ARG

Arctic Research Group

2019 Expedition

To

Bockfjorden, Svalbard

Report filed December 2019

Humpback whale breaching, near Amsterdamoya. Photograph: Will Shaw

Note

This Final Report has been compiled to meet the requirements of certain grant funding bodies, for general interest and for the Sysselmann for Svalbard.

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

Keywords: Bockfjord, Svalbard, 2019, expedition, research, Arctic Research Group

Contents

1. Summary

This report provides an overview of the Arctic Research Group's expedition to Bockfjorden, North-west Spitsbergen during late July and early August 2019.

This was a seven-man, multidisciplinary scientific expedition that built upon the ARG members' long experience of Svalbard exploration that goes back to the late 1970s and, more specifically, on its 2017 expedition to Bockfjorden. The latter provided insights into the area that would prove invaluable in 2019.

The field area lies in a remote area of fjord, glacier, mountain and tundra and is accessible only by helicopter or a 36 hour boat journey from Longyearbyen. For cost reasons the boat option was taken here.

The expedition established a base camp under canvas near the south western shore of Bockfjorden and used this as the base for its work. A camp was also briefly established on the Nygaardbre glacier to carry out some of the geological field work.

Of the seven scientific objectives - spanning plant ecology, geology, planetary geology and environmental science - five were successfully achieved and all seven were energetically attempted.

The ARG is a charity registered in England, dependent wholly on the generosity of its donors and sponsors and the time freely given by its volunteers. Further background on the ARG may be found at www.arcticresearchgroup.org

Maps of Spitsbergen courtesy of Norsk Polarinstitutt

2. Personnel

The seven members of the Bockfjorden expedition, with their main areas of responsibility, were:

- Dr Steve Staley (59) – Expedition leader, geology and environmental science
- Professor George Shaw (58) – Plant Ecology
- Mr Chris Searston (63) – Meteorites
- Mr Dan Clarke (54) – Mountain leader and safety
- Mr Mike Haynes (57) – Food and logistics
- Mr Will Shaw (20) – Photography
- Mr Henry Staley (22) – Dental project and medical

We were ably supported by Mr Ian Frearson, ARG Group Leader, as home agent and remote support.

3. Planning & Logistics

Planning of this expedition effectively began before 2016, when the first of two smaller "recce" expeditions to this area was attempted. Though this did not reach the area, the second expedition did, in 2017, and provided us with invaluable information and contacts for the 2019 expedition.

These two recces underlined the importance of securing all the necessary permissions needed to visit, and carry out scientific work in, the North-west Spitsbergen National Park well in advance of the expedition. As a national park, the restrictions on, and requirements for, travel to this area are rightly tighter than in the non-park areas of the archipelago. The basic permissions process is to register your scientific projects on the Research In Svalbard portal https://www.researchinsvalbard.no and then make applications for travel to, and living in, the Sysselmann, the Governor of Svalbard. We did all this in good time, before the end of 2018, only to find early in 2019 that what we thought was a firm booking for the boat "Farm" for the duration of the expedition was not as firm as we had been led to believe. Flights had already been booked, so changing dates would be costly. Plan A – on which our submission to the Sysselmann had been founded - had been to base ourselves on Farm whilst in Bockfjorden, with no need for a permanent camp on land. However the boat would now only be available to take us there and bring us back – it had another booking in the middle of the expedition, so we would have to set up a camp for the duration of our time in Bockfjord. This meant a feverish reshaping of our plans; tents needed to be hired, stoves found, fuel purchased, our food requirements completely rehashed and a new set of applications quickly resubmitted for the Sysselmann's approval.

In the end, all was well and our permissions were granted with the exception, applied to all visitors, that no access was allowed to the Troll Springs.

All members of the expedition travelled to Manchester Airport on Sunday 28th July 2019 to catch an SAS afternoon flight to Oslo, connecting there with a direct flight to Longyearbyen. There was no need for freight to be sent ahead because of the combination of excess baggage, ARG kit already in Longyearbyen, hire of other kit and purchase of fuel and some food there.

We arrived there late that night and, gathering our kit, food and firearms from the luggage belt, found our way by taxi the short distance to where "Farm", lay anchored at the quay near the airport terminal. Stig Henningsen, the owner and skipper, wasn't there but suggested we make ourselves comfortable for the night. The next day we collected a generator and the main tent in the town, bought fuel and more food and picked up a variety of equipment kept in storage in a shipping container.

We set sail for Bockfjorden at 16.35 on the 29th and arrived at about 19.00 on the 30th without incident, save for some mild seasickness when we hit the swell as we came out of the protection of Isfjorden. From here we sailed north up Forlandsundet before eventually turning east and then south into Woodfjord and then Bockfjord. Sea ice conditions were a matter of considerable concern prior to travel, as these had caused our colleagues major problems during the 2017 expedition. However, by travelling later in the year and with a dash of good luck, the seas remained free of any appreciable ice during our journeys in and out Bockfjorden.

A party of three were landed on the west coast of Bockfjord to find a site for the camp. The Norsk Polarinstitutt map of the area showed an unnamed stream to the north of the Vulkanbekken stream (which is fed by snow-melt off Sverrefjellet) so this was the area we aimed for. This proved to be a fortuitous choice as the unnamed stream was flowing clean, glacier-fed water from Adolfbreen whilst Vulkanbekken had dried up. A flat area was found within 50 metres of the stream and about 500 m from the beach, the kit landed, carried up and base camp established by 2.30 am the next day. A long lie in until late morning was enjoyed by all. We would be woken most nights by the crash of rocks sliding down the front face of the Adolfbre terminal moraine.

The weather during the expedition was generally good. Several days of bright sunshine were enjoyed, though we also had occasional periods of low cloud and low temperatures. With the exception of a few drops of rain there was no precipitation during our time in Bockfjorden and any winds were light.

Travel by foot from base camp was generally easy over the tundra but we met with some challenges elsewhere. As always, crossing areas of moraine around the Friedrichbre, Adolfbre and Nygaardbre glaciers made for difficult and slow going. Also, the unnamed river issuing from the snout of Adolfbreen that we had to cross to reach the Jotun Springs and Friedrichbreen was fast-flowing, in places deep and with slippy rocks. The multiple crossings were carried out without mishap but with some trepidation. This river could vary in in its flow volume considerably on a day-to-day basis, so you never knew what you would find. By contrast travel on the Nygaardbre glacier was straightforward as, at the time of year we experienced it, it was free of slush and deep snow, with no open crevasses and jumpable supraglacial rivers.

Communications between different parties of our expedition was via VHF radios, with regular radio schedules when groups were separated. We also took an Iridium 9555 satellite phone for use in emergencies and as a means of keeping a tenuous link to our home agent by short daily text messages. An EPIRB was taken; both this and the satellite phone are requirements for the Sysselmann's approval of travel to this region.

Power was provided by a petrol-fueled Honda suitcase generator, purchased in the UK and taken as hold baggage by air to Svalbard. This proved reliable and was backed up by a second generator kindly lent to us by Prof Andy Hodson in Longyearbyen.

Previous expeditions had shown the ARG the necessity of taking ample precautions against the possibility of meeting a **polar bear**. Precautions included:

- Carrying of a firearm; we brought from the UK a side-by-side, 12-bore shotgun with slug ammunition, a rifle and a flare pistol
- Establishment of a bear alarm trip wire around all camps

- A choice of a campsite with good all-round visibility
- No party of less than three to leave the camp
- All parties to carry either the shotgun or rifle

The expedition relied on a mix of **food** brought with us from the UK and bought in Longyearbyen on our arrival. The former included tinned meats, dehydrated pre-prepared "expedition" meals, chocolate, pasta, nuts, sultanas and breakfast cereals. Bulkier and fresh food was bought at the Co-op in Longyearbyen. A list of the food and equipment shipped from the UK, excluding firearms and personal kit, is given in Appendix 1.

Return travel to the UK followed the same route as the outbound; we were picked up by Farm at 11.00 on Friday 9th August, arriving in Longyearbyen at 16.00 on Saturday 10th. We spent that night in the town, using the following day to return equipment, deposit samples with UNIS and have a look around the settlement, including the museum.

Our return flight left at 02.25 on Monday morning, this time via Oslo and Copenhagen, getting us back to Manchester at 09.30 the same morning. A tiring, but mercifully uneventful, journey.

4. Programme

We were able to carry out all the projects that we had planned over the months preceding the expedition. Each of the projects is described in the following sections.

Towards the end of the expedition, with scientific objectives largely achieved, five of the expedition members climbed the geologically juvenile Sverrefjellet volcano. This mountain dominated the skyline as seen from our base camp site and had, a few tens of thousands of years ago, ejected from great depth green, crystalline olivine which now littered where we camped. With the warm springs and the volcano itself, these were the more obvious signs of the thermal activity beneath our feet.

The time spent on each project and on travel, establishing camp, etc. is broken down in the table below.

Expenditure is also detailed below. As a UK-registered charity, the vast majority of the ARG's income comes from the donations of its members and others. Grants were made from the bodies listed in the "Acknowledgements' section.

Actual mandays spent on individual projects and other activities

ARCTIC RESEARCH GROUP SVALBARD 2019 EXPEDITION																	
ACTIVITIES BY MANDAYS - ACTUAL																	
PROJECT	28/07/2019	29/07/2019	30/07/2019	31/07/2019	01/08/2019	02/08/2019	03/08/2019	04/08/2019	05/08/2019	06/08/2019	07/08/2019	08/08/2019	09/08/2019	10/08/2019	11/08/2019	12/08/2019	Totals
	Air travel from UK	Longyearbyen, boat travel	Boat travel, set up camp	Set up camp, recce									Break out camp, boat travel	Boat travel, Longyearbyen	Longyearbyen	Air travel to UK	
Meteorites						3											**3**
Plant Ecology				4		4	3	3	3		4						**21**
Springs/outcrop					7			4	4								**15**
Beach rubbish							4			7	3						**14**
Other	7	7	7	3								7	7	7	7	7	**59**
Totals	**7**	**7**	**7**	**7**	**7**	**7**	**7**	**7**	**7**	**7**	**7**	**7**	**7**	**7**	**7**	**7**	**112**

5. Expenditure

Item	Cost (£)
Food	**710**
Fuel (paraffin & petrol) & oil and travel to/from Manchester Airport	**242**
Return flights UK to Svalbard, 7 persons, including extra baggage	**2,542**
Transport of freight UK – Svalbard / return	**0**
Transport within Svalbard	**12,956**
Field Equipment – purchase	**660**
Field Equipment – hire	**322**
Search & Rescue Insurance, 7 persons	**1,104**
Accommodation, Longyearbyen (1 night, 7 persons)	**561**
Airline firearms fees	**110**
Total	**£19,207**

Notes:
Transport within Svalbard includes the return boat journey from Longyearbyen to Bockfjorden and taxis within the town.
Field equipment items purchased included a suitcase generator and jerry cans.
Field equipment items hired included an 8-man tent (from Norsk Polarinstittut in Longyearbyen).
Expenditures in NKR are converted to sterling at the average bank rate of the day, NKR 1 = £0.092 is used here.

By far the largest cost item was the hire of MS Farm for the boat journey to and from Bockfjorden. The only other viable transport alternative from Longyearbyen was by helicopter, but this was prohibitively expensive.

The ARG has a significant cache of equipment, including tents, stoves and bear alarms, in Longyearbyen that it utilises for expeditions.

6. Projects

6(a) Early colonisation and greenhouse gas fluxes on substrates exposed by glacier retreat

Background and Objectives

Accelerated melting and retreat of glaciers in response to climate warming in the Arctic is now well documented (MOSJ, 2018). Glacier retreat results in the exposure of land surfaces for colonisation by both macroscopic plant life and microorganisms, part of a process of environmental change which also involves the accumulation of organic matter in the exposed substrates. The potential for organic carbon accumulation in freshly exposed substrates will depend on the speed and extent to which colonisation by microorganisms and vegetation occurs. This can be slow, though the rate can be estimated from examination of chronosequences of surfaces left behind by glacier retreat. Another important part of this process is the balance of fluxes of carbon-containing gases, CO_2 and CH_4, to and from exposed glacial substrates. These fluxes contribute to the net gains and losses of carbon from the developing soil and have important consequences for the changing sinks and sources of greenhouse gases in the rapidly warming Arctic. In the Bockfjorden area there are several glaciers which are visibly in retreat, leaving recently exposed forefield materials in which vegetation colonisation, organic matter accumulation and greenhouse gas fluxes can be assessed. We examined the plant communities on substrates in and adjacent to the forefield of Adolfbreen glacier where we also measured CO_2 and CH_4 fluxes to assess the impact of *recent glacial retreat in the area.*

Methods

Before departing from the UK a stratified random sampling strategy was used to identify sample locations in and adjacent to the forefield of Adolfbreen (Figure 1). These were converted into spatial coordinates (UTM) which were located in the field (± 2-3 m) using a hand-held GPS unit (Garmin 60 CSx). A photographic record of all sampling sites was made and the vegetation present was recorded quantitatively (using a 1 m^2 quadrat) and qualitatively by identifying as many vascular plant species as possible within the general sampling area. A list of the plant species recorded is given in Table 1. Composite surface soil samples representative of the sample area were taken and transported to the UK for analysis, including measurement of gravimetric water content.

In the field, *in situ* gas flux measurements were made using a duplicate static chamber method. This involved the collection of four 20 mL gas samples within 4 litre 'headspace' chambers over a time-course of 1 hour (Figure 2). Gas samples from the chambers were injected into partially evacuated glass 'Exetainer' vials with rubber septum caps. The gas samples were transported to the UK and analysed for CO_2 and CH_4 using gas chromatography. From the data obtained, fluxes of each gas were calculated and expressed as $mg/m^2/day$, representing the rate at which each gas is exchanged between the 'soil' surface and the atmosphere. This flux can be either positive (from soil to atmosphere) or negative (from atmosphere to soil).

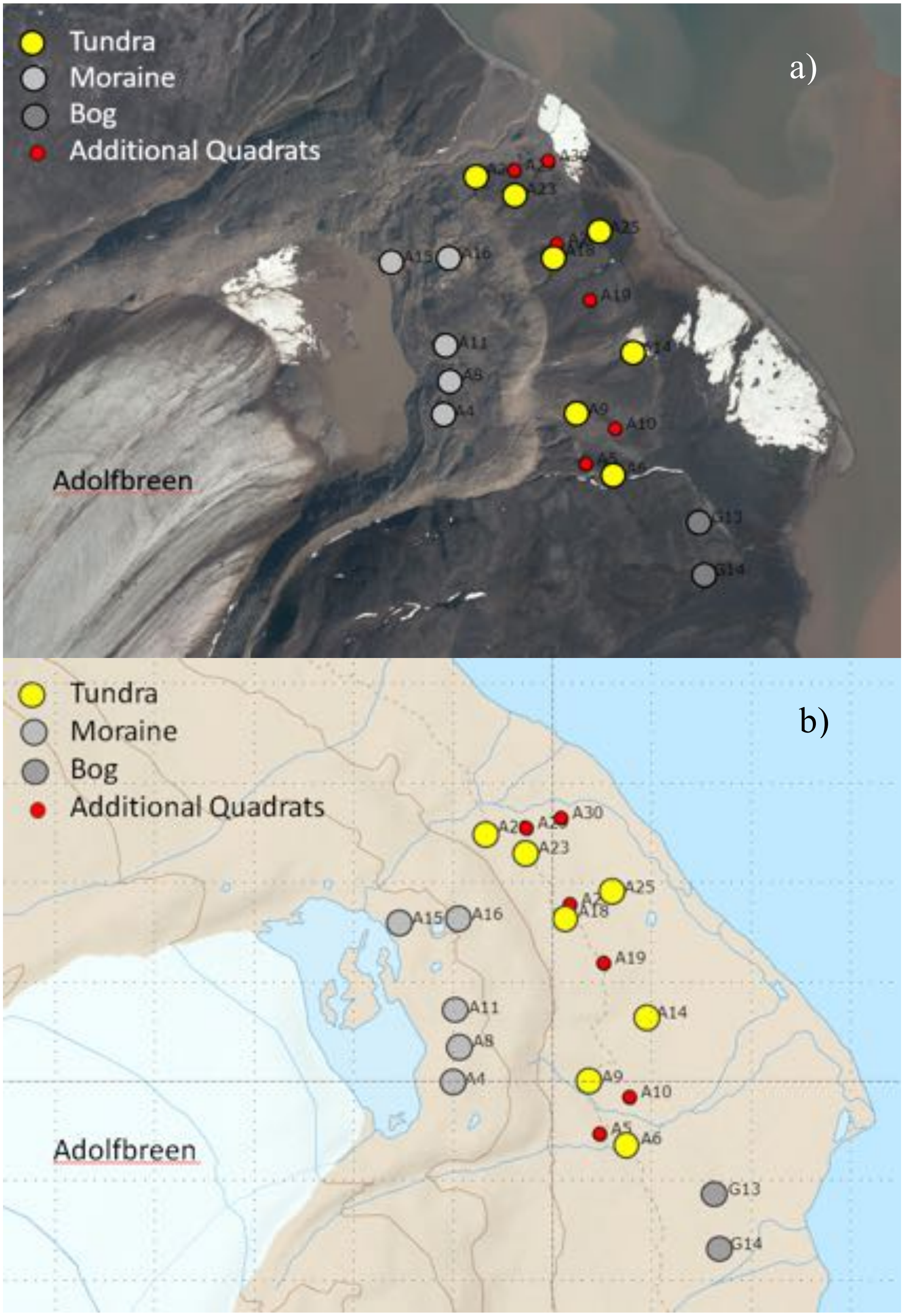


Figure 1*: a) Aerial photograph and b) map showing gas flux sampling points in and adjacent to the forefield of Adolfbreen, Bockfjord. Sampling points where no gas samples were taken are shown as small red points. Source of aerial photograph and map: https://toposvalbard.npolar.no/ (Norsk Polar Institutt)*

***Figure 2**: Gas flux sampling using duplicate ‘headspace’ chambers a) Site A15 (see Figure 1) on glacial moraine in the Adolfbreen forefield (Adolfbreen in the background), b) Site A6 (see Figure 1), a typical dry tundra site (Bockfjord in the background). Photo: Will Shaw*

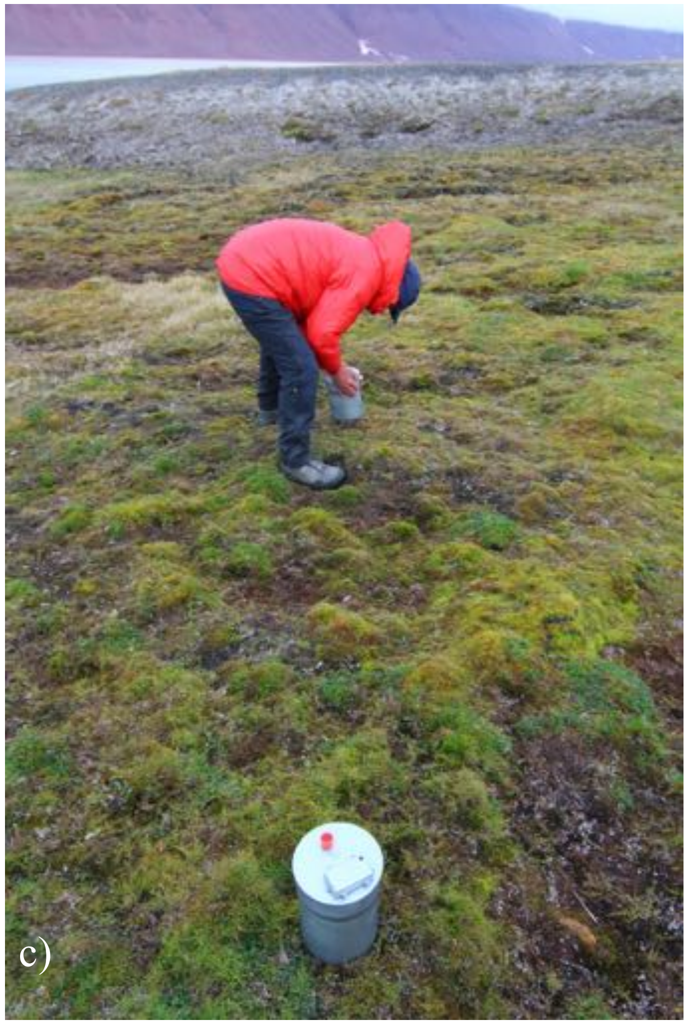


Figure 2 continued*: c) Gas flux sampling using duplicate 'headspace' chambers at Site G13 (see Figure 1) on a bog adjacent to the Adolfbreen forefield. Photo: Will Shaw*

Results

A total of 20 sample points were investigated in the field; vascular plant species were recorded at each of these sites and gas fluxes were measured at 14 sites. In Figure 1 it can be seen that gas flux samples were taken at five locations on recently exposed moraine within the glacier forefield, seven gas flux samples were taken on tundra immediately below the terminal moraine of Adolfbreen and two gas flux measurements were made on bogs to the immediate south east of the push moraine. Figure 2 shows views of gas flux samplers at a typical example of each of these sites. The characteristics of sites classified as 'moraine', 'tundra' or 'bog' were quite distinct. Tundra sites below the terminal moraine (yellow points in Figure 1) were generally dry with varying degrees of vegetation cover. The dominant plant species at most of the tundra sites was *Dryas octopetala* with varying amounts of *Salix polaris* and *Saxifraga oppositifolia*. However, most tundra sites had a significant percentage of ground area with no plant cover. The exception to this was site A18 which had an almost closed cover of grasses (*Deschampsia* and *Poa*) and *Polygonum viviparum* in fine sand within a low-lying shallow gully. The moraine material in the forefield had extremely sparse vegetation cover. Gas flux measurements could only be made in small areas where there were signs of vegetation colonisation and some organic matter accumulation, usually in depressions among boulders and rock rubble. In complete contrast, the two bog sites were entirely covered in mosses, grasses and *Polygonum viviparum*. Figure 3 shows that the soil moisture contents of the three types of surface differed markedly. The bog sites were very wet, with 80% moisture contents. The tundra and moraine sites has similar median water contents, but the tundra sites tended to be skewed towards low moisture contents (as low as 0.3% water content) while the moraine sites were skewed towards higher moisture contents (as high as 35% water content), though much drier than the bog sites.

Fluxes of CO_2 (Figure 3, centre) did not differ significantly, overall, between tundra, moraine and bog. However, the ranges of CO_2 fluxes were much higher in the moraine and especially the tundra sites. The maximum CO_2 flux (3783 mg/m^2/d) was measured at tundra site A18 where plant cover was 100%. Positive CO_2 fluxes represent rates of CO_2 escape from the soil to the atmosphere and can be interpreted as a measure of soil respiration rate at each sampling site. As such, it is quite surprising that the median CO_2 flux on the moraine was higher than the median CO_2 flux on the tundra, where the soil biology was clearly more developed. This may be linked to the slightly higher soil moisture contents on the moraine; soil respiration is known to be increased by non-limiting moisture supply, as was the case for site A18.

While CO_2 provides an indication of net soil respiration, CH_4 behaves in a more complex way. Figure 3 (left hand graph) shows that CH_4 fluxes were both positive and negative. The horizontal dashed line in the CH_4 graph shows the line of net zero flux: fluxes >0 indicate net methane production in the soil and outgassing from soil to atmosphere while fluxes <0 indicate net methane consumption within the soil resulting in 'drawdown' of CH_4 from the atmosphere into the soil. In other words, when CH_4 flux is positive the soil is providing a source of atmospheric CH_4 and when CH_4 is negative the soil is providing a sink for atmospheric CH_4. The explanation for this contrasting behaviour lies in the specialised microorganisms which either produce or consume methane in the soil. These are the methanogenic and methanotrophic bacterial communities, respectively. The methanogens are obligate anaerobes and are only active in very wet and saturated soils while the methanotrophs require a strictly aerobic environment. Figure 3 shows clearly that the saturated bog sites were producing a positive net flux of CH_4, from the peat surface to the atmosphere, as would be expected if the methanogenic community were active. The much drier tundra sites were all consuming CH_4 as shown by the negative (atmosphere to soil) fluxes. What is also clear from Figure 3 is that the moraine surfaces, within the Adolfbreen forefield, showed a wide range of CH_4 fluxes, from positive to negative. Particularly interesting is that fact that two sites on the moraine (sites A8 and A15) produced higher positive CH_4 fluxes than the bog sites, indicating that there is significant potential for CH_4 outgassing from moraine materials even in the early stages of vegetation colonisation and organic matter accumulation. Broadly, the correspondence between CH_4 fluxes and soil moisture content can be seen by comparing the left- and right-hand graphs in Figure 3; there is a compelling correlation between net CH_4 flux and soil moisture, although the highest CH_4 fluxes from the moraine could not be predicted purely on the basis of the soil moisture contents at sites A8 and A15.

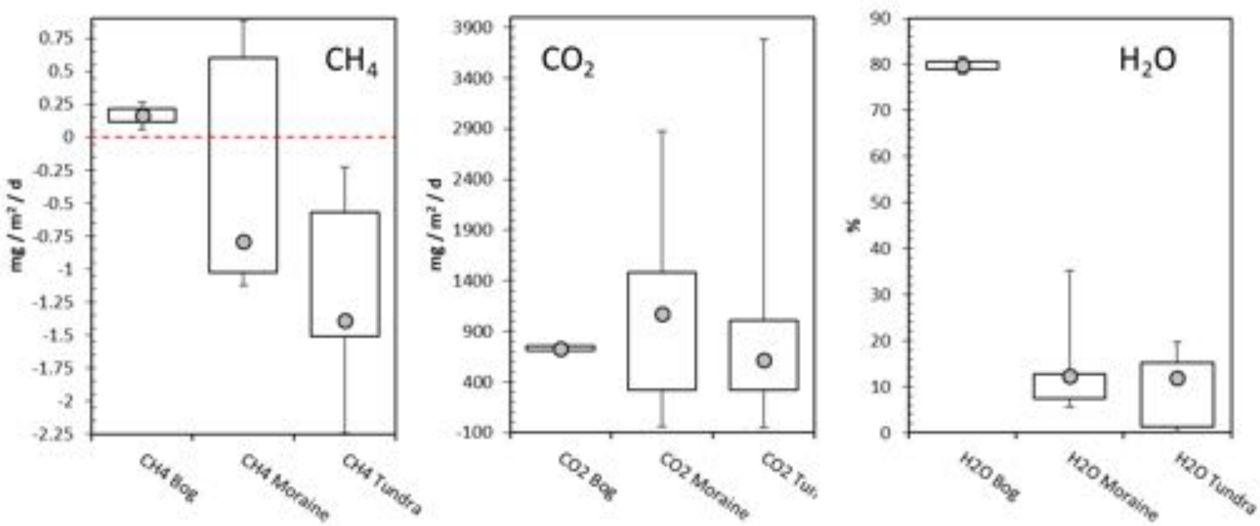


***Figure 3**: Summary of net fluxes (mg/m^2/d) of CH_4 and CO_2 (left and centre) measured at bog, moraine and tundra sites across the study area. Gravimetric water content (%) of surface soil at the sampling sites is shown on the right. Points are median values, boxes show interquartile values, whiskers show maxima and minima.*

To put our measurements into context, Whalen & Reeburgh (1990) reported mean CH_4 consumption (methanotrophy) rates of 2.7 mg/m^2/d for tundra soil on Unalaska Island in the Aleutians, which lies in the middle of the reported range of methane consumption rates from 0.2 – 4.2 mg/m^2/d. Our CH_4 consumption rates ranged from 0.22 to 2.24 mg/m^2/d, somewhat lower than Whalen & Reeburgh's (1990) rate though, nevertheless, demonstrating that CH_4 consumption is occurring, especially in the drier tundra soils below the Adolfbreen terminal moraine.

Conclusions

Our measurements present only a 'snapshot' of greenhouse gas fluxes associated with the forefield of a retreating glacier in northwest Spitsbergen. However, they clearly show that moraine materials freshly exposed by glacier retreat not only have the capacity to exchange the two major greenhouse gases associated with biological activity in the surface material, but that the balances of fluxes of these gases are unexpectedly complex. This is especially true for CH_4 for which freshly exposed moraine can evidently act as both a sink and a source, probably reflecting the complexity of 'niches' available for plant colonisation, organic matter and moisture accumulation on the moraine surface. The ages of the individual sites at which we took measurements are impossible to determine with accuracy. However, from an oblique aerial photograph taken in 1938 (Figure 4) it can be seen that our 'moraine' survey area has been exposed for a maximum of c. 80 years. Plant colonisation during this time has been very limited and highly localised, as might be expected at such a high latitude. Our gas flux measurements give important clues as to the microbial colonisation of the surface materials which has also taken place during the same time period. In terms of the impacts of glacier melting on greenhouse gas balances in this part of the high Arctic, it is the (presumably) rapidly adjusting soil microbial communities which are of particular significance.

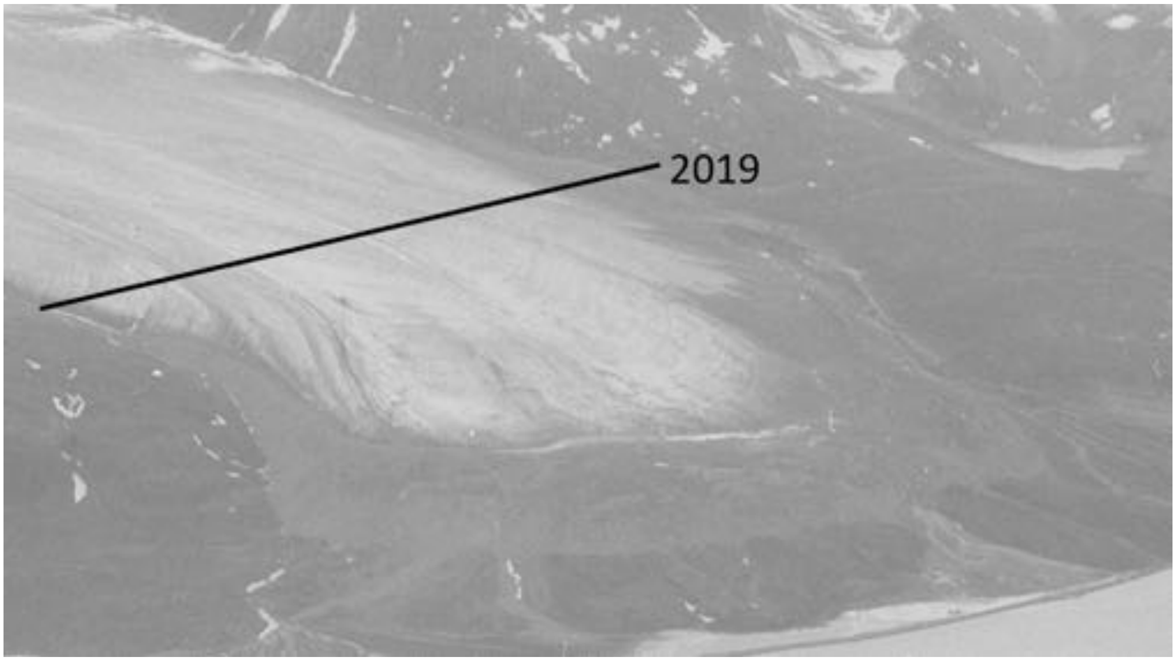


***Figure 4**: Oblique aerial photograph of Adolfbreen taken in 1938 (© Norsk Polarinstitutt). The approximate position of the ice front in 2019 is shown.*

References

MOSJ (Miljøovervåking Svalbard og Jan Mayen) (2018) Mass balance for glaciers in Svalbard. http://www.mosj.no/en/climate/land/mass-balance-glaciers.html.
Rønning, O. I. (1979) Svalbard's flora. Polar Handbook No. 1, Norsk Polarinstitutt, Oslo.
Whalen, S. C. & W. S. Reeburgh (1990) Consumption of atmospheric methane by tundra soils. Nature (letters to), 346, 160-162.

Species	Family	English name
Erigeron humilis	Asteraceae	Arctic Alpine fleabane
Petasites frigidus	Asteraceae	Arctic butterbur
Cardamine pratensis L. ssp. *angustifolia*	Brassicaceae	Polar cress
Draba spp.	Brassicaceae	Whitlow grasses (yellow and white flowered spp.)
Cerastium arcticum	Caryophyllaceae	Arctic mouse ear
Silene uralensis ssp. *arctica*	Caryophyllaceae	Nodding lychnis
Minuartia rubella	Caryophyllaceae	Arctic sandwort
Silene acaulis	Caryophyllaceae	Moss campion
Stellaria longipes	Caryophyllaceae	Longstalk starwort
Carex spp.	Cyperaceae	Several sedge species
Equisetum spp.	Equisetaceae	Several horsetail species
Cassiope tetragona	Ericaceae	Arctic bell heather
Huperzia arctica	Lycopodiaceae	Mountain fir moss
Papaver dahlianum	Papaveraceae	Svalbard poppy
Deschampsia alpina	Poaceae	Alpine hair grass

Festuca viviparoidea	Poaceae	Northern fescue
Trisetum spicatum	Poaceae	Spike trisetum
Poa alpine	Poaceae	Alpine meadow grass
Poa alpina var. *vivipara*	Poaceae	Viviparous alpine meadow grass
Oxyria digyna	Polygonaceae	Mountain sorrel
Bistorta viviparum	Polygonaceae	Alpine bistort
Ranunculus pygmaeus	Ranunculaceae	Pygmy buttercup
Ranunculus sulphureus	Ranunculaceae	Sulphur buttercup
Dryas octopetala	Rosaceae	Mountain avens
Salix polaris	Salicaceae	Polar willow
Micranthes hieraciifolia	Saxifragaceae	Stiff stem saxifrage
Saxifraga cernua	Saxifragaceae	Drooping saxifrage
Saxifraga cespitosa	Saxifragaceae	Tufted saxifrage
Saxifraga oppositifolia	Saxifragaceae	Purple saxifrage
Pedicularis dasyantha	Scrophulariaceae	Woolly lousewort
Pedicularis hirsuta	Scrophulariaceae	Hairy lousewort
Cystopteris fragilis	Woodsiaceae	Brittle bladder fern

***Table 1**: Vascular plant species recorded in and adjacent to the forefield of Adolfbreen, Bockfjord. Primary identification in the field was made using Rønning's (1979) field guide. On return to the UK, identifications were cross checked against the online flora of Svalbard's vascular plant species (https://svalbardflora.no/) which includes records of species sightings for the area.*

George Shaw

6(b) Warm Springs at Jotunkjeldene & Gyregkjelda.

Background

Collection of water and gas samples for stable isotopic analysis of noble gases, hydrogen and oxygen from the Jotun Springs (the most northerly land-based thermal springs in the world) was carried out in cooperation with Professor Igor Tolstikhin and Alena Kompanchenkon of the Kola Scientific Centre (Russia). The main goal of the work was to provide data which would enable estimates to be made of transit time in the subsurface hydrodynamic system of the waters now emerging at the surface and so help to better understand what is driving this system. To our knowledge, there are no published data on noble gas compositions of spring waters from this part of Svalbard.

Equipment and method

The Kola Institute provided the expedition with sealable 200 ml thick glass bottles for both gas and water samples. In addition, a bespoke padded wooden box arrangement was provided which both held the bottles such that they were very unlikely to leak and protected them from possible breakage during transportation. For gas sampling a metal funnel and rubber hose were also used.

Water samples were taken by completely submerging a bottle in the water to be sampled and then removing the rubber stopper whilst ensuring that no bubbles remained in the bottle. Keeping the bottle completely submerged a short length of thin, plastic-coated wire was introduced into it, with a "tail" protruding from the bottle, and the stopper replaced. Whilst carefully ensuring that the stopper remained firmly in place, the wire was slowly withdrawn so as to create a small bubble in the bottle.

To **sample gas** from the springs the funnel and attached hose were totally submerged and completely filled with water, taking care to dislodge any bubbles within them. The sample bottle was uncorked, completely filled with spring water, checked for bubbles of air and attached to the other end of the hose. The inverted funnel was then placed over areas where bubbles could be seen to be escaping and the gas collected until it had completely displaced the water in the bottle. The hose was then removed and, keeping the bottle totally submerged, tipped slightly to allow a small amount of gas to escape and water to enter. The bottle is corked firmly and kept upside down for transportation.

The Jotun Springs were sampled on 1st and 2nd August 2019 and the Gyregkjelda on the 2nd August. A total of three water samples and one gas sample were taken from Jotun Spring 1JA3 (see map below), the only flowing and the only gas-producing Jotun spring and the most prominent, visible from well out to sea. Two water samples were taken from the Gyregkjelda Spring; no gas was seen in any part of the Gyregkjelda Springs. Though not marked on all maps, these springs were sampled at N 79° 27' 18.7", E 13° 14' 14.2"

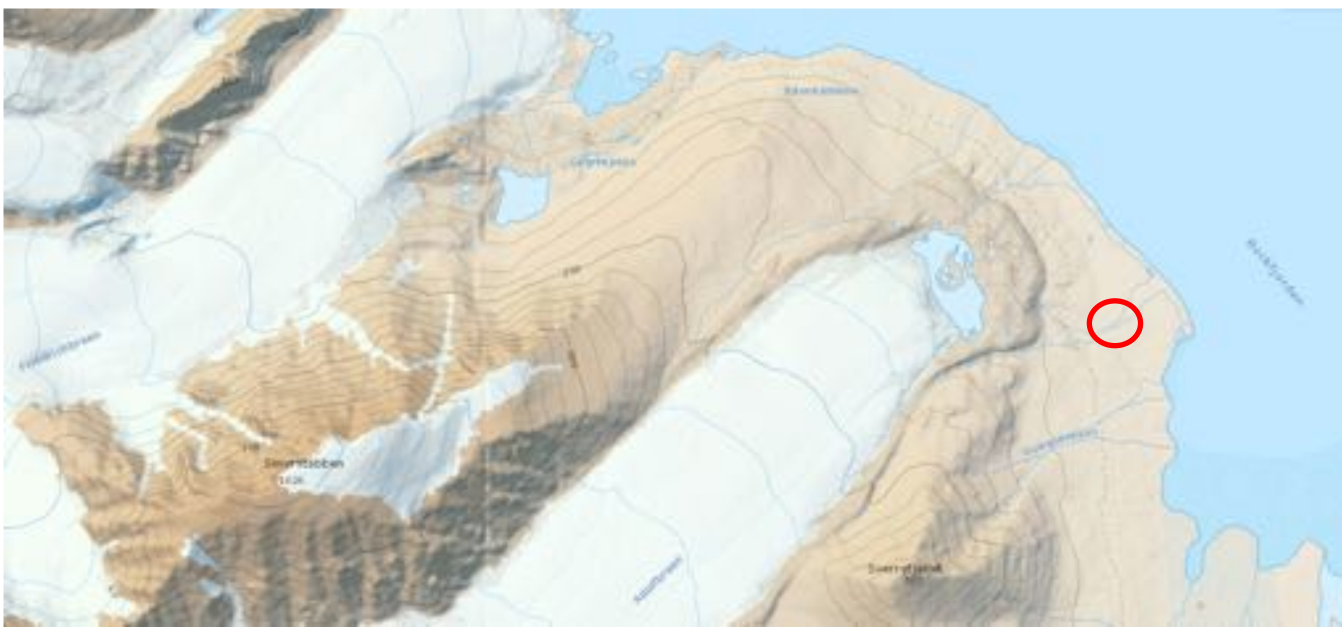
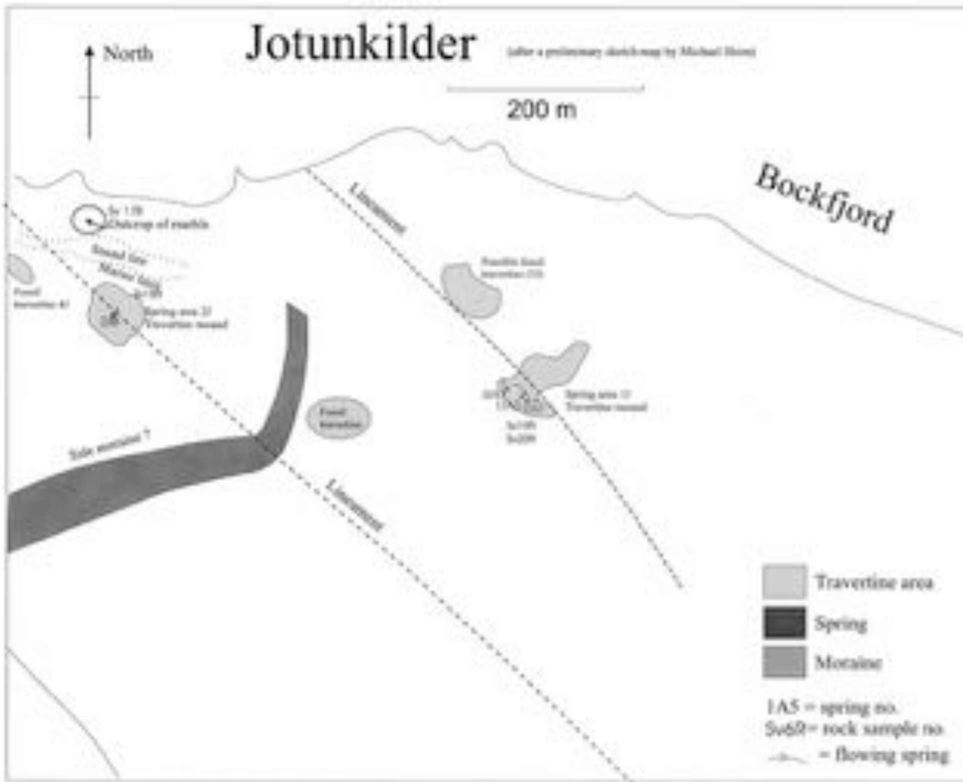


Image courtesy of Norsk Polarinstitutt, showing location of Jotun and Gyrekjelda warm springs; also of Friedrichbreen, the site of the meteorite search. Red circle indicates location of base camp.



From: Banks et al, 1999, The thermal springs of Bockfjorden, Svalbard: II: selected aspects of trace element hydrochemistry. Showing location of sampling location at spring 1JA3.

The samples were packed for shipping and left at the University of Svalbard where they were collected by Kola.

There the samples will be analysed for isotopic tracers: ^{3}H, ^{14}C, ^{3}He(^{3}H), ^{4}He/^{20}Ne, ^{21}Ne/^{20}Ne in waters; these are time-dependent and shed light on the residence time of the water. In addition, δ^{18}O, δ^{2}H, ^{3}He/^{4}He, ^{3}He/^{20}N analyses will assist in determining the ultimate sources of the water and gas samples. It is expected that these analyses will be completed in the first quarter of 2020 and ready for publication shortly thereafter.


Collecting a gas sample from the Jotun Springs. Photograph: Will Shaw

Steve Staley

6(c) Lost springs and country rock sampling

Two projects related to the spring water and gas sampling were built into the 2019 expedition plan. These were searches for (a) samples of relatively fresh, unweathered outcrop from the dominant local carbonate "country rock" and for (b) the "lost springs" of Hoel and Holtedahl. As they were carried out by the same team, in the same area and at the same time they are reported together here.

Country Rock

Background

The term "country rock" refers to the bodies of rock which enclose an intrusive mass of igneous rock. Here the basaltic rocks associated with the Quaternary Sverrefllet volcano are, to a large degree, enclosed within the country rock of the much older (Neoproterozoic) marbles of the Generalfjella Formation.

Mr Dave Banks, who has co-authored a number of learned papers (including those referenced below) on the geochemistry and geology of the Jotun and Troll Springs, had asked that the ARG collect samples from the Generalfjella Formation, as samples collected from one of his previous expeditions to the area had been lost in transit. Samples of this formation are important for an understanding of the chemical evolution and possible sources and routes of these spring waters and of the broader hydrodynamic system of which they are part. This is because the Generalfjella is likely to represent much of the subsurface route of the spring waters before they re-emerge at the surface and so provide the majority of the dissolved chemical species present in these waters. Having relatively unweathered samples is important, as weathering can selectively leach soluble ions from the rock over time to produce a rock that is unrepresentative of the rock below the surface. However, freeze-thaw shattering, particularly nivation on a diurnal cycle, is a particularly effective process in Svalbard for much of the year. As any visitor to these climes knows, finding rock that hasn't been weathered to pieces can be a challenge.

However, we were fortunate to have the benefit of recce work from the ARG's 2017 expedition to Bockfjord. This had identified a likely candidate area for decent Generalfjella outcrop immediately to the south of Nygaardbreen. Though the 2017 team had not had time to visit the outcrop, seeing it only from beyond the glacier's terminal moraine, the Norsk Polarinstitutt 1:100,000 geological map of the area suggested that the outcrop should be accessible, consist of the Generalfjella Formation and (because it was north-facing) be less affected by nivation than a south-facing slope.

Method

On 4th August four members travelled from base camp, via the northerly lateral moraine of the Nygaardbreen and onto the glacier. Here an ice camp was set up and the likely country rock outcrop was seen to the south in the northern flank of Ryptind. The team then crossed the southern lateral moraine to the point shown in the photograph below and found good, freshly exposed bedrock, latlong 79° 24' 14.7" N 13° 17' 50.7" E.

New rockfalls had smashed open fresh surfaces; work on these with lump hammer and chisel got to even fresher rock. Three samples were taken from the general location and a small part of each (subsequently discarded) was tested with a drop of 10% dilute hydrocholoric acid to confirm that they were calcium carbonate.

Country rock outcrop sample site, directly above head of foreground figure and below dark, 45^o tuff layer. Dark outcrop to the right is of mica schists of the Krossfjorden Group. Photograph: Steve Staley

The outcrop samples were brought back to the UK and are now with the University of Glasgow for chemical analysis, which we expect to receive early in 2020.

References

Banks, D., Siewers, U., Sletten, R. S., Haldorsen, S., Dale, B, Heim, M. and Swensen, B.(1999) "The thermal springs of Bockfjorden, Svalbard: II: selected aspects of trace element hydrochemistry". In "Geothermics", 28 (1999), pp713-728

Haldorsen, S., Heim, M., Dale, B., Landvik, J. Y., van der Ploeg, M. Leijnse, A.,Salvigsen, O., Hagen, J. O., Banks, D. (2010) "Sensitivity to long-term climate change of sub-permafrost groundwater systems in Svalbard"; in "Quaternary Research" 73 (2010), pp 393-402

Steve Staley

Lost Springs

Background

In 1911 A. Hoel and O. Holtedahl led an expedition to north-west Spitsbergen that was financed by Prince Albert I of Monaco, himself having undertaken several expeditions to the archipelago. The names of local features, notably Monacobreen, are reminders of earlier Monegasque-financed expeditions that were primarily looking for commercial mining opportunities. In their 1911 account of the expedition (in French) Hoel and Holtedahl describe the local thermal springs we still see today – but they also describe finding a dry spring, as evidenced by calcareous tufa, directly to the south of Nygaardbreen. These are the same sorts of deposits found today around the Jotun and Troll Springs. As far as we are aware, no one has attempted to rediscover these springs since 1911.

Limited sampling of these deposits from the relict system should provide additional useful chemical and stable isotopic data in trying to understand the local hydrodynamic system.

Method

As planned, we used our drone to conduct a low-altitude, airborne search for these lost springs along the northern flank of Ryptind, where it meets the southern Nygaardbreen lateral moraine. A search on foot would have taken several days over this difficult, boulder-strewn terrain. Several sweeps were made and the recorded video footage examined in detail. Unfortunately, no sign was seen of any tufa-like materials. It is likely that the continued rockfalls from the mountain and glacial scouring of the mountain's flank have carried the tufa away and/or covered it over in the years since 1911.

References

Hoel, A. and Holtedahl, O., 1911, "Les nappes de lave, les volcans, et les sources thermals dans les environs de al Baie Wood au Spitsbergen", page 36.

Steve Staley

6(d) Dental Health

Background

The aim of this study was to identify changes in oral hygiene habits on a camp-based research expedition in the Arctic (from 28th July to 12th August 2019). The study highlights the extent to which oral health is prioritised when individuals are faced with new challenges.

Method

Each of the 6 participants were asked to fill in an oral hygiene diary at home in the UK for 2 weeks, and then again in the Arctic for 2 weeks for comparison.

Information regarding the challenges that each participant felt in carrying out their oral hygiene habits, as well as some background information on each participant was also collected via a survey carried out during the expedition.

Results

From the results collected, it is clear that oral hygiene habits did change on the expedition compared to at home, with the most change in flossing habits. Mean number of times brushed a day of all participants changed from 1.728 times a day at home to 1.416 times in the Arctic.

Time spent per brush (missed brushing not counted) also decreased from an overall mean of 2.07 minutes at home to 1.72 minutes in the Arctic. This means that whilst number of brushes per day fell, the quality of the brushing also decreased.

These changes are thought to be due to a lack of time, running water, mirrors, electric toothbrushes and a change in priorities during the expedition. 24 hours of sunlight also means that a routine was hard to keep to.

It may be argued that the change is not as large as it would be if there were no oral hygiene diary to fill in/ attention had not been brought to oral hygiene.

Whilst a 2-week period is unlikely to cause significant harm, longer expeditions or cumulative neglect of oral hygiene may lead to an increased incidence of caries, periodontal disease, infections, trauma and pain.

It seems appropriate to recommend that expeditions bring along an emergency dental kit, attend a dental check-up before the expedition and are educated on good prevention methods to undertake whilst away.

The consent, oral hygiene diary and survey forms can be found in Appendix 2 at the end of this expedition report.

Henry Staley

6(e) Meteorite Recovery

The project

The aim of the meteorite project was to identify and recover meteoritic material following their transportation from their original impact sites. Due to the beneficial dynamics of moving ice, which will move and deposit any material caught up in its train, this material tends to be deposited and concentrated at the fore of the tongue of a receding (land-based) glacier.

Hence, prior the expedition a lot of effort was spent in identifying such a glacier. In addition this glacier should, if possible, be attached an ice cap that can act as an extended “landing ground” for meteorites. The Friedrichbre appeared to be a good candidiate and within reasonable walking distance of our base camp.

Friedrichbreen glacier, looking northwest - August 2019. Photo: Chris Searston

Methods

After trekking to the snout of Friedrichbreen glacier, a drone was deployed to survey and identify the most promising search areas. As all meteorites contain varying amounts of iron the actual ground search was to be done on foot, using a metal detector.

Results

It was quickly established that the ground was far too wet for any sensible search and recovery attempts to be made and this resulted in the unfortunate decision to abandon this project.

Friedrichbreen glacier, looking northwards - August 2019. Photo: Chris Searston

Chris Searston

6(f) Sea-borne Rubbish

Background

The ARG had been in communication for a long time before the expedition with a number of research institutions working on the problem of oceanic rubbish. North western Spitsbergen is an interesting area for this work as it lies at the extreme northern end of the North Atlantic Drift, that current that is the last vestige of the warming, cross-Atlantic Gulf Stream. As well as helping to keep the sea approach to our field area free of ice for some of the summer the North Atlantic Drift also acts as a potential conveyor of floating rubbish from a huge area of the North Atlantic Ocean. The “dead end” morphology of the local fjords (Bockforden included) meant there could be substantial amounts of rubbish washed up the beaches of Bockfjorden, as once there it would tend not to leave. As far as we could ascertain there had been no previous studies or clean-ups of rubbish in this area. Discussions with SALT, based in Tromso, with input from Wageningen University and Research of the Netherlands, led us to the take the approach described below.

Method

The south-western shore of Bockfjorden, to the east and north-east of Sverrefjellet, was chosen for this work as it was easily accessible from our base camp and made up primarily of sand and cobble-sized rocks. This made it a suitable beach for study, the shoreline at the southern end of Bockfjorden being much muddier and more gently shelving. The full-length logs seen on many Svalbard beaches were a common feature here. The beach grades into a vegetated area and a shallow lagoon to landward.

Typical beach rubbish laid out on collection bag. Photograph: Steve Staley

SALT was particularly interested in our collecting "combustible" non-fishing-related rubbish from the beaches, that is non-metallic and non-glass. As far as weight and volume would allow we would attempt to clear all types of rubbish, leaving behind the weightier pieces. The rubbish would be left in Longyearbyen for analysis by SALT, where possible, of its ultimate origin and date of entry into the oceans. These data will be used to try to stop entry of such rubbish into the oceans in the first place.

During 3rd and 6th August we managed to clear a total of 500 metres of beach front. The 500 metres was made up of two separate stretches close to each other, just south of the mouth of the main glacial river produced by Adolfbreen:

1. A 300 m long stretch southward from 79° 27’ 09.0” N, 13° 20’ 36.5” E, collected on 3rd August 2019 and yielding a total of about 25 kg of collected rubbish.
2. A 200 m long section southward from 79° 26’ 50.8” N, 13° 22’ 19.0” E, collected on 6th August 2019 and yielding a total of approximately 25 kg of collected rubbish.

These weights do not include the many heavy and bulky items, including a considerable number of large fishing nets, that had to be left because of lack of space on the return journey. We recorded the mesh sizes for many of these. The total combustible non-fishing element from the total 500 m weighed 22.7 kg. We made the following observations:

- Considering that the nearest permanent human habitation is the small settlement of Ny-Alesund, some 45 miles away over an ice cap as the crow flies and about four times that far by sea, this rubbish must have nearly all travelled a great distance by sea from other sources to reach these beaches.
- The rubbish is overwhelmingly plastic.
- There was a lot of plastic “banding”, used to secure items onto pallets etc. This could well be fishing-related, but this is by no means certain. Much of this banding was of sufficient age to have become very brittle and to literally fall apart in our hands. We assume that this indicates that it had been in the sea/on the beach for a considerable time.
- A balloon which formed part of a McDonald’s “Minions” Happy Meal was found. From basic research on when they ran this promotion, this would seem to have entered the ocean in 2017, exact point of entry unknown.

The rubbish was sorted into labelled, sealed heavy-duty rubble bags as non-fishing combustibles, fishing combustibles and metals plus glass and transported by boat back to Longyearbyen. The non-fishing combustible items were left in a container on the quay at Longyearbyen at Bykaia by SALT for our and other collaborators’ rubbish. The rest was disposed of into the yellow municipal rubbish container next to it.

Drone video footage of the beaches prior to clean up was acquired to aid SALT with their interpretation of the data, which is ongoing and which we should have early in 2020.

Steve Staley

6(g) Drone

Introduction

The objectives of using a small Unmanned Aircraft System (sUAS)* or ‘drone’ on this expedition were to have practical experience of this rapidly developing technology and evaluate the potential of using drones to extend research inputs and evaluate operational issues in the High Arctic.

Low cost, high quality aerial imagery provided by drones is revolutionising filming and surveying and being increasingly used across multiple applications, notably including search and rescue operations, sports videography and asset management. The ability to have remotely controlled aerial imagery that is instantly visible by the operator, is recordable and can even be linked to be viewed in real time anywhere, is incredibly powerful.

The key attribute that the drone provides of being able to transmit images back to the operator in the delicate and vulnerable Arctic wilderness, means that the drone can effectively reduce the need for researchers to visit an area of study and thus their impact on the environment.

Our expectations therefore for the inputs of the drone to the research projects were that the video imagery would allow additional visual data to be collected, thanks to being able to locate the images using the GPS position data captured by the drone. In addition, the drone would be able to provide remote video imagery reconnaissance and thereby reduce the amount of travel time required to select research areas or routes.

Dimensions

The overall weight of the DJI Mavic Pro drone and equipment carried all in the padded case are a total of just 3.5kg. The dimensions of the padded case are 22cm x 32cm x 13cm.
The weight of the laptop and charging adapter was 1.8kg and dimensions of the laptop are 22cm x 32cm x 2cm.

DJI Mavic Pro
image ©William Shaw

Regulatory restrictions

Flying drones outside the prohibition zones around the settlements requires familiarisation with the local rules of drone flying. The most important can be found at: https://www.sysselmannen.no/en/drones-on-svalbard/

Operation in the field

For flying operations, the drone, a mini iPad and auxiliary equipment were carried in the padded case weighing just 2.8kg including our batteries and without the intelligent charging hub and transformer.
The drone is operated via the DJI GO App using the Apple mini iPad. The same operating App can be used with an Apple iPhone and the flight controller can be used with either the mini iPad or the iPhone. The advantage and therefore choice of using the mini iPad over the iPhone is solely due to a larger screen size of the mini iPad providing a larger view of the imagery being captured by the drone and the in-flight information provided on the screen. An iPhone was available as back up for the mini iPad.

Light gloves with touch screen fingertip pads provided some protection from the cold during flying and these worked well. Even in the challenging terrain, it was always possible to find a suitable take off location as the drone required less than one square metre of clear, nearly flat, space. In flight, the drone had one operational issue where imagery on the controller screen became unstable and the drone was flown back to home, closed down, restarted and this solved the issue.

Battery life of the Mavic Pro batteries allows approximately 15-20 minutes flight time per battery depending on conditions, flight speeds and flight plan. While the battery life did of course limit the amount of flying time possible, with four batteries available, flying time was carefully considered and controlled for the purposes of capturing the imagery for the projects.

The laptop computer was used to provide memory storage of the drone imagery and to facilitate review of the imagery on a larger screen. Editing images could have been carried out on the laptop computer, Apple mini iPad or even the I Phone with an operator experienced in video editing. The video captured has been retained in its' original recording. The captured imagery was also backed up on a rugged memory device, though after return to the UK this device has failed.

Project inputs

Plastic pollution – video of the areas of beach that were cleared of visible plastic pollution.
Plant ecology – video of study areas for the gas sampling to allow extrapolation of the outputs from the physical research to more of the study area.
Geology – video of the thermal springs and the sampling process; reconnaissance search for the location of the thermal springs.
Meteorites – reconnaissance search for suitable study sites and accessibility routes to potential search areas.
Filming – video of expedition activities.

Weather considerations

The drone should only be flown in dry weather and with wind speeds that are within the operational limits of the drone. Dry weather is required for two main reasons: the electric motors of the drone are open to atmosphere and therefore moisture will affect their operation and the imagery will likely be affected by moisture on the camera lens. The operating software includes ample warnings for the wind speed limits of operation.

The weather conditions experienced during the expedition provided ample opportunities to fly the drone and capture imagery for the projects. There were occasional periods when increased wind speeds or high humidity meant that flying was not recommended.

Environmental concerns

Previous experience of High Arctic environments provided a keen awareness of the potential impacts of fine dust and low temperatures on delicate electronic and battery-operated technical equipment. The precautions taken for the drone included having motor dust-caps for the drone which could be fitted if necessary. With the use of the carrying case, it was not found necessary to use the dust caps. The temperatures experienced during the expedition meant that freezing temperatures affecting battery life and equipment operation were not experienced.

Battery charging

Investigation prior to the expedition into the use of solar panels or wind vane generators to provide recharging of the drone batteries was unsuccessful in discovering a suitable and affordable solution.
Battery charging was therefore facilitated using the Honda generator.
Drone flights were usually terminated following warnings from the software of the App notifying the operator that the battery had sufficient charge remaining to return to the take-off location.

Lessons learned

Preparations – The drone had more than sufficient capability to deliver imagery that should readily be used in the ways expected. The utilisation of the imagery captured is yet to be attempted and therefore there is a potential that the process may not deliver the desired outputs. The preparation work should have included full practice of the process to the output stage.

Operator skills - The benefits of the drone could have been much further exploited and extended than they were and this was limited by the low level of skill and experience of the operator. The capabilities of the drone were not therefore fully utilised and this is a key lesson to ensure that the operator has the necessary skills and experience to deliver the maximum outputs.

Filming – it is necessary to allow time within the programme of work and resources to carry out the filming process. This can also include multiple repetitions of the flights being made in order to achieve the desired outputs.

Inexperience – there was reluctance to deplete the batteries and require additional running of the generator for battery charging and this resulted in less use of the drone than was possible. Improved planning and objective setting from experience would have delivered more flights and therefore more output from the drone.

Regulation limitations – the regulations are restrictive in requiring the drone to remain in visual range from the operator location. To fully benefit from the feasible range of the drone in extending the research areas and delivering the reconnaissance capabilities, it would be necessary to fly well beyond unaided and even aided visual range.

Mike Haynes

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APPENDIX 1 - EQUIPMENT AND FOOD

	Barrel 1
50m 9mm Kernmantle rope	1
25m 9mm Kernmantle rope	1
Climbing harness with leg loops	3
60ml empty sample bottles	20
Clipboard	2
Aquafilter Pump	1
Smash potato 280g (9 servings each)	5
First Aid Kit (see list below)	1
1kg Couscous	1
Sardines in tomato sauce	8
Sardines in vegetable oil	8
Stacking billies set of 3	1
Warthog - ice screws	8
Drive in ice screws	2
Carabiner	1
Redline sleeping bag & stuffsac (Henry Staley)	1
Weight	**21.4kg**
First Aid Kit - detailed list	
1 dry bag	
1 empty resealable plastic bag for rubbish	
1 pencil	
1 paper A4	
1 scissors	
1sterile unmedicated wound dressing 12x12cm	
5 pairs surgical gloves	
6 Melolin 5x5cm dressing (grazes minor burns)	
2 As above 9x10cm	
2 Pre-injection swabs	
6 safety pins	
1 pack of 4 expandable trauma treatment bandages	
2 low adherent absorbent dressing 10x10cm	
1 extra large unmedicated dressing28x17cm	
2 10cm conforming bandages	
3 triangular bandages	
1 sterile wound dressing pad 7.5x10cm	
1 pair tweezers	
1 sterile no.16 eye pad	
3 20ml saline steripoules	
1 chest seal	
1 plastic finger/toe sling	
8 200mg ibuprofen tablets	
8 500mg paracetamol tablets	
1 instant icepack	
2 antiseptic wipes	
1 gel blister pad	
40 assorted sized plasters	
1 pack x6 Imodium capsules (anti-diahroea)	
1 pack Ceclor antibiotic tablets (750mg, 10 tablets)	
1 Celox Rapid anti-bleed gauze	
1 Tourni-Key Plus	
Plus, outside the kit:	
1 SAM mouldable splint	

	Barrel 2
Twix bars	32
Kit Kat	24
Cock Soup mix 250g	1
Milk powder 340g	6
Almonds sachet 45g	30
Peanut sachet 45g	10
Cashew sachet 45g	10
Almonds 1.13kg	1
Dried blueberries 567g	1
Marmite 600g	1
Azera coffee powder 100g	2
Breakfast biscuits 12 pack	2
Grinola cereal 400g	2
Digestive biscuits 400g	4
Ginger biscuits 250g	2
Rich Tea biscuits 300g	2
Hobnobs 300g	2
Tartlets 135g	6
Peanut butter 340g	1
Alpen Muesli 1.1kg (Day 1)	1
Weight	**20.9kg**

	Barrel 3
Summit to Eat dehydrated meals (variety	71
Pulled pork Turmak Meal	1
Thai curry Turmak Meal	1
Instant custard 3 pack	3
AA batteries (disposable)	40
Tinned sardines	12
Tinned John West sardines	12
Tinned Spam	6
Weight	**22.6 kg**

	Barrel 4
rubble sacks (15 bags each)	3
tea bags (240 bags each)	2
choco almonds jar 1.2kg	1
choco raisins jar 1.1kg	1
marathons	32
mars bars	32
biscuits (4 digestive, 2 hobnob)	6
soreen malt loaf (4 loaves)	3
goldenberry dehydrated fruit	1
water bladder (Dan)	1
waterproof coat (Dan)	1
waterproof trousers (Dan)	1
down jacket (Dan)	1
Cooker (Dan)	1
mug (Dan)	1
weight	**22 kg**

	Barrel 5
Tinned spam	6
Tinned corned beef	12
Tinned mackerel	5
oat so simple	50
Tinned tuna	15
rubble sacks (5 bags)	1
4 seasons seasoning (400g)	1
hot chocolate powder (450g)	1
polos (34g each)	32
Sleeping bag (Stat)	1
weight	**21 kg**

	Barrel 6
Dairy milk choc bars	22
Sultanas (2kg)	1
Thermos flask (Stat)	1
Assorted nuts packs _ Kirkland	30
Weetabix (48 bars)	2
Belvita (12 bars)	2
Kirkland granola bars	60
Alpen 1kg	1
Wheat crackers pack	2
Oatcakes pack	2
Dried noodles packs	12
Jam	2
Honey	3
Fruit drink additives	7
weight	**21.5 kg**

	Barrel 7
Big Cadburys choco bars	2
Pair of boots (Dan)	1
Climbing harness (Dan)	1
ice screw	2
slings	4
prussic loop	2
screw gate	9
Natures Valley bars	40
Azera coffee 100g tin	4
Welch's fruit snacks pack	79
Minestrone soup	4
Tomato + vegetable	4
Chicken + vegtable	4
Heavenly Delight pudding mix	24
Butterscotch	3
Srawberry	3
Chocolate	3
reoasted veg couscous	3
sundried tomota + garlic couscous	3
Simnel cake	1
Flapjack box	2
Sausages pack of 12	3
Dried soy bags	3
Weight	**26 kg**

	Barrel 8	120L
Ice Axe	1	
Ice axe hammer (Ian)	1	
Tarpaulin Direct groundsheet	1	
Ascendeurs with leg loops	1	
4 way 3 pin adapter with 2m cable	1	
Pair of mess tins	1	
Roll of Duck Tape	1	
Rubber gloves pairs	3	
Fire lighter	1	
Primus spanner	1	
Tin opener	1	
Buffalo fleece lined sleeping bag (William Shaw)	1	
Extension cable 20m	1	
Generator (Dry) in two plastic bags	1	
Karrimat (Mike)	1	
Walking pole (Mike)	1	
Union Flag	1	
Canal Trust banner	1	
Cellox Rapid dressing	1	
Ceclor750mg packet	1	
Imodium packet	1	
First Aid Kit (See list below)	1	
40x 3.5mm screws, box of 200.	1	
Tournikey	1	
Sam Splint	2	
Crampons pair	2	
Weight	**38.4kg**	

Chris Searston	Black Stripe Barrel	
Toolkit		1
Metal Detector		1
20m of paracord		1
Primus 96 stove (dry)		1
Spare generator plug		1
Generator instructions		1
Trip wire alarms		6
Trip wirebrackets - set		1
Collapsible water carrier		1
Aluminum sections		20
Socket set		1
First Aid Kit (See list below)		1
Ice Axes		2
Crampons (pair)		2
Duck Tape roll		1
Walking pole (Mike)		1
Weight	22.6kg	

APPENDIX 2 – DENTAL PROJECT FORMS

UNIVERSITY OF LEEDS

Oral Hygiene Diary

Please fill this in daily following each oral hygiene routine.
Please use tallies to indicate number of times per day.
In the brushing duration row please state duration per brushing episode in that day.

Task	Day 1	2	3	4	5	6	7	8	9	10	11	12	13	14
Tooth Brushing (e.g. 1 times/day)														
Brushing duration (e.g. 1/2/3 mins)														
Cleaning between teeth (e.g. flossing/ Tepe)														
Mouthwash														

Oral hygiene habits in the Arctic Survey

About the questionnaire
Thank you for your interest in this questionnaire.
This questionnaire aims to explore background information about participants in this study. It also aims to identify specific challenges faced by participants in carrying out their oral hygiene routines whilst in the Arctic.
This survey has two parts; the first is multiple-choice questions about your background information and your oral health knowledge.
In the second part of the survey, there is space for you to write about any specific challenges you faced when carrying out your oral hygiene routine whilst in the Arctic.
Please read each question carefully and select your answer below. The questionnaire should take between 10-15 minutes.
All your answers are anonymous and we cannot link your answers with your personal identity.

Part 1
Introduction: About you

A) What is your age?
Under 18
18-24
25-34
35-44
45-54
55-64
65+

B) Please select your gender:
1) Male
2) Female
3) Other/ Prefer not to say

C) Please select your region:
- East Anglia
- East Midlands
- London
- North East
- North West
- South East
- South West
- West Midlands
- Yorkshire & Humberside

D) What is your highest level of education?
1) No education
2) Primary education (elementary school / left school at age 11-14)
3) Secondary school (left school after age 14 without qualification)
4) Pre-vocational / vocational education (GCSEs, Standard Grade, GNVQ Foundation & Intermediate, NVQ levels 1 and 2)
5) Pre-vocational / vocational education (GCSE A/AS levels, Higher Grade, CSYS, GNVQ Advanced, NVQ Level 3)
6) Vocational qualification (qualification in higher education)

7) University (Bachelor, Master and doctoral degree)
8) Prefer not to say

E) When did you last visit a dentist about your teeth, dentures or gums?
1) Less than 1 year ago
2) 1 to less than 2 years ago
3) 2 or more years ago
4) Never
5) I can't remember

F) What was the reason for your last visit to the dentist? **(Single choice)**
(1) For a routine check-up, examination or cleaning
(2) For emergency or urgent treatment,
(3) For other treatment (planned, non-emergency, non-urgent)?
(4) Some other reason
(5) Don't know / can't remember

G) If you need dental care, do you usually have access to a dentist? **(Single choice)**
1) Yes
2) No
3) I don't know

H) How do you pay for your dental care and treatment? **(Single choice)**
1) Partially by the NHS (you will pay £21.90 for a check-up/band 1 course of treatment)
2) Completely by the NHS (exempt from payment)
2) Completely by myself (private patient)
3) Private insurance scheme (e.g.- Denplan)
4) I don't know

Looking after your teeth
The following are questions or statements about looking after your teeth and gums. Please answer them as best you can. You may find some of these tricky so don't worry if you don't know the answer.

A.1. How often is it recommended you brush your teeth? **(Single choice)**
1.) Once a day
2) At least twice a day
3) Less than once a day
4) I don't think I need to
5) I don't know

A.2. When is the most important time to brush your teeth? **(Single choice)**
1) Before breakfast
2) After breakfast
3) After lunch
4) Last thing at night
5) After each meal
6) I don't know

A.3. What is the most important characteristic of toothpaste in preventing tooth decay? **(Single choice)**
1) Whitening
2) Fluoride
3) That it is abrasive (gritty)
4) Foam

5) I don't know

A.4. What amount of fluoride is recommended in toothpaste for adults? **(Single choice)**
1) Approximately 500 parts per million (PPM)
2) Approximately 1000 parts per million (PPM)
3) At least 1350 parts per million (PPM)
4) I don't know
5) It does not matter to me

A.5. After brushing my teeth with toothpaste I should spit the toothpaste out and….(complete the sentence) **(Single choice)**
1) Not rinse my mouth with water
2) Rinse my mouth with water
3) Rinse my mouth with mouthwash
4) I don't know

A.6. When is the best time to use a general everyday mouthwash? **(Single choice)**
1) Straight after brushing
2) Just before brushing
3) At a different time to brushing
4) Instead of brushing
5) I don't know

A.7. From the following options which is likely to be worst for your dental health? **(Single choice)**
1) Consuming sugary products at meal times only
2) Consuming one large amount of sugary product at one time in the day
3) A small amount of sugary products spread throughout the day
4) I don't know

A.8. My oral health could affect my general health **(Single choice)**
1) Agree
2) Disagree
3) I don't know

A.9. When should you start brushing a child's teeth? **(Single choice)**
1) When they are between one -two years old
2) When they are between two-four years old
3) As soon as teeth erupt in the mouth
4) Wait until the child can brush their own teeth
5) If they are in pain
6) I don't need to
7) I don't know

Part 2

What were the main challenges you faced when carrying out your oral hygiene routine in the Arctic?

Any other comments

THANK YOU
Thank you for completing this survey.

For more information about how to care for your teeth please click here (link: https://www.nhs.uk/live-well/healthy-body/take-care-of-your-teeth-and-gums/

University of Leeds Dental School Research

30.06.19

Centre Number:
Study Number: 200916094
Patient Identification Number for this trial:

CONSENT FORM

Title of project: A study exploring the challenges faced by individuals in maintaining their oral hygiene habits when their circumstances change.

Name of Researcher: Henry Staley

Please initial

box

1. I confirm I have read and understand the information sheet for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐

2. I understand that my participation is voluntary and that I am free to withdraw up until the point of data analysis without giving any reason, without my medical care or legal rights being affected. ☐

3. I understand that relevant sections of my data collected during the study may be looked at by individuals from Leeds Dental School, from regulatory authorities or from the NHS Trust, where it is relevant to my taking part in this research. I give permission for these individuals to have access to my records. ☐

4. I agree to take part in the above study. ☐

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Name of Participant	Date	Signature
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Name of Person taking consent	Date	Signature

ARG