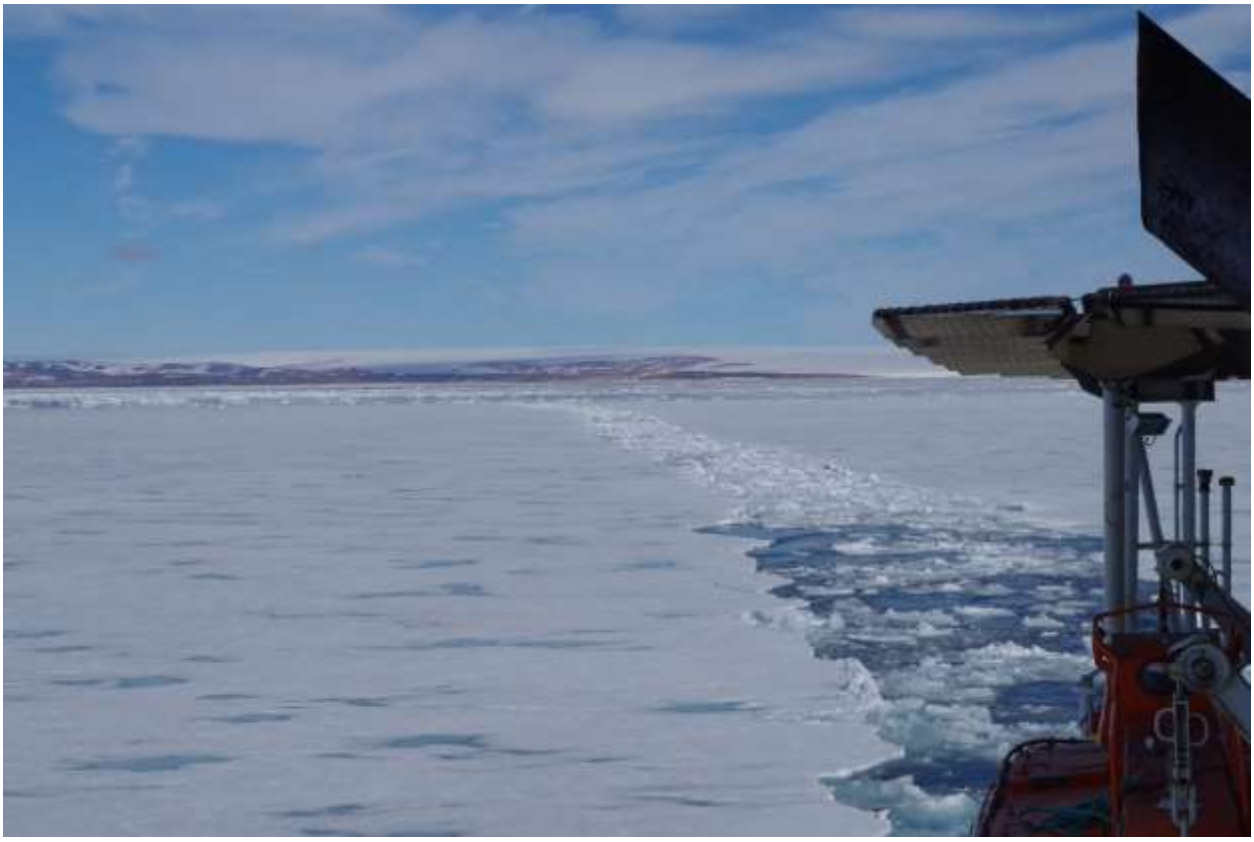
Bockfjorden 2017

Final Report

Arctic Research Group



Pushing through pack ice in Wahlenbergfjorden, Nordaustlandet. Photograph IF

Author Note

This Final Report has been compiled to meet the requirements of certain grant funding bodies whose conditions ask for a final report within a year of the actual expedition. Analytical results from a number of research establishments have now been received and consultations with other ARG members on the various areas and topics have been completed. It is assumed that anyone interested in these will appreciate that without the opportunity to complete these analyses and to subsequently undertake the assessment of these the whole trip, albeit truncated and seriously affected in its original form, would have been seriously compromised. The offer of substantial savings on analyses and reporting have added to the delay, which has had to fit in with day to day work activities.

The Group thanks everyone interested in this for being patient and for bearing with us during the intervening period.

Keywords: Bockfjord Svalbard July 2017 Arctic Research Group

Abstract

The original proposal for this expedition was four researchers to visit Bockfjorden, North Svalbard, during the month of July 2017 and to undertake a series of independent but interlinked projects in a variety of disciplines that would enable a better understanding to be made of the area. These projects in included the objectives that are to be found in more detail in the Group Prospectus, available on line on request from ian@arcticresearchgroup.org . These may also be viewed on the Group website www.arcticresearchgroup.org .

Bockfjorden 2017

Planning took place over a period of two years to determine the nature and extent of the research proposals that were to be considered. A reconnaissance planned for 2016 was curtailed by two major factors.

One was the lateness of the application for travel by the ARG. The other was the governing body in Svalbard, Sysselmannen På Svalbard, which did not feel able to grant permission for the planned helicopter trip on the grounds that, in their opinion, it did not in itself provide any useful scientific function.

A wasted trip by two members in Summer 2016 meant therefore that the 2017 expedition was planned without the benefit of this essential part of the projects, which would have been most useful and beneficial in deciding on timing as well as the planning of routes and proposed camp sites in order to minimize the effects of anthropogenic activity on the fragile ground.

Proposed Area of Activity. Abstract from Map of Spitsbergen

Personnel

The Arctic Research Group chooses members for each expedition based on the project work to be undertaken. There are no freeloading places available. As such the personnel chosen for the 2017 expedition reflected the work to be undertaken. The final group were : Ian Frearson – ARG Group Leader. George (Haddon) Winter – Research assistant. Prof. Andrew J Hodson – Project Leader. Dr. Aga Nowak – Project leader.

Travel and Transport

Members used the daily SAS flights from the UK via Oso to Svalbard. Any fears there may have been regarding the taking of firearms were quickly forgotten as all the authorities seemed to be interested in was securing the money required for their transfer. Little time was wasted over the transfer from hand to secure accommodation. The next seen of them was at Longyearbyen, Svalbard, where the flight case appeared in the special baggage conveyor.

The ARG has worked alongside and in conjunction with Norsk Polarinstitutt in the past and this, together with meetings with their Chief of Operations, Håvard Hansen, allowed the Group the opportunity of transport out on Lance, NP Research Ship. This was particularly poignant since she was to be taken out of service in 2017 so we were to travel on her final work cruise (Now revised due to lateness of replacement).

Since Lance would only be able to drop the group off in Bockfjord and time restraints on other projects were critical, two members were to return to Longyearbyen on a charter tourist ship visiting close to the research area (Liefdefjorden). Arrangements with two other groups, one from Imperial College the other from St. Catherine University Minnesota, which were also working on different aspects of the springs, were made for return transport for expedition freight and the remaining two members. In the end additional alternative arrangements had to be made due to unforeseen weather conditions and an enforced revised programme.

Programme

The initial programme was as set out below and, under favourable conditions, could have been achieved with little problems other than interference by unforeseen weather. As it transpired, these affected the proceedings more than could have possibly been anticipated.

Initial Programme as planned

Item	Date	Activity	Comments
1	26 Jun	International Travel	Home – Oslo - Longyearbyen
2	27 Jun	Make contacts Check freight	Contact Norsk Polarinstitutt
3	28 jun	Log in with Sysselmann, Repack & Load	Obtain Travel Permit Make ready to travel to site
4	29 Jun	Join Lance, Leave Longyearbyen	Travel to Bockfjord
5	30 Jun		Travel
6	1 Jul		Travel
7	2 Jul		Travel
8	3 Jul	Arrive Bockfjord	Offload to field site
9	4 Jul	Locate site & build camp	Choose best site with least effect
10	5 Jul	Visit Jotun Springs	Start sampling logging & photographs
11	6 Jul	Ditto	Continue with sampling
12	7 Jul	Visit Gygrekjelda Spring site	Sampling logging & photographs
13	8 Jul	Visit Troll Springs	Assess Start sampling & logging
14	9 Jul	Ditto	Continue sampling & photographs
15	10 Jul	Photograph Friedrichbre	Find old site & repeat photographs
16	11 Jul	Extend camp to accommodate additional 9 persons	2 persons to leave for return passage Two other groups to arrive.
17	12 Jul	Commence Ecology project	Transects & quadrats of Jotun area
18	13 Jul	Ditto	Assess colonisation extent & type
19	14 Jul	Commence Meteorite project	Transport gear to Kaarlsbre
20	15 Jul	Ditto	Search ground for samples
21	16 Jul	Move site	Transport West towards Monacobre
22	17 Jul	Observe Monacobre areas	Look for drawdown of ice
23	18 Jul	Return to Sverrefjellet site	Set up for exploring Nygaardbre
24	19 Jul	Search for 'Lost' spring & look for	South side of lower moraine
25	20 Jul	Colonisation of moraines	Cover as much moraine as possible
26	21 Jul	& recently exposed ground	Seek colonisation evidence
27	22 Jul	Break camp	Preparation for return
28	23 Jul	Travel	Ship transport back to Longyear
29	24 Jul	Travel	
30	25 Jul	Arrive LYB offload & sort Depart Svalbard 02:30 26th	Divide equipment & food & – that to return to UK, that to remain in Svalbard Travel to Airport 23 :30
31	26 Jul	Arrive LHR 09 :20	Travel back home

15 days of movement or planning, counted as 'lost' days, with 16 days of field work planned

Thanks to abnormal sea ice conditions this was adjusted initially as below during the voyage on Lance to plan for what we thought might be the best case scenario.

First Revised programme

Item	Date	Activity	Comments
1	26 Jun	International Travel	Home – Oslo - Longyearbyen
2	27 Jun	Make contacts Check freight	Contact Norsk Polarinstitutt
3	28 Jun	Log in with Sysselmann Repack & Load	Obtain Travel Permit Make ready to travel to site
4	29 Jun	Join Lance, Leave Longyearbyen	Travel to Bockfjord Anticlockwise
5	30 Jun	On lance	Travel Van Mijenfjord / Van Keulenfjord
6	1 Jul	Ditto	Travel Towards Sorkap
7	2 Jul	Ditto	Travel Hopen
8	3 Jul	Ditto	Travel Agardbukta & Hinlopen Strait
9	4 Jul	Ditto	Travel Wahlenbergfjord
10	5 Jul	Ditto	Travel Murchison Wijdefjord, Woodfjord
11	6 Jul	Arrive Bockfjord	Offload to field site
12	7 Jul	Locate site & build camp	Choose best site with least effect
13	8 Jul	Visit Jotun Springs	Start sampling logging & photographs
14	9 Jul	Ditto	
15	10 Jul	Ditto	
16	11 Jul	Two leave for return to LYB Extend camp for other 9	Two other groups arrive. Co-ordinate projects with others
17	12 Jul	Visit Troll Springs	Sampling logging & photographs
18	13 Jul	Ditto	
19	14 Jul	Ditto	
20	15 Jul	Commence Meteorite project	Travel to Kaarlsbre
21	16 Jul	Ditto	Search area for samples
22	17 Jul	Travel back calling at Nygaarbre	Look for signs of 'lost ' spring & for signs of recent plant colonisation
23	18 Jul	Break camp & load to leave	Commence return journey to LYB
24	19 Jul	Ditto	
25	20 Jul	Arrive LYB	Offload & transport to container
26	21 Jul	Sort gear	Preparation for leaving some equipment for further visits
27	22 Jul	Clean & pack gear to remain	Divide gear for being left in container
28	23 Jul	Return hire gear	Clean sort & return
29	24 Jul	Relax	Visit church, museum & other areas
30	25 Jul	Arrange transport of freight back to UK Depart Svalbard 02:30 on 26th	Divide equipment food & clothing between that to remain in Svalbard & that to return to UK. Return Permit to Sysselmann
31	26 Jul	Arrive LHR 09:20	Travel back home

20 days of travel & sorting leaving 11 days for fieldwork reduced science potential. This situation still considered viable and acceptable.

Continued developments in both the initial conditions of sea ice and those enforced by problems encountered by other groups required a further serious plan to be adopted. In the end the planned period of almost three weeks in the field was reduced to under five whole days which is detailed below. This illustrates the frailty of plans when operating at such extremes of latitude.

Second revised programme

Item	Date	Activity	Comments
1	26 Jun	International Travel	Home – Oslo - Longyearbyen
2	27 Jun	Make contacts Check freight	Contact Norsk Polarinstitutt
3	28 Jun	Log in with Sysselmann Repack & Load	Obtain Travel Permit Make ready to travel to site
4	29 Jun	Join Lance, Leave Longyearbyen	Travel to Bockfjord Anticlockwise
5	30 Jun	Van-Mijenfjord / Van Keulenfjord	Travel - see Whales, Blue + others
6	1 Jul	Hopen	Travel through increasing ice
7	2 Jul	Agardbukta	Travel through solid pack
8	3 Jul	Wahlenbergfjord	Travel through solid pack See bear on ice
9	4 Jul	Arrive Bockfjord & assess Sea ice too much to remain.	Three hours ashore taking samples at Jotun site then return to ship
10	5 Jul	Arrive back in Longyear	Offload & check gear
11	6 Jul	Planning	
12	7 Jul	Planning	
13	8 Jul	Meet other groups	Delays due to non arrival of equipment
14	9 Jul	Waiting	More delays
15	10 Jul	Waiting	Similar
16	11 Jul	One boat leaves for Bockfjord	1 ARG member on board
17	12 Jul	Last packing & checking of gear	Last night in LYB. Shower & bed for IF
18	13 Jul	Second boat leaves	Unfortunately ARG members separated
19	14 Jul	Arrive Bockfjord. Ashore p.m.	Visit Jotun site & take first samples. Weather too poor to see Friedrichbre
20	15 Jul	ARG Decision on camps made	Camp built & visit Troll site
21	16 Jul	Climb Sverrefjellet	Photographs & assess remaining work
22	17 Jul	Visit Troll springs	Final sampling & photographs
23	18 Jul	Visit Jotun springs, leave p.m.	Locate view for Friedrichbre, take photographs then leave for LYB
24	19 Jul	Travel towards LYB	
25	20 Jul	Storm so put into Ny-Ålesund	Break journey for bad weather
26	21 Jul	Arrive LYB	Offload & sort gear. Back to container
27	22 Jul	Sort gear	Sort into gear for Rubbhahl & container
28	23 Jul	Sort gear & write records	Transport barrels to container
29	24 Jul	Final sort of gear	Return flare pistol to NP
30	25 Jul	Arrange transport of freight back to UK Depart Svalbard 02:30	Divide equipment food & clothing between that to remain in Svalbard & that to return to UK. Return Permit to Sysselmann
31	26 Jul	Arrive LHR 09:20	Travel back home.

It will be seen from the last eventual programme that a total of just Five out of a complete Expedition period of thirty-one days was actually achieved in the field, with Twenty six lost to travel, packing & planning. Despite our best efforts and many hours of planning and re-planning plus negotiating with other groups, no better outcome could be secured. It is a tribute to the Captain & Crew of Lance and Staff from Norsk Polarintstitutt that we managed to get ashore at all on the first attempt and for that we are eternally grateful. This outcome reinforces our long-employed fundamental principle, that every trip is planned on a similar basis, involving a number of separate disciplines so that the loss of one or more does not mean the loss of the whole trip.

Expenditure Costs So Far

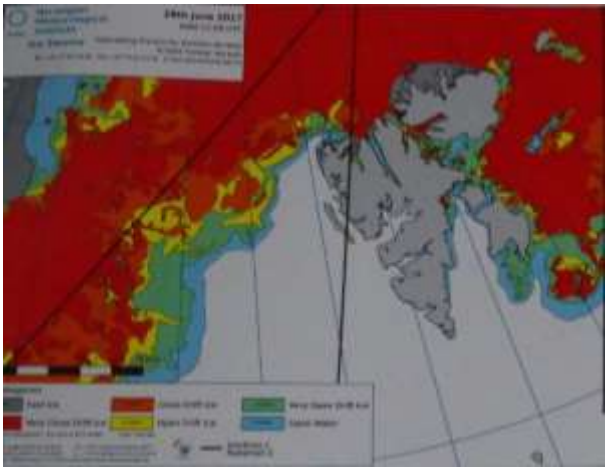
item	Actual cost
Pre-fieldwork / preparation	**£700**
Flights UK to Svalbard	**£1,800**
Transport of freight UK – Svalbard / return	**£1,580**
Internal transport & Subsistence	**£3,300**
Field Equipment	**£660**
SAR Insurance	**£675**
Film / Photography	**£230**
Post fieldwork1 Report /	**£300**
Testing & analyses	**£150**
Dissemination of Findings	**£100**
Food	**£220**
Fuel (paraffin & petrol)	**£15**
Total	**£9730**
Contingency (10%)	**£000**
Grand total	**£9730**

The above indicates a substantial amount of savings over the original plan. This of course has been substantially due to the dramatically reduced period in the field, with the attendant analyses and generous help from both groups with return transport.

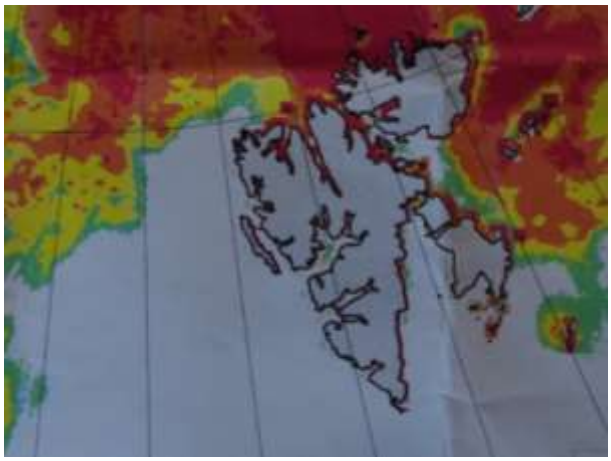
Achieved Travel

During the course of the voyage on Lance daily satellite photographs of sea ice conditions were obtained. These showed increasingly that the right decision to travel anti-clockwise had been made and that the chance of access to Woodfjord at all was slim. A few of these photographs have been reproduced here as witness to the accuracy of modern satellite photography and the benefit it offers to mariners. Fast ice is shown grey, Thick heavy pack red / orange, Broken, loose / very loose ice yellow / green. If only we had seen more of the last two and less of the first three we may have seen more time in the field.

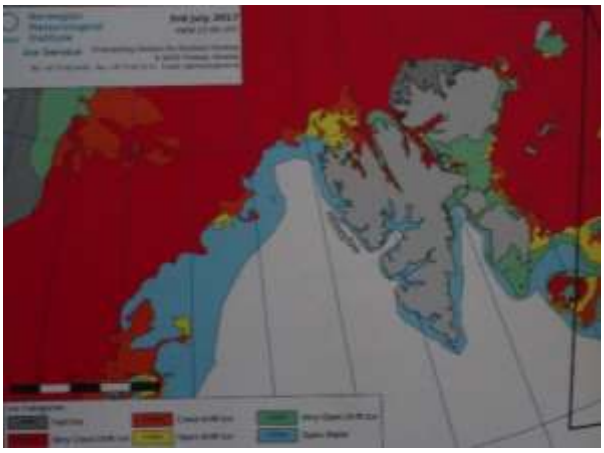
28th June



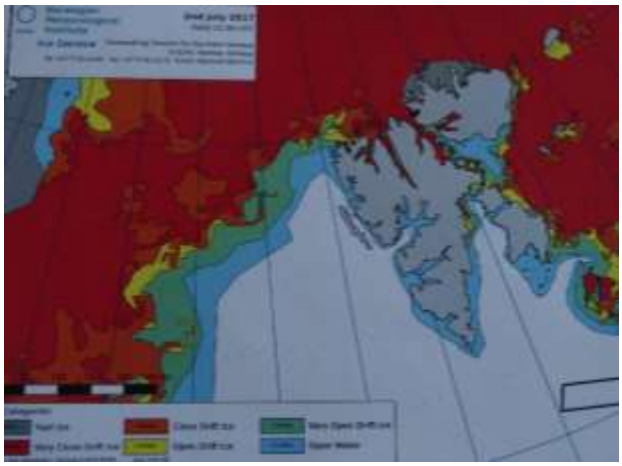
1st July



2nd July



3rd July



Various satellite photographs showing development of sea ice around Svalbard

Provided thanks to Captain and staff of RV Lance.

Projects

Warm Springs at Jotunkjeldene & Trollkjeldene.

Due to the protracted and unforeseen travel problems encountered a mere four full days total were available for the whole research programme to be undertaken. First to be visited were the Jotun springs, during a three-hour flying visit from Lance, during which three sets of samples were secured, the remaining work being curtailed due to the rapid increase of sea ice. In the end the return boat transport party took two hours to collect the shore party, having to change boats in order to make any sort of passage through the increasing pack ice.

Waiting to be collected for return to Lance Photograph IF

During the return trip the four days were all that could be allocated due to transport dates, resulting in concentration being made on two visits to the Troll springs and one short return to the Jotun springs. Water and travertine samples from both sites were secured and water analyses and interpretation for the spring waters have been carried out.

The data are presented in Appendix 1..

The principal purpose of collecting the water samples was in order to characterise the major ion, trace element and stable isotope composition of the springs. These data were also supplemented with dissolved gas measurements, specifically methane and carbon dioxide. The purpose of this work was to add these thermal springs to a wider, regional characterisation of ground water chemistry in Svalbard. In so doing, it was hoped to develop a more complete understanding of groundwater geochemistry in continuous permafrost settings, and then establish which sites are vulnerable to increased greenhouse gas emissions under climate change scenarios. The results were surprising for methane: showing negligible methane levels at the detection limit (i.e. < 0.01 ppm dissolved CH_4). Research will therefore establish whether this is due to either no methane production in the first instance, or whether methane is consumed at the site by oxidation. The latter could, for example, reflect methanotrophy by the microbial community in the pools that the springs discharge into. This is made more likely by the fact the volume of the pool was large relative to the inflow rate, giving ample time for methane oxidation.

Given the above outcome, the groundwater chemistry data will instead be used to better understand the flowpath and water source characteristics of the system. Furthermore, the results will enable us to consider whether these processes demonstrate longer-term change, perhaps due to variable recharge or mixing rates. This analysis will therefore be conducted in the near future, when all the data are available and have been subject to quality control

The results currently available show a mixture of reduced and oxygenated groundwaters at the Jotun springs. Significant oxygen depletion in the most active springs was observed, and this seems to correlate with there being no detectable NO_3. Therefore, denitrification seems to be the most obvious cause of the oxygen demand. Surprisingly, the sulphur and the iron geochemistry revealed little evidence for processes such as sulphide oxidation, sulphate reduction or iron reduction. By far the most distinctive characteristic of the spring waters, apart from their temperature (ca. 23 ^{o}C at Jotun Springs), was the high levels of dissolved Silica (> 60 mg/L). The ratio of dissolved Silica to other, ionic constituents derived from silicate mineral weathering (e.g. potassium) is far higher than that of surface waters, and thus shows the effects of long residence times and higher temperatures on the efficacy (or stoichiometry) of the weathering processes. Future work will further characterise these silicate mineral dissolution characteristics. It will also examine the carbonate system,

since our data show, as expected, that calcite weathering leads to saturation. Therefore carbonate precipitation, leading to the development of the travertines is clearly on-going. Geochemical modelling using Phreeq geochemical speciation software (USGS) confirmed that the samples were saturated with respect to calcite and several simple silicate (chalcedony and quartz) and iron (Geothite, Haematite) mineral phases. The modelling also suggested very high pCO_2, indicating that the springs were degassing CO_2 upon emergence because they had more than two orders of magnitude more CO_2 than would be the case at thermodynamic equilibrium.

A final aspect of the results worth reporting here is that, although NO_3 levels were typically low, other inorganic nutrients were present at levels which greatly exceed those found in natural surface waters, at least in the case of the most active Jotun springs. Therefore, NH_4 and PO_4 levels almost certainly contribute to biological production in the local aquatic ecosystems. This makes the streams natural laboratories for looking at nutrient enrichment effects. Furthermore, the same nutrient enrichment occurs in the thermal spring system in Southern Spitsbergen. The high nutrient levels most likely result from the mineralisation of organic matter, but could also be derived from weathering reactions involving the silicate minerals and apatite, respectively.

Professor Andrew J Hodson

Photograph of Troll Springs showing extensive travertine and one spring source. Photograph IF

Photographs of the two areas were also taken for record purposes as well as samples of the travertine from a number of spring sites.

Sadly the plan to also visit and sample springs located adjacent to a glacier near Jotun – Friedrichbre, the springs being marked on the map as Gygrekjelda – was not possible due entirely to the restriction in time available.

Cascading travertine from one of the Troll springs Photograph IF

Extinct Volcano Sverrefjellet.

A prominent feature of the West side of the entrance to Bockfjord is the extinct volcano of Sverrefjellet. It was thought that the summit of this might offer a good panorama of the area, so two members climbed this and assessed the area from the summit of the cone. The majority of the volcano is heavily weathered out providing delightfully soft fine screes which afforded a fast, comfortable descent route.

Summit of Sverrefjellet Photograph IF

Flora.

One of the projects to be undertaken was a comprehensive look at vascular plant species in the immediate vicinity of and remote from the springs, as well as a general overall plan of those on areas of tundra. In the event this too was not possible due to the following: Firstly the restricted time available simply did not allow us to undertake the work. Secondly we had planned the expedition at this time of year in order to benefit from the flush of Arctic flora. In the event the ground cover, where it did occur in the more open steeper areas, was dominated by a few species including Purple Saxifrage (*Saxifraga cernua*|) Arctic Whitlow Grass (*Draba sp.*) and the ever present Moss Campion (*Silene acaulis*). The richer moorland areas with Arctic Bell heather (*Casiope tetragona*), specimens of both Viviparous knotweed (*Polyganum viviparum*) and *Mountain* Sorrel (*Oxyria digyna*) and a few examples of Hawkweed Saxifrage (*Saxifraga hieracifolia*). Sadly nothing was seen of the sought and hoped for Sibbalidi (*Sibbaldia procumbens*) at either spring location. Isolated specimens of Polar dandelion (*Taraxacum*

arcticum) were seen Along with several species of grass and both mosses and lichens, as were the isolated plants of Arctic Saltmarsh grass (*Calpodium*). Few examples of Cotton grass were seen as were the usually common Arctic willow (*Salix polaris*) All specimens were notably smaller than had been seen on other trips, presumably a sign of the more severe climate to be found at almost 80º N. A full account of the identifiable plants encountered will be shown in the final report.

The varied types of ground encountered indicated dramatic changes in species present. Those present on the steeper slopes tended to be the harder more woody varieties such as Salix, whereas the flatter more boggy areas were dominated by the softer stemmed water loving species, as was expected. One element that was observed and did seem possible was the apparent natural occurence of Lithic Mulching just through the general distribution of rocks, which seemed to encourage the retention of water, thus feeding all of the plant species where present, but particularly the water loving varieties such as Ranunculus. When first we set off from Longyearbyen on Lance satellite images showed most of Bockfjord having much sea ice and snow cover to sea level. This proved to be our undoing since only a relative few species seemed to be in flower during our visit. For anyone planning to visit this area – and I would recommend it – then August I feel would very likely make for a more productive period and could produce both flowering and seeding examples.

Geology

It had been planned to visit the areas of Devonian outcrop to the East of the fjord to search for the examples of the exoskeletal fish fossils. Due to time restraints this was not possible and it is hoped that a return trip to undertake this may be made. It was also planned to collect samples of the carbonate 'country rock' to compare with the travertine chemical and stable isotopic analyses. Once again time did not allow this to be undertaken. Anyone who has enjoyed the rigours of foot travel in the Arctic will understand just how much time it takes to get from A to just beyond A, not to mention back.

Glaciology

Likewise it was hoped to visit areas of several local glaciers to look for any colonisation of the recently exposed ground. This too was not possible although passing and distant views of the many and huge moraines did give the impression that little obvious colonisation has currently taken place in the majority of cases. However a more detailed examination would be required to determine this with any confidence. The end moraines of Kaarlsbre did show some evidence of sporadic greening and this alone would merit further investigation. A proposal to visit the upper accumulation regions of Monacobre to look for possible evidence of drawdown areas was once again not possible, although this was reconsidered during the course of the trip and rejected as being of little merit due to the massive extent of the area involved.

Meteorites

It was hoped to spend some time examining the upstream side of the Nunatak on Kaarlsbre for the presence of meteorites brought to the surface by upthrust the action of ice movement, but this too proved to be out of the question due once again to the time restraints. So another project is saved for the future. It was however noted that the ice retreat on Friedrichbre has left a substantial and accessible shoreline area that would be ideal for such an undertaking and this will be considered for any future ARG visits.

Photography

As with all trips, many photographs were taken with mixed results. A combination of some inexperience with at least one camera resulted in some very poor results, the best being obtained from the Fuji XE1 with XF18-55 mm lens and Canon cameras, with some big lenses, giving closer access to the more distant wildlife. The Fuji provided some stunning panoramas thanks to the inbuilt facility.

A series of short videos were made to illustrate one or two points, again with mixed success. The most serious fault being the lack of good quality sound and the wind interfering with recording quality.

One group sharing the boat with us did take a drone, which provided some stunning views of the research areas and this method of recording expeditions is to be considered for all future ARG trips. No problems were experienced with battery use and the relative mild conditions (usually around +4ºC) made for comfortable, easy operation.

One last minute request from another Arctic club member gave us the challenge to repeat an original photograph of Friedrichbre taken in 1923 by Noel Odell. Conditions on our initial visit with visibility was unacceptably poor. If this had been otherwise it would have been frustrating since the time element imposed by encroaching sea ice would have proved our undoing. Secondly the persistent low cloud frustrated any attempts to secure a suitable shot, even if the correct spot could have been relocated. On the very last day before departure conditions were favourable and an attempt was made to relocate the exact spot of the original photograph.

This was eventually agreed upon and photographs taken. One proved to be as close as could be expected to find & a good match made. The location X,Y & Z co-ordinates recorded and sent off for consideration.

Sadly the photographs taken were all saved as jpegs whereas a better alternative, for manipulation purposes, would have been RAW format, a lesson for the future.

Photograph of Friedrichbre, Bockfjorden, taken in 1923 by Noel Odell

Unfortunately we have no details of the camera, lens or exposure that went into the taking of this photograph. Certainly Friedrichbre does appear in this shot to be either during or immediately post surge conditions. The weather conditions and that of the sea lead one to suggest that it was taken during the very short Summer period that occurs at almost 80º North.

The distinct rock formations on the near horizon were the key factors in helping to relocate this position and attempt to reproduce the shot. The shoreline exposed at the lower edge appears to have changed little between 1923 and 2017.

Attempt to retake Noel Odell photograph of Friedrichbre taken in 2017 by Ian Frearson

When this accompanying photograph was taken sea ice had only recently left the fjord in a safe navigable state, reaffirming once again the uncertainty of travel at any time of year in these latitudes. The quite distinct rocks shown in the original photograph were the guide by which we were able to relocate the shot and another reminder of the longevity of natural features at this remote location. The rather sad and dark ice cored element at the far side of the shot is in stark contrast with the impressive ice cliffs shown in the 1923 photograph. Friedrichbre too exhibits signs of colossal ice loss.

Photograph taken at location 79º 27'.296 N 013º 15'.728 E Altitude 123m.

Fauna

Although it was never the intention to record or observe the fauna seen during this expedition, the sheer scale of the travelling, the areas visited and the likelihood of never repeating this voyage has prompted us to mention some of the species and the situation in which they were seen. This is not a report on groups, species or individuals seen in or around the expedition area of Bockfjord but a progressive log of what was observed from both the boats and during the short time spent ashore. In and around Adventfjord there were constant examples of seabird, including the ever popular Eider, complete with their young, sometimes in Creches of a single duck with around 20 youngsters. One of the less common species seen here was a single pair of Long Tailed duck, by the old Quay and possibly prospecting for their daily food. Snow Buntings were ever present as were the ubiquitous Glaucus Gulls, with a few Fulmars usually around.

During the voyage the first real surprise was the appearance of several large whales, some 600 metres from the ship. They were identified by the captain as two Blue in company with possibly Humpback or Fin. No real positive sighting of the creatures was seen but the giant blow plumes were very impressive and distinct, rising to some 12 metres high. These were encountered heading South a couple of miles offshore close to Sorkap.

Fulmar, a regular sight. Photograph IF

Whale spout from Lance Photograph HW

Many fulmars and Kittiwakes followed the ship's progress but, whale spouts aside, nothing of note until we encountered the frozen Wahlenbergfjord, where fresh bear prints accompanied by fox prints were spotted on the fjord ice. As the ship forced its way through the close pack, Kittiwake followed its progress and appeared to be feeding on tiny fish exposed by the ships track.

Once back in Hinloptenstret, and with some open water around, one bear was seen trying unsuccessfully to lift a walrus carcass out of the sea onto the floe. Several seals, Ring and Bearded were seen out on the pack in and around both Wahlenbergfjord and in Hinlopenstret, and a couple of Bearded on small floes. A few Walrus were seen on the Western side of Nordaustlandet just before the entrance to Wahlenbergfjord. In the seas around Woodfjord and Bockfjord Minke whales were seen, whilst on land the almost constant presence of Snow Buntings lifted the general feeling of the day. On a few occasions the haunting cry of Barnacle Geese was heard and one or two were seen flying around the landward areas West of the research camp. One single ptarmigan was seen close to the Jotun springs and one single reindeer, young and sporting quite distinct and identifiable antler, was seen on several occasions. A few waders were seen flitting around the littoral and one identified as Purple Sandpiper. None of the more usual seabirds such as Razorbill or Guillemot were seen possibly due to the lack of suitable nesting sites locally in Bockfjord, although a few were spotted along the voyage. The return passage saw us passing close to Danskoya, following an earlier reported stranding of a large Sperm Whale there. By the time we arrived little was left of the carcass, but its bulk had evidently been much appreciated by the numbers of bear that were still close by. These were completely rotund and showed little interest in anything beyond resting their renewed bulk on the shore. One sad aside was the presence of a mother and cub seen high on adjacent mountain clearly too afraid for their lives to venture near the life-giving food that was slowly rotting away on the littoral.

One fat Bear on Danskoya after feeding on Sperm Whale Photograph HW

Camp site with Mud flats on tundra looking towards Troll Springs Photograph IF

Food stuffs proposed and donations

	Item	Number/day	Weight/day	total	Source	donated
1	Muesli	1x 26 x 4	100 x 21x2	4.5kgs	**Lidl**	✓
2	Instant porridge	1 x 26 x 4	100 x 21x2	4.5 kgs	**Lidl**	✓
3	Milk Powder			4 kgs	**Pritchitt**	✓
4	Sultanas		65 x 2 x 21	3 kgs	**Co-op**	✓
5	Apricots		65 x 2 x 21	3 kgs	**Co-op**	✓
6	Ryvita	2 x 2 x 21		100 No	**Co-op**	✓
7	Cheese tube			10 No		
8	Chocciez Biscuit	1 x 2 x 21		48 No	**Tunnock**	✓
9	Tinned Fish	1 x 21		21 no	**Pak**	✓
10	Cheese		1 x 50 x 21	500gms		✓
11	Pasta	2 x 7	65	1 kg	**Co-op**	✓
12	Arborio rice	2x7	65	1 kg		
13	Smash potato	2x7	50	700Gms		
14	Cous-Cous	2x7	65	1 kg	**Co-op**	✓
15	Almonds	2 x 100 x 21		4.2 kgs	**Sharif**	✓
16	Walnuts	2 x 100 x 21			**Sharif**	✓
17	Figs			500 Gms		✓
18	Chocolate bars	2 x 28	56 Mixed			✓
19	Condensed milk	4 x 2 x 2	16 tubes		**MFrearson**	✓
20	Tea bags	2 x 21 x 4	170 No		**G Staley**	✓
21	Coffee	2 x 100 Gms	200Gms			✓
22	Dried onions			1Kg	**EFI**	✓
23	Mushrooms			200 Gms	**EFI**	✓
24	Vegetables			2Kgs	**EFI**	✓
25	biscuits	2 x 3		6Packets	**Co-op**	✓
26	Malted Milk	2 x 3		6packets	**Co-op**	✓
27	Spread			6 tubs	**Co-op**	✓
28	Butter			500 Gms		
29	Sealable Bags A5			400		✓
30	Sealable Bags A6			400		✓
31	Sosmix			1 kg		✓

The above foodstuffs were proposed and in the main taken. These were either donated by various local or National organisations or were purchased from ARG funds. Where there is no

tick the items were secured locally in Svalbard. In the end far less was required due to the time lost but all were much appreciated and are in store for future use

In a place where average daily consumption requirements can be as much as 8,000 Kcals the need for good reliable food is paramount. One soon becomes tired of the daily ration of chocolate, so sturdy high calorific savoury foods are frequently yearned for. Experience has shown that there are certain foodstuffs that never seem to pall and on that basis we prepared the above list. The ARG is greatly indebted to all those manufacturers and suppliers who gave freely of the above supplies. Once again, experience has shown that, in areas of high latitude, items such as milk powder seem to last almost indefinitely so it is no surprise that we have just exhausted stocks originally taken in 1990. It is hard to imagine that a portion of instant potato mixed with dried chillies, tomato puree and cheese would make a palatable and sustainable meal, but in the right circumstances, it does. A bag of nuts and dried fruit carried every day provided most of the hill food lunches and stream water was drunk. Breakfasts were mostly instant porridge or muesli, pre-mixed with dried milk, and mixed with either cold or hot water to taste. Tea was the staple drink throughout with no alternative taken.

So our thanks and appreciation go to donations from the following suppliers:-

The Coop supermarket	EFI
Lidl Supermarket	Pak foods
Pritchitt Foods	Sharif & Sons
Tunnocks	GHS Staley

Our grateful thanks also to

The Arctic Club & Gino Watkins Memorial Trust for their support by way of a grant
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Geoffrey Halliday for his advice and information regarding the warm springs in this and other locations together with the generous loan of papers articles and photographs for our use
Dr. Steve Staley (ARG Deputy Group Leader) for acting as our home agent and all the work that this role uncovered
Our many other supporters both financial and practical without whom we would not have managed the trip
Lastly to our families without whose support, which is much needed and appreciated, we would not have gone.

Ian Frearson
Group Leader
Arctic Research Group

APPENDIX 1

Spring water analyses

Sample ID			pH	O2	ORP	temp	EC uS/cm	dH-H2O	dO-H2O	Chloride ppm	NO3 ppm	NH4 ppm	Si ppm	HCO3	SO4 ppm	PO4 (ppm P)
J1 4_7_17	thermal spring	Jotun thermal spring	6.81	0.1	-108.1	23.5	3760	-127.87	-16.40	780.4175	0	0.62	62.95	829.76	98.3875	0.0043
J2 4_7_18	mixed spring	travertine west of Jotun	7.3	8.73	85.5	10.7	2460	-122.32	-16.17	460.605	0	0.03	36.39	590.62	84.485	0.0077
J3 4_7_19	thermal spring	Jotun thermal spring	6.91	0.39	-177.9	23	4040	-126.70	-16.31	890.0475	0	1.14	62.29	617.31	114.375	0.0039
Jotun Small stream	stream		-	-	-	-	-			965	0	-	-	646.6	97	-
Jotun 14-VII Stream 1 Time 15:46	stream		-	-	-	-	-			958	0.3	-	-	646.6	96.3	-
1JA1	stream		-	-	-	-	-			953.2	0	-	-	646.6	96.1	-
1A2	hot spring	1A2	8.18		-	15.2	1340			124.5	0	-	-	634.4	39.3	-
2A4i	hot spring	2A4i	8.47		-	16.6	1533			148	0	-	-	658.8	46.5	-
3A2	hot spring	3A2	8.37		-	21.7	1575			152.9	0	-	-	671	48.1	-
Area 3	hot spring	Area 3	9.42		-	23.1	1626			152.2	0	-	-	671	47.5	-
6A1	hot spring	6A1	8.36		-	18.4	1867			209.1	0	-	-	683.2	52.6	-
5A2	hot spring	5A2	8.93		-	16.5	1902			224.6	0.4	-	-	683.2	53.2	-

Sample ID			Na ppm	K ppm	Mg ppm	Ca ppm	S (ICP OES) ppm	Sr ppb	Al ppb	As ppb	Co ppb	Cr ppb	Cu ppb	Fe ppb	Mn	U	V ppb
J1 4_7_17	thermal spring	Jotun thermal spring	655.02	46.99	32.57	115.64	37.53	1582.75	7.49	5.83	616.20	0.00	4.07	12.68	0.00	0.11	206.88
J2 4_7_18	mixed spring	travertine west of Jotun	400.18	23.93	25.49	92.49	25.75	1050.09	194.95	6.62	147.98	0.60	1.03	0.00	0.00	1.73	184.54
J3 4_7_19	thermal spring	Jotun thermal spring	677.31	41.73	29.59	105.09	34.50	1560.06	10.13	6.32	623.86	0.00	0.89	12.47	0.00	0.11	203.90
Jotun Small stream	stream		682	56.4	32.8	49.3	-	-	-	-	-	-	-	-	-	-	-
Jotun 14-VII Stream 1 Time 15:46	stream		691.8	56.4	33.7	123	-	-	-	-	-	-	-	-	-	-	-
1JA1	stream		687.2	56.2	33.5	114.6	-	-	-	-	-	-	-	-	-	-	-
1A2	hot spring	1A2	175	24.3	30	77.5	-	-	-	-	-	-	-	-	-	-	-
2A4i	hot spring	2A4i	214	27.1	34.3	57.7	-	-	-	-	-	-	-	-	-	-	-
3A2	hot spring	3A2	219.3	21	35.3	58.7	-	-	-	-	-	-	-	-	-	-	-
Area 3	hot spring	Area 3	220	21	35.2	73.5	-	-	-	-	-	-	-	-	-	-	-
6A1	hot spring	6A1	284.6	22.8	30.3	76	-	-	-	-	-	-	-	-	-	-	-
5A2	hot spring	5A2	295.4	24.1	33.5	71.5	-	-	-	-	-	-	-	-	-	-	-

ARG