospect the main first aid kit probably had more antibiotics than were needed for such a cold-temperature expedition. It may have been better instead to have taken more courses of a general purpose anitbiotic such as Ciproxin (though this is expensive) and not the other antibiotics. Of course, we were lucky not to need any of the antibiotics that

we took. In the end mosquitoes were not a problem for us but we were warned that they can be an extreme nuisance.

Hygiene

Personal hygiene was maintained at a high level throughout the expedition and there was a good awareness of general principles. Wherever possible a camp site was chosen with running water. Selection of appropriate toilet, washing (personal, clothes, and food were separated) and drinking sites was amongst the first tasks when setting up the new camp. Water supplies were checked for mica flakes and other sediment but no significant suspended sediments were found. The science camp, at which we were resident for three weeks, was situated next to a fast-moving stream at the ice/rock boundary which provided an ideal range of locations for these activities. Despite some reservations about using a running-water system as our toilet (to avoid long-range environmental pollution and since we might later wish to use it as drinking water when we travelled down the glacier), this was the most practical solution for hygiene purposes. All waste was instantly washed away and the toilet area kept clean and smell-free except on a few occasions when the stream froze over. Even then, the afternoon melt did an excellent job of washing everything away.

When away from running water a toilet pit was dug, and covered over before we left camp. This covering was for cosmetic purposes only since subsequent melt is likely to uncover the site and little decomposition will take place in the frozen environment. Wherever possible this pit was located downhill of our chosen water supply or at least a significant distance away.

At first we burned all used toilet roll on an individual basis, but this was quickly found to be impractical, time consuming, and wasteful of lighters and matches. Later we implemented a system of double-bagging used pieces which were stored together for several days before being burned en masse. This system worked well as long as care was taken with bag-sealing and hand-washing. Discussion of toilet habits, precipitated by a grading system, provided a good level of personal interest and encouraged awareness of this important indicator of health.

Washing of bodies and clothes was weather- and situation-dependant. All members found that a snow-scrub of essential areas was refreshing, effective, and could be accomplished whilst clothed if drying was guaranteed. In this way a wash every few days was achieved. Feet and lower legs caused the most problems since they were often warm and damp due to sweat. Some swelling and irritation appeared around the top of the boots on several members. This was especially noticed in the male members around hair roots, presumably due to constant rubbing. These were relieved with tape (Micropore or Elastoplast) and special attention was paid to washing these areas. Application of Hydrocortisone cream in one instance provided some relief. Some rubbing in other sweaty (groin and armpits) areas provided a level of discomfort but this was always found to be due to a particular set of clothes and a change prevented the problem recurring. Peeling and discomfort of feet, especially after wet days, was relieved in part by airing before sleeping, to allow some of the moisture to escape.

All used cooking equipment was washed daily and this was a contributing factor in preventing the spread of illness. We found it easier to eat from the same pan since this best maintained the temperature of the food.

Medical problems

There were no incidents requiring significant first aid or medical attention. Responsibility for this must be given not just to good luck, but to the experience, awareness and caution of the expedition team at all times.

Several of the team members reported that exposed areas of skin (ears and cheeks especially) stung and itched severely when brought in to a warm tent. This coincided in some cases with blistering and scabbing reminiscent of that in severe sunburn although this was certainly not the cause. Frost-nip was initially ruled out as the symptoms did not appear during the coldest weather that we encountered. However, later research revealed that frost-nip can occur at temperatures above freezing, usually after prolonged exposure to wet-cold conditions; and many experienced Arctic expeditioners agreed on seeing the symptoms that it was definitely frost-nip. Treatment with Hydrocortisone cream relieved the swelling and symptoms disappeared over several weeks.

During the course of the expedition each team member was host to a personal selection of aches and pains. The severity of these varied from the unnoticed to the temporarily inhibiting. Care was taken with distribution of loads and tasks throughout, to balance physical and mental strengths and maintain a feeling of fair contribution to the team by each member. This balancing, although sometimes unpopular, became increasingly successful as individuals grew to know the limits of others.

Medical Summary

A basic level of first aid training for all participants is essential in the expedition environment since the Medical Officer may either be injured or otherwise unavailable. The MO should undergo further medical (as opposed to first aid) training if at all possible, since this experience leads to increased confidence in the use of manuals such as those provided by WMT and the Cambridge Medical Scheme. A philosophy of personal responsibility in individual first aid kits was effective. The expedition medical kit was used only on one occasion and would therefore have been fully available in case of emergency. Designated water, washing, and toilet points help to reduce the risk of contamination even in a small expedition setting. Experience in camp safety and of safe travel techniques leads to a healthy atmosphere of slight caution and awareness.

18 ACKNOWLEDGEMENTS

As with any expedition of this sort, nothing would have been possible without the help and support of many people throughout the last two years. Assistance has been given in many forms - from simply genuine interest and encouragement, to loan of equipment, financial support, provision of discounted or free food and climbing gear, help in finding information, writing of references.....
We would like to thank the following for their help:

Prof. Peter Friend	Patronage, references, general advice
Prof. Mike Hambrey	Patronage and glaciological advice
David Hempleman-Adams	Patronage
Fridrik Adolfsson	Logistical support
Hauge Andersson	Advice and logistical support
Arcturus Expeditions	Hire of pulks
Ben Boddy (BSES Expeditions)	Advice and hire of tents
CASP	Financial and logistical support, food in Akureyri
Clare College	Financial support
Corpus Christi College	Financial support
Enterprise Oil	Financial support
Sarah Farquhar	Loan of GPS
Fluor Ltd.	Financial support
Dr. Hilmar Gudmundsson	Glaciological discussions
Dave Harrison	Free skydives
Dr. Tony Higgins	Information, references, maps, photographs
Clive Johnson	Much information and advice, loan of pulks, boat pick-up
Mike Kobold (Kobold Chronographs)	Major financial support
Anders Nielsen	Loan of aerial photographs
Dr. Caroline Pickles	Advice and encouragement
Dr. David Pyle	Loan of GPS, references
Dr. Dave Rippon	Glaciological discussions
Isabelle Ryder	Boat pick-up
Shell	Financial support
Ian Steen	Information and advice
Dr. Tim Stott (Liverpool John Moores)	Scientific advice
St. Catharine's College	Financial support
Swaffham Lions	Financial support
The Alpine Ski Club	Endorsement and financial support
The Arctic Club (Derek Fordham)	Financial support and advice
The Augustine Courtauld Trust	Financial support
The British Mountaineering Council	Endorsement and financial support
The Cambridge Expeditions Society	Endorsement and financial support
The Dennis Curry Charitable Trust	Financial support
The Donald Robertson Award	Financial support

The Eagle Ski Club	Financial support
The Gino Watkins Memorial Fund	Financial support
The Malthus Trust	Financial support
The Mount Everest Foundation (Bill Ruthven)	Endorsement and financial support
The RGS	Endorsement and financial support
The Royal Society of St. George	Financial support
The Rotary Club of Bungay	Financial support
The St. Albans High School OGA	Financial support
John Thorogood	Information and advice
Heather Tinsley	Analysis of pollen trap contents
Matt Tinsley	Many advice sessions, support and encouragement
Paul Walker (Tangent Expeditions)	Advice, information, freight arrangements
Dr. Andy Whitham	Advice and encouragement
Dr. Nicky White	Major financial support
Dr. Ian Willis	Many long glaciological discussions, references, advice, loan of equipment

There are, of course, many others who also offered their time and encouragement. We would like also to mention our friends and relatives for their continued interest and encouragement. Thanks to the many individual donors - they are named in the Financial section. We would also like to say a big thank you to the companies who gave us free or heavily discounted gear - they are mentioned in the Sponsorship section. And last, but by no means least, thank you to our families, for remaining supportive throughout, even when they realised what we wanted to do.

APPENDIX 1: EQUIPMENT

CLOTHING

DESCRIPTION	MANUFACTURER	QUANTITY (per person)	COMMENTS
Base Layer: Thermal tops and long johns	Lowe Alpine Dry-flo	2	Excellent moisture control; some thought these too thin
Base Layer: underwear	Lowe Alpine Dry-flo, M&S Active, North Cape	2	Lowe Alpine again good, as were Marks&Spencer 'Active' range. Buttons on North Cape Boxers proved weak. Having two different styles worked well as a reflief to chafing in certain areas!
Mid Layer: Fleece Sweaters	Lowe Alpine, Lafuma	1	Useful when cold and inactive.
Mid Layer: Fleece Salopettes	Mountain Equipment	1	Another essential item, worn all the time. Good for keeping the small of the back and stomach warm
Outer Layer: Fleece/Pertex Smock	Rab	1	An ideal garment for the job; worn almost non-stop throughout the expedition, as a top layer over thermals on a warm day and also as part of a layer system on colder days. Big pockets always full.
Down Jacket	Rab	1	Not essential but comforting and warm
Gortex Trousers and Jacket	Various	1 of each	Not used often but much apreciated in bad weather. Excellent for stopping wind on the ice-cap.
Shorts	Various	1	Good for laughs on very warm days
Hat and neck warmer	Various	1 of each	Essential
Sunhat		1	Essential for long days in fine weather
Inner gloves	Various	1 or 2	Essential - dexterity important
Outer waterproof gloves/mitts	Various	1	Essential
Inner socks	Bridgedale	2 pairs	2 pairs (important to alternate when wet).
Outer socks	Bridgedale, Thorlo	2 pairs	Thorlos wore into holes and finally disintegrated with lots of skiing
Glacier goggles	Julbo	1 pair	Worn all the time and very effective at stopping glare. One pair of wrap-around sunglasses was worn; these were also perfectly adequate.
Gaiters	Camp, Mountain Equipment	1pair	Only used occasionally as all negotiation of deep snow was done on skis. Could not be fitted to the ski boots. Camp gaiters were on the baggy side.

SKIING EQUIPMENT

DESCRIPTION	MANUFACTURER	QUANTITY (per person)	COMMENTS
Ski-Mountaineering Boots	Scarpa Denali	1 pair	Very versatile, good for rock climbing, cramponing, walking and skiing. Not particularly comfortable, but it would be possible to use just these if no hard rock climbing were envisaged.
Skis	Various (all ski-mountaineering style) with Fritchi bindings	1 pair	We all used a ski-mountaineering setup which meant that we were flexible when there were opportunities for downhill skiing. The springs inside the bindings proved very weak and broke without exception. The skis themselves bore up well, and were useful fo
Ski Crampons	Fritschi	1 pair	Came into their own when the snow became steep on the second ski-mountaineering venture
Skins	Montana or Pomoco	1 pair	Essential but caused a lot of trouble as they were in bad condition and needed constant re-glueing. Two cans of spray adhesive were only just enough for the five of us. The rubber toe pieces were sometimes weak, as were the retaining clips at the back. T
Ski Poles	Various	1 pair	Ideally these should be long (up to the shoulders).
Pulks	Snowsled 1.6m Greenland (x3), Fjellpulken 1.4m (x2)	1	These took a lot of abuse, partly because of bad conditions and partly because we thought they were indestructible - they were not. The Snowsleds stood up badly to repeated stream crossings and hard ice and quickly developed holes and cracks.

SKI REPAIR KIT

DESCRIPTION	MANUFACTURER	QUANTITY (per person)	COMMENTS
Spair skins			Essential; another pair would have been useful
Glue	Various	2	Essential; was used many times. Could have done with another bottle
Binding toe piece			
Skin toe piece			
Wax		1	Wrong temperature for fresh snow, but did aid glide.

CLIMBING EQUIPMENT

DESCRIPTION	MANUFACTURER	QUANTITY (per person)	COMMENTS
Mountaineering Boots	Salomon Super Mountain 9, Scarpa Matterhorn	1 pair	Ideal for the rock climbing that we did and a comfortable release from the ski boots
Technical Ice axe and hammer	DMM: The Fly	1 of each	Not essential for the climbing that we undertook. One alpine style axe would have been sufficient. More technical ascents possible in the area. Useful as tent pegs in deep snow.
Crampons	Charlet Moser	1 pair	These perfomed excellently
Helmets	Petzl	1	Worn only occasionally but essential with risks of rockfall. Easy to adjust and comfortable.
Harnesses	Black Diamond	1	Excellent; detachable leg loops ideal for use with skis.
Ropes: 30m x 6mm glacier rope		1 (group)	Ideal for 2-person glacier travel, light and easy to handle
60m x 10mm climbing rope		2 (group)	Ideal length for roped glacier travel with 5 people
50m x 10.5mm climbing rope		1 (group)	Good for climbing, too short for comfortable roped glacier travel with 5 people.
Rucksacs	Various	1	Essential for individual equipment when climbing and for ferrying equipment over poor terrain

INDIVIDUAL CLIMBING RACK

DESCRIPTION	MANUFACTURER	QUANTITY (per person)	COMMENTS
Assorted Slings			
Quickdraws			
Karabiners			
Dead man		1	Were not used
Ice screws			Not used in climbing, but many other uses.

LEADER CLIMBING RACK

DESCRIPTION	MANUFACTURER	QUANTITY (per person)	COMMENTS
Set of nuts 1 - 10			Essential
Tricams			Useful
Pitons			Essential
Abseil tat			Essential for abseiling and many other uses

COOKING EQUIPMENT

DESCRIPTION	MANUFACTURER	QUANTITY (group)	COMMENTS
Stoves	MSR Dragonfly and WhisperLite	1 of each	Dragonfly worked well. The WhisperLite needed regular cleaning and a lot of priming. The plastic pump section on both models proved weak under regular use and broke, requiring tape and cable ties to hold them together
Stove Repair Kit	MSR	1	Essential for repairs and general maintenance
Jerry cans		3x 20L steel, Norweigan style; 2x 5L plastic	Replaced original 10L plastic jerries that did not arrive. Minimal leakage. Steel cans were very heavy.
Fuel	Jet A1	70L	Dirty, worked well in the Dragonfly. WhisperLite struggled.
Funnels		2	One for decanting and filtering fuel, one for water/ spare. Essential.
Cooking pan sets	MSR	1x small (1L), 1x medium (1.5L), 1x large (3L)	A large pan of water took a very long time to boil, but was essential for mixing and formed the group trough.
Eating bowl		1 each	Unused
Cutlery set		1 each	Only the spoons were used
Mug		1 each	Ideally would have all been the same size (1pint is a good size), Insulated plastic is ideal.
Scourers		2	Useful for general hygiene. Could have done with more.
Sponge cloths		6	Very useful for mopping up spillages
Matches and Lighters		10 lighters, 6 boxes matches	Very important - were treated like gold. Matches retained for emergency. Only 3 lighters were used.

Pen-knife		1 each	Essential
Water bottles		1 or 2 each	Prone to freezing (all types)
Steel "Thermos" Flasks	Various	1 each	Perfect for tea breaks.

SLEEPING AND CAMPING EQUIPMENT

DESCRIPTION	MANUFACTURER	QUANTITY	COMMENTS
Sleeping bags	Mountain Hardwear (down, 1), Vango (synthetic, 1), Phoenix (down, 3)	1 each	Four down and one synthetic was taken. The Phoenix bags leaked a lot of down and were only warm enough for the warm sleepers. The Mountain Hardwear bag was warm, light and didn't leak down. The Vango bag performed well.
Karrimat		1 each	Used under the Thermarest; together they provided excellent insulation.
Thermarest		1 each	Excellent
Survival bag	Rab	1 each	Good breathability and waterproofing, latex inner lining was poor and perished quickly.
Liner	Various	1 each	Cotton and silk both perfomed well. Silk recommended for comfort, weight and bulk
Tents	2x The North Face (Himalayan Hotel), 1x FjallRaven Polar		Our Terra Nova tents were late being freighted so we borrowed two North Face Himalayan Hotel tents. These were large but had weak zips and were awkward to put up, and they lacked snow valances. The other borrowed tent was a FjallRaven dome tent with snow
Toilet roll		9 (group)	Only 6-7 were used
Head-torch		1 each	Never used in the field - uneccesary at this time of year at this latitude.

COMMUNICATIONS AND POWER

DESCRIPTION	MANUFACTURER	QUANTITY	COMMENTS
HF Radio		1	Another essential piece of equipment. Reception was often poor due to problems with atmospheric conditions, but we were able to maintain sporadic contact with Mesters Vig. The solar charged batteries worked well powering the radio. Was used to receive in
Solar Panel		1	This met all our power needs without difficulty
Batteries 12V 7.2 Ah		4	Used for radio and Total Station; we took a large number due to uncertainty about the efficiency of the solar panel. Two would have been sufficient - they were heavy!
Handheld 2-way radios (with charger)	Motorolla	2	Very useful when setting up scientific equipment and when the group split. Not essential.
EPIRB (emergency personal locator beacon)		1	An essential pre-requisite for entering the National Park. Fortunately was not used.
Satellite Telephone	Motorolla; hired from Mobell Communications	1	Used to call UK with progress updates. Very useful when radio reception is poor.

NAVIGATION AND SAFETY

DESCRIPTION	MANUFACTURER	QUANTITY	COMMENTS
GPS	Magellan; ETrex	2	These were useful for marking depots and for navigating to marked points in bad weather. However, note that without pre-programmed co-ordinates they are not very useful as the maps are not sufficiently detailed.
Maps			1:100 000 scale of the study area; one very large scale sheet covering entire distance travelled.
Aerial Photographs		2 (team)	Collage produce prior to expedition and laminated. Used in conjunction with maps to give reasonable estimate of terrain and best route! Aerial photographs were at 1:150 000 scale.
Compass		1 each	Mainly used to set direction of travel. It is worth ensuring they are good quality and easy to use.
Polythene Survival bags		1 each	Used as extra waterproof layer under tent groundsheets
Emergency shelter	Terra Nova - Bothy	1 (team)	Not used, but necessary for emergencies
Rifle: Remington .308 (soft-nosed rounds)		1	Essential pre-requisite for entering the National Park. Used in practice only.
Avalanche Probes	Orthovox	2 (team)	Used very occasionally to check safety of ground; not used in an emergency situation
Shovels	Camp / Orthovox	2	Excellent, very useful for digging toilets, filling snow valances and digging out buried equipment in snowdrifts. Also used as paddles when crossing river.

MISCELLANEOUS

DESCRIPTION	MANUFACTURER	QUANTITY	COMMENTS
Cardboard freight boxes		Around 30	Excellent for freight, light and cheap, good for storage when dry. Very annoying when wet...
Tarpaulin		1	Used to protect food depot against the elements
Garden canes		8	Used to mark food depot and raise radio aerial
Books		1 each	Shared around, and provided excellent group entertainment when read aloud .

Playing cards		1	Essential!!!
Camera	Various	1 each	There were no serious camera problems
Films	Kodak Royal (print); Fuji Sensia (slide)	Around 10 each	Both slide and print film produced excellent images

GENERAL REPAIR KIT

DESCRIPTION	MANUFACTURER	QUANTITY	COMMENTS
Set of Allen keys (for ice axes)		1	
Screwdriver		1	
Pliers			Useful in cleaning/ mending stoves
Epoxy resin			Used for mending sledges en-route. Did not work well - in future use Araldite rather than solid epoxy.
Roll of stiff copper wire			Useful for mending sledge tracers, but prone to fatigue.
Stove maintenance/ repair kits	MSR		Essential
Tough Nylon thread and needles			Useful for running repairs on the skins
Gaffer tape			Essential - we used a whole roll
Electrical tape			Also very useful
Spare straps and webbing			Webbing was used to attach one set of sledge tracers.
Thin parachute cord			Essential for mending sledge tracers and other odds and ends. Take a good length, eg 20m
Stanley knife			
Tent repair kits (fabric patches and pole sleeves)	Terra Nova		
Spare inner and outer gloves			
Spare glacier goggles			
Spare AA batteries			GPS run through batteries quite quickly.
Packet of cable ties			Essential! - for mending anything and everything.
Bottle iodine tablets		1 bottle	Used only down by the fjords.

SCIENTIFIC EQUIPMENT

DESCRIPTION	MANUFACTURER	QUANTITY	COMMENTS
Total Station (8.5Kg)	Leica	1	New power cables were built to allow to run off same batteries as the radio. Scientific equipment was heavy and difficult to pack, but vital for completion of scientific objectives.
Tripod (6.5Kg)	Leica	1	
Icedrill (5.5Kg)		1	
Surveying Stakes		1	Thin Polythene tubing, prone to bending under weight of prism following large amounts of ablation.
Surveying Prisms		14	
Pocket Weather Station	Silva	1	Small and light-weight, ideal for spot readings.
Prism mounts	Homemade	About 20	Wooden but fairly chunky
Plastic rain gauge		1	

APPENDIX 2: MEDICAL KIT

PERSONAL FIRST AID KIT (supplemented according to preference)

DESCRIPTION	MANUFACTURER	QUANTITY	COMMENTS
Sun cream and protection for lips			At least Factor 25
Blister kit			
Assorted plasters			
Analgesics			
Rehydration powders			
Senna			
Triangular bandages			
Indigestion relief			
Hand cream			
Tape (e.g. micropore/ zinc oxide)			Essential for taping over moleskin blister dressings
Crepe bandages and dressings			

TEAM FIRSTAID KIT

DESCRIPTION	MANUFACTURER	QUANTITY	COMMENTS
Dressings etc.	All Van Heek Medical or unbranded		
Medipad (10x10cm pad)		4	
Eye pad		2	
Filmated swabs		2	
Triangular bandage		1	
Large crepe bandage		1	
Small crepe bandage		1	
Large sterile dressing		2	
Medium sterile dressing		1	
Eye dressing		1	
Finger dressing		1	
Adaptoplast plaster strip	Cuxson Gerrard	4	
Micropore	Urgo Labs	1 roll	
Moist wipes	Safa Healthcare	15	
Plasters (various)	Safa Healthcare	10	
Pack 5 steristrips	Urgo Labs	3 packs	

Medical			
Small thermometer in protective case		1	

10ml syringe	Terumo	2	
5ml syringe	Terumo	2	
Needles (green)	Terumo	2	
Needles (blue)	Terumo	2	
Course Zirtek tablets	unbranded	1	
30g tube Hydrocortisone Cream	GlaxoSmithklein	1	
Eye ointment	APS	1	
Antiseptic paint	Seton	1	
Dihydrocodeine tablets	Unbranded	10	
Antibiotics etc.	All unbranded		
Fasigyn (course)		2	
Norfloxacin (course)		2	
Daktarin (pot)		2	
Ciproxin (course)		1	
Flucloxacillin (course)		1	
Amoxycillin (course)		1	
Augmentin (course)		2	
Paracetamol tablets (pot)		1	
Maxalon (course)		1	
Digestion			
Immodium (12 in a pack)	Johnson & Johnson	2 packs	
Dioralyte sachet	Rhone-Poulenc-Rorer	20	
Gaviscon	Reckitt and Coleman	20	
Miscellaneous			
50% Diethyltoluamide insect repellant (60ml)	Nomad Medical	2 packs	
Citrus insect repellant (100ml)	Mosi-Guard International	1	

APPENDIX 3 - FOOD

Based on advice from previous expeditions, we used an energy content of 4500 kcal per day as a target for our menus. The aim was to include plenty of variety, as well as ensuring that we had enough protein and carbohydrate. The majority of the intake was planned for during the day, when the most energy was being used. We tended to stop for a quick food break roughly every 90 minutes.

While at base-camp we usually did not finish our full quota of food. This meant that by the time we left on the trek, we had accumulated quite a lot of spare nuts and raisins, and chocolate bars. By about two weeks into the trek, we often felt hungry even after finishing everything, and supplemented our rations with the spare food we had taken from base camp. The two girls, Sam and Derek lost a couple of kg or stayed the same weight, while Chris lost 8 kg. With hindsight, 4500 kcal per day was about right at base-camp, but probably not quite enough for the trek.

Prior to leaving, we packed the food into bags containing a meal for all five of us. This worked well, as it meant we just ate whatever was in the bag, rather than picking and choosing what we preferred. These bags were then packed into boxes each containing three days' worth of food. We had a fair amount of variety, which meant that the food didn't get too monotonous.

BREAKFAST

Item	Weight (g)	Weight x5 (g)	Calories (each)	Carbohydrate (g) (each)
Jordans porridge oats	80	400	290	49
Sugar	20	100	80	34
Skimmed milk powder	12	60	61	5
Shortcake biscuits	80	400	404	50
Hot chocolate powder	28	140	120	18
		1100	**955**	**156**
MENU 2				
Jordans maple and pecan crunch	75	375	346	45
Skimmed milk powder	12	60	61	5
Chocolate homewheat digestives	80	400	403	53
Hot chocolate powder	28	140	120	18
		975	**930**	**121**

The porridge was a firm favourite as it was warm and filled us up. We used porridge oats rather than instant porridge and it took about 10 minutes to cook after adding boiling water. The crunchy cereal we had with cold milk. This was useful on the icecap when we were having to melt snow for water, as it required much less water than the porridge. However, it didn't fill us up as well as the porridge, even though it contained the same number of calories.

LUNCH

Item	Weight (g)	Weight x5 (g)	Calories (each)	Carbohydrate (g) (each)
Oatcakes	60	300	290	38
Peperami Hot/ Spicy	25	125	134	0
Tracker bar	27	135	127	15
Jordans Frusli bar	33	165	142	22
Mars bar/ Boost	55	275	285	29
Mixed nuts/raisins	150	750	765	42
Milk chocolate	80	400	392	46
Flapjack (ski trek only)	80	400	400	
[or Kendal mint cake]	40	200	160	
		2750	**2535**	**192**

We ate lunch throughout the day in a series of short stops, rather than all at once in the middle of the day. Again, variety was the spice of life:

Frusli	Nut and raisin/ Wild berry
Tracker	Chocolate chip/ 'Breakfast' Boost/ Mars bar
Peperami	'Hot'/ 'Spicy'
Primula	Original/ Cheese and chive
Chocolate	Milk/ Dark/ Fruit and Nut

During the ski-trek we were burning much more energy than we had while at base-camp, and we therefore added flapjack into the skiing rations.

DINNER

Item	Weight (g)	Weight x5 (g)	Calories (each)	Carbohydrate (g) (each)
Batchelors Golden savoury rice	120	600	437	90
Tinned corned beef		340	153	0
Sachet of soup	25	125	42	7
Hot chocolate powder	28	140	120	18
		1205	**752**	**115**
MENU 2				
Pasta	150	750	520	104
Pasta sauce		280	85	11
Sachet of soup	25	125	42	7
Hot chocolate powder	28	140	120	18
		1295	**767**	**140**
MENU 3				
Couscous (sun-dried tomato flavour)	120	600	300	74
Sachet of soup	25	125	42	7
Hot chocolate powder	28	140	120	18
Garibaldi biscuits	40	200	156	27
Custard powder	30	150	128	23
		615	**746**	**149**
MENU 4				
Soya and powdered soup	100	500	262	
Mixed beans and spicy sauce		300	47	8
Pork crackling	50	250	120	18
Sachet of soup	25	125	42	7
Hot chocolate powder	28	140	120	18
		1315	**591**	**51**
MENU 5				
Vesta Chow Mein	161	805	512	87
Sachet of soup	25	125	42	7
Hot chocolate powder	28	140	120	18
		1070	**674**	**112**

We took salt and pepper, dried herbs and dried chillies to add to our dinners. These made a great difference and are thoroughly recommended! We enjoyed having soup before dinner, especially during the trek.

APPENDIX 4 - FINANCIAL SUMMARY

BREAKDOWN OF EXPENDITURE

Item	Description	Cost	
FLIGHTS, FREIGHT & INSURANCE			
Insurance	x5	1150	
Flights	UK - Keflavik (return)	2611.50	
Flights	Reykjavik - Akureyri (return)	500	
Flights	Akureyri to Constable Point	2500	
Stopover	via Mestersvig	400	
Flights	Constable Point to LBL	3000	
Flight	MV - Akureyri (DPC)	2000	
Cargo		500	
Boat Pick-up		3750	
Penalty	P.Walker cancellation	650	
Freight		1300	
Total			**18361.50**
ADMINISTRATION			
Costs in Iceland	Hostel	100	
Transport	Van hire + diesel for freight transport	150	
Report	Publication and travel	200	
Total			**450.00**
TECHNICAL EQUIPMENT			
Individual Equipment			
Technical ice axes		687.38	
Deadman	x4	53.76	
Ice screws	3 borrow	0	
Quick-draws		37.48	
Slings	6 short, 2 long plus 2 long (O.A.)	37.69	
Screw-gate karabiners	2 each (plus one wide-bore each)	68.77	
Belay plates		25.85	
Pulleys	x4	32	
Skis/ boots/ bindings/ skins	Braemar Mountain Lodge(600 for the package)	600	
Avalanche probe	1 owned, 1 bought	42.45	
Shovels	1 owned, 1 bought	40	
Sub-total		**1625.38**	
Spares + Miscellaneous (x1 for group)			
rope	2x50m	0	
gloves	1x outer	0	
GPS	2 borrow	0	
spare climbing stuff	abseil tat, tape, clips	33.84	
glasses	x1 (borrow)	0	
pulk harness and tracers		193	
Sub-total		**226.84**	
Total			**1852.22**
CAMP EQUIPMENT			
Survival bags	x4	8	
Food		841.57	
Fuel	Kerosene	100	
Ammunition		40	
Jerry cans		40	
Stoves	2 owned	0	

Utensils	Borrow	0	
Solar panels and batteries	Hire	0	
Batteries		68	
Flares + emergency beacon + radio	From CASP; insurance only	0	
Satellite phone	270 (hire) + 30 (calls)	270	
Phone calls		200	
Medical kit		44.12	
Pulks	Buy 2 (260) hire 2 (40 each) 1 clive J	340	
Tents	Borrowed from BSES	160	
Snow valence (+postage)		57.95	
Repair kit (general)		25.45	
Shelter		30.89	
Snow shovel		30	
Misc		11.69	
Total			**2267.67**
SCIENCE EQUIPMENT			
Stakes		45	
Computer	Borrow	0	
Measuring device	Borrow	0	
Total			**45.00**
TRAINING			
Course	**Description**	**Cost**	
Conville	Flights (80x2)	320	
	Food (10x4)	40	
	Course (40x4)	160	
Scotland	Ski instruction (86x4)	344	
	Transport	100	
	Food	90	
	Accommodation (45x4 + 50)	230	
Medical	St. John's	0	
Sub-total		**1284**	
Wilderness MT course		150	
Total			**1434.00**

APPENDIX 5 - CONTACTS LIST

LOGISTICAL CONTACTS

Fridrik Adolfsson, Flugfelag Islands, *Akureyri, Iceland,* **fridrik@flugfelag.is**, *Tel: 00 354 460 7080 (office) or 00 354 894 5390 (mobile)*

Air Iceland *(Reykjavik) 00 354 570 3030 (Akureyri) 00354 460 7000,* **www.airisland.is**

Airport Bus Service *(Reykjavik) 00 354 562 1011*

AON Risk Services, *Richmond House, College Street, Southampton, Hants, SO14 3PS, Tel: 01703 225616.*

The British Mountaineering Council, *177-179 Burton Road, Manchester, M20 2BB, Tel: 0161 445 4747,* **www.thebmc.co.uk**

CASP, (Christine Brouet-Menzies, Director and Chief Administrator), *West Building, 181a Huntingdon Road, Cambridge, CB3 0DH,* **www.casp.cam.ac.uk**

Chief Constable, *P.H.Lundsteensvej 1, PO Box 1006, DK-3900 Nuuk, Greenland, Tel: 00299 321 448, Fax: 00299 324 194*

Danish Polar Centre, *Strandgade 100H, DK-1401 Copenhagen K, Denmark, Tel: 0045 3288 0100* **www.dpc.dk**

Eimskip *(UK agents are* MGH Ltd, *Middle Platt Road, Immingham, South Humberside, DN40 1AH, Tel:01469 571880)*

Govier & Ault Limited Insurance Brokers, *Kinder House, Lombard Street, West Bromwich, West Midlands, B70 8SD.*

Go *0870 6076 543,* **www.go-fly.net**

Greenland Tourist Board**: tourism@greennet.gl**

Harrison Beaumont, *2 Des Roches Square, Witan Way, Witney, Oxon, OX8 6BE, Tel: 01993 700200,* **www.hbinsurance.co.uk**

Icelandair, *172 Tottenham Court Road, London, W1P 9LG, Tel: 0207 874 1000,* **www.icelandair.co.uk**

Clive Johnson, Logistics Manager, CASP, *01298 25405*

Kort-og Matrikelstyrelsen / National Survey and Cadastre, (Anders Nielsen, Senior Cartographer, Map and Chart Division), *Rentemestervej 8, DK-2400 Copenhagen NV, Tel: +45 35 87 50 50,* **www.kms.dk**

Nonni Travel *(UK Consultant is Bernard Lockett, Tel: 01303 226050)* **www.nonnitravel.is**

Premium Liferaft Services, *Liferaft House, Burnham Business Park, Burnham on Crouch, Essex, CM0 8TE Tel: 0161 784858*

Radio Administration, *PO Box 1002, DK-3900 Nuuk, Greenland, Tel: 00299 323120*

Salvation Army Guest House, *Kirkjustraeti 2, Tel: 00 354 561 3203*

Samskip, *The Maltings, Silvester House, Silvester Street, Hull, HU1 3HA, Tel: 01482 322399*

Tangent Expeditions International, (Paul Walker), *3 Mill Beck, New Hutton, Kendal, Cumbria, LA8 0DB, England, Tel: 0044 1539 737757*
paul@tangentexp.demon.co.uk
www.tangent-expeditions.co.uk

www.viking-direct.co.uk

Walden Export, *Convent Drive, Denny Industrial Centre, Waterbeach, Cambridge, CB5 9QT, UK, Tel: 01223 861460,* **www.waldex.co.uk**

FINANCIAL AWARDS AND FUNDS

The Alpine Ski Club (contact: Jay Turner, Chair, ASC Awards Sub-Committee), *34 Clarence Way, Langshott, Horley, Surrey, RH6 9GT,* **www.alpineskiclub.org.uk**

The Arctic Club (managed with the Gino Watkins Memorial Fund)

The Augustine Courtauld Award, *The Augustine Courtauld Trust, Red House, Halstead, Essex, CO9 2DZ,* **www.augustinecourtauldtrust.org**

The Dennis Curry Charitable Trust, (contact: Messers Alliotts), *5th Floor, 9 Kingsway, London, WC2B 6XF, Tel: 020 7240 9971*

The Eagle Ski Club (contact: Mike Hendry, Touring Secretary of the Eagle Ski Club), *Eastlea, Felix Lane, Shepperton, TW17 8NN.*

The Gino Watkins Memorial Fund, (contact: The Secretary), *c/o The Director, Scott Polar Research Institute, Lensfield Road, Cambridge, CB2 1ER,* **www.spri.cam.ac.uk**

The Mount Everest Foundation, (contact: The Hon Sectretary Bill Ruthven), *Gowrie, Cardwell Close, Warton, Preston, PR4 1SH, Tel. & Fax: 01772 635346,* **bill.ruthven@ukgateway.net, www.mef.org.uk**

The MR Mill Trust Fund (through the Royal Geographical Society),*1 Kensington Gore, London, SW7 2AR, Tel: 0207 591 3000, Fax: 0207 591 3001,* **www.rgs.org, grants@rgs.org**

The Royal Society of St. George Expedition Award (contact: Brigadier Miles Hunt Davies, CVO CBE), *Buckingham Palace, London, SW1A 1AA*

FOOD AND EQUIPMENT SUPPLIERS AN D SPONSORS

www.7dayshop.com (photographic equipment)

Agfa-Gevaert Ltd. (contact: Philip Miller), *27 Great West Road, Brentford, Middlesex, TW8 9AY,* **agfabrentford.gb.ag@agfa.co.uk**

Cairngorm Mountain Supplies, *Ski Road, Inverdruie, Aviemore, Invernesshire*

CAMP, c/o Allcord Limited (contact: Colin Westwood), *Ilford Road, Newcastle Upon Tyne, NE2 3NX, Tel: 0191 284 8444,* **www.allcord.co.uk**

DMM International Ltd. (contact: Chris Rolands), *Y Glyn, Llanberis, Gwynedd, LL55 4EL, Tel: 01286 873500,* **www.dmmclimbing.com**

Jordans Cereals (Amanda Halliwell), *Holme Mill, Biggleswade, Bedfordshire, SG18 9JY, 01767 318222.* **Amanda.halliwell@jordans-cereals.co.uk, www.jordans-cereals.co.uk**

Lyon Equipment Limited (contact: Simon Tulley), *Rise Hill Mill, Dent, Sedbergh, Cumbria, LA10 5QL, Tel: 01539625493,* **si@lyon.co.uk**

Mobell Communications Limited, (Simon George), *The Winding House, Walkers Rise, Rugeley Road, Hednesford, Staffs. WS12 5QU,* **www.mobell.com**

Mountain Boot Company (contact: Steve), *Unit 5, New York Way, New York Industrial Estate, Wallsend, Newcastle Upon Tyne, NE27 0QF, Tel: 0191 296 0212*

Rab Carrington Ltd (contact: Paavo Lane), *32 Edward Street, Sheffield, S3 7GB, Tel: 0114 275 7544,* **www.rab.uk.com**

Soreen, (contact: Roger Woodward), *Taylor Road, Urmston, Manchester, M41 7WF, 0161 748 1235,* **www.soreen.com**

Unilever Plc London, (Nick Partridge), *Unilever House, Blackfriars, London, EC4P 4BQ*

Vango, AMG Outdoor Limited, *Kelburn Business Park, Port Glasgow, Scotland, PA14 6TD,* **www.amg-outdoor.co.uk**

VentureSport (contact: Neal), *17, Westlegate, Norwich, NR1 3TL, Tel: 01603 613378,* **neal@venturesport.co.uk**

OTHER USEFUL SOURCES OF INFORMATION

http://www.thepoles.com/ (general information page about current and previous polar expeditions)

http://www.greenland-guide.gl/ (official site of the Greenland Tourist Agency)

http://www.alpine-club.org.uk/ (club whose aims include promoting mountain climbing and exploration throughout the world, and encouraging protection of the mountain environment. Good for general inspiration)

http://www.trentcollege.nott.sch.uk/expedit/ (School has led various expeditions to Greenland and Iceland over the past 5 years. Generally gives good information about logistical arrangements and provision of equipment)

http://www.antarctica.ac.uk (British Antarctic Survey)

http://www.wayupnorth.clara.co.uk/ (useful website including expedition reports from expeditions to Greenland and Spitsbergen)

APPENDIX 6: WEATHER

Day No.	Date	Precipitation (mm)	Windspeed (km/h)	Temp (°C)	Temp (wind chill) (°C)	Cloud cover (octare)	Visibility	Notes
1	7/10/02	0	10	11	7	1	Unlimited	
2	7/11/02	0	12	12	8	0	Unlimited	
3	7/12/02	0	14	8	3	7	Unlimited	
4	13/7/2002	0	10	10	3	7	Unlimited	
5	14/7/2002	1.23	6	11	0	8	20m	Precipitation fell as snow, measured as water
6	15/7/2002	0	0	11	11	4	Unlimited	
7	16/7/2002	-	-	-	-	-	-	Dangerous: Heavy snow and poor visibilty.
8	17/7/2002	30	0	6	6	2	Unlimited	30mm snowfall
9	18/7/2002	0	9	8	3	1	Unlimited	
10	19/7/2002	0	10	14	9	2	Unlimited	
11	20/7/2002	0.5	7	11	7	1	Unlimited	Continual light rainfall
12	21/7/2002	0	7	14	12	0	Unlimited	
13	22/7/2002	0	0	13	12	0	Unlimited	
14	23/7/2002	0	10	13	12	0	Unlimited	
15	24/7/2002	0	4	12	11	0	Unlimited	
16	25/7/2002	0	0	6	6	6	Unlimited	
17	26/7/2002	0	2	5	5	8	Unlimited	
18	27/7/2002	0	2	2	0	6	Unlimited	
19	28/7/2002	0	8	6	-1	4	Unlimited	
20	29/7/2002	0	0	6	6	8	35km	
21	30/7/2002	10	7	4	2	4	60km	Snow

Weather readings were taken every morning whilst the glaciology survey was being carried out.
The temperature and windspeed readings were taken using a SILVA WINDWATCH

Windspeed: Peak average measured in km/h over 30s intervals
Temperature: Current Temperature in degrees centigrade
Windchill: minimum using current windspeed in degrees centigrade
July in summary: In general the weather for July was very pleasant. There were occasionally days of poor visibilty, preventing any activity.
August in summary: The weather in August (for which regular precise readings were not taken) was much worse.
Generally colder and windier; the worst *recorded* conditions were -15°C with 20km/h winds.

APPENDIX 7: SKI TREK MAP