Accident Report

Avalanche Accident

Fridtjovbreen – Marcussenfjellet

Spitsbergen, Svalbard

20. February 2020

ARCTIC SAFETY CENTRE
AT THE UNIVERSITY CENTRE IN SVALBARD

Contents

About the report

This report is an English translation of the accident report written in Norwegian, published in June 2020. The Norwegian-language accident report was published on the 1st of June 2020 on unis.no and varsom.no. The report is translated by S. Cohen, UNIS.

The report is written by a group of participants from the Arctic Safety Centre (UNIS), Longyearbyen Red Cross Avalanche Group, and local observers in the avalanche warning group – varsom.no. The purpose of the report is to draw lessons from this serious accident. This is done by describing facts about the accident, weather and snowpack history, terrain, and current avalanche problems from the days before and on the day of the accident. The report concludes with a summary of learning points related to snowmobile traffic.

NVE's template for accident reports in the event of avalanches is used as a template for this report.

Sources:
Inspection of the avalanche on the 21. and 29. February 2020.
(regobs.no/Registration/215644 and regobs.no/Registration/218217).

Interviews with rescue crews who participated in the operation.

Interviews with those involved in the avalanche accident.

Svalbardposten.no

Yr.no

Varsom.no

Maps: Norwegian Polar Institute, Topo Svalbard

Longyearbyen 23. November 2020

Martin Indreiten

Acting Operating Manager, Arctic Safety Centre

1 Facts about the incident

Deceased	2 deceased, 1 female and 1 male
Activity	Organized snowmobile trip with guide
Terrain	Runout zone under steep slope
Weak Layer	Persistent weak layer of faceted snow under a wind slab and a persistent weak layer of depth hoar at the ground
Terrain Trap	Dip in the terrain in the transition between the steep slope and the glacier
Rescue Equipment	Group had shovels and probes. No one had an avalanche beacon.
KAST class	The trip in its entirety can be classified as terrain class 1, but the location where the avalanche occurred together with the adjacent terrain can be classified as KAST class 3.

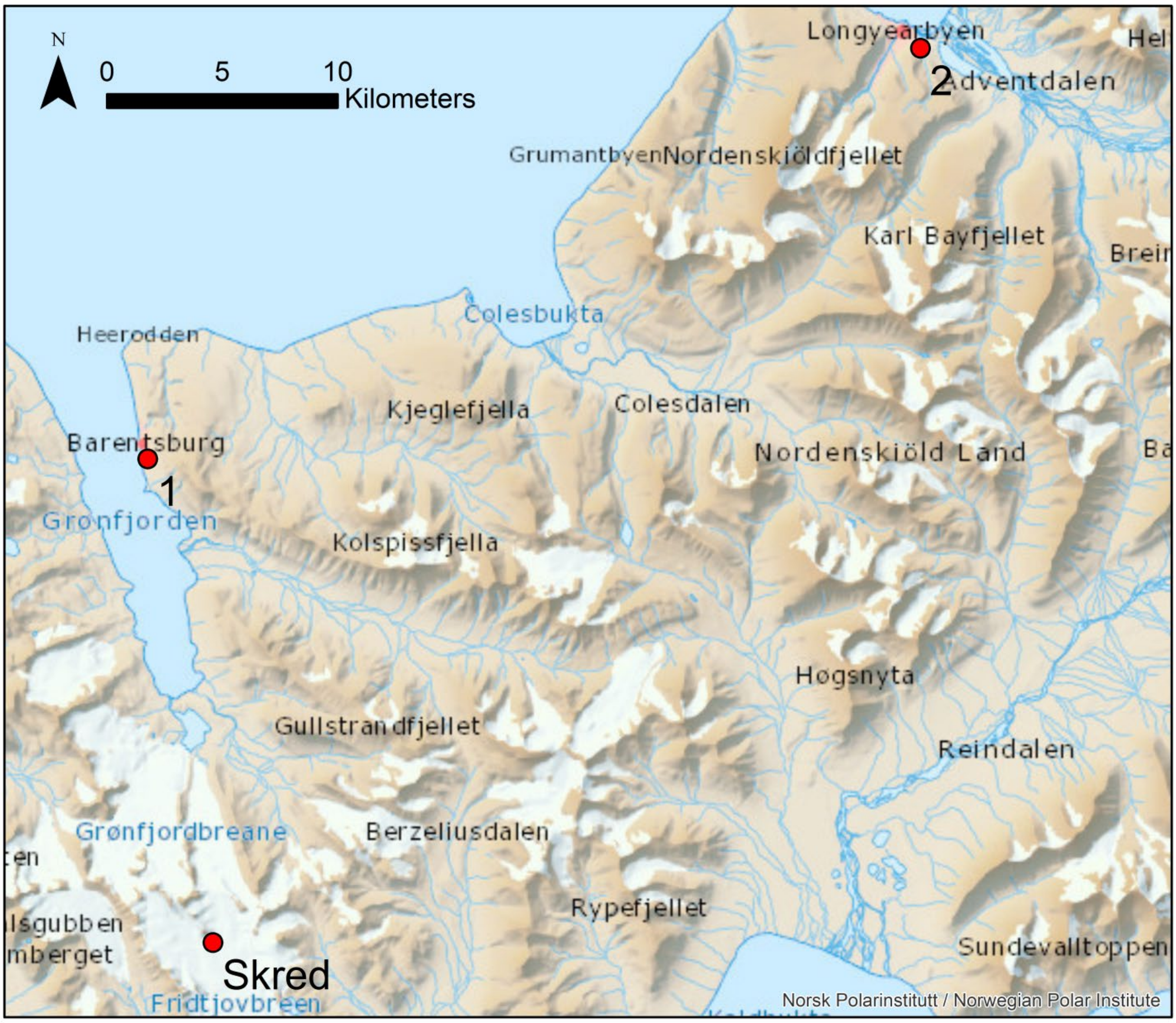


Figure 1: Avalanche position in relation to (1) Barentsburg where the trip started and (2) Longyearbyen where the organized rescue came from.

2 Sequence of Events

A snowmobile group with a local tour operator consisting of a total of seven people, five guests and two guides (all on individual snowmobiles) drove in the afternoon on 20.02.2020 from the Russian settlement of Barentsburg (figure 1). The destination for the trip was the glacier front of the Fridtjov glacier. Along the way, the group took a detour from the main route to look at an ice cave/ice formation by a meltwater channel on the Fridtjov glacier. The route that was followed by the group goes through different types of terrain, mainly driving on land and glaciers. The route that was followed over the glacier can be described as the normal route that several snowmobile trips follow during the season (figure 2). The ice cave that the group stopped at is an added attraction on the trip, but not the main destination. The cave is part of the meltwater channels along Marcussenfjellet. To get to the ice cave, the snowmobile group drove towards the mountainside and down into a depression to park the snowmobiles at the entrance to the cave. The terrain in which they parked is the runout area under a steep slope facing south-east (SE). The three first snowmobiles in the group were about to park and stood still, while the rest of the group followed behind and were in motion when the avalanche started from the steep slope above them. When the avalanche stopped, two people were completely buried, two people were partially buried, and three people were untouched by the avalanche. The two people who were completely buried died.

3 Rescue

3.1 Companion rescue and warning

No one in the group had an avalanche beacon. The two guides had a shovel and probe each and the others in the group had shovels on their snowmobiles. There is no cell phone coverage in the area. The accident was notified by text message via InReach to the company's office in Barentsburg. They then notified the Governor of Longyearbyen. The group had a satellite phone that was stored on one of the snowmobiles but was inaccessible when the snowmobile was buried in the avalanche. The InReach was available because it was kept on the body of one of the guides who was not taken in the avalanche. One of the people who was partially buried managed to free himself from the avalanche debris. The other person was excavated by the group, this person had body parts visible on the surface. The two dead people were found using a probe by the others in the group and excavated. Lifesaving first aid was initiated on the spot. Both dead people were found near the snowmobiles. The dead were found at a depth of 0.5 meters and 2 meters, respectively. The dead had been buried between 20 minutes (buried at 0.5 m) and one hour (buried at 2 m) before they were exhumed.

3.2 Organized rescue

The avalanche is in a direct line approximately 50 km from Longyearbyen where rescue resources on Svalbard are stationed. Notification to the Governor (Police) came just before 1500. A helicopter was sent out with a doctor, police, rescue personnel and an avalanche dog. At the same time, snowmobile patrols form the Red Cross and the Governor were organized to get to the avalanche. The helicopter could not land at the avalanche due to impaired visibility in the area by the Fridtjov glacier. Instead they landed in the area Bretjørna, north of Vestre Grønnfjordbreen (approximately 10km from the avalanche site). The rescue personnel from the helicopter were then transported in by snowmobiles coming from Barentsburg. The rescue personnel arrived at the avalanche around 17.00, about two hours after notification, all avalanche victims were then accounted for and excavated. The victims were declared dead by a doctor on arrival at the avalanche site. The snowmobile patrol from Longyearbyen then arrived in the middle of Vestre Grønnfjordbreen and was notified to return to Longyearbyen when the operation ended.

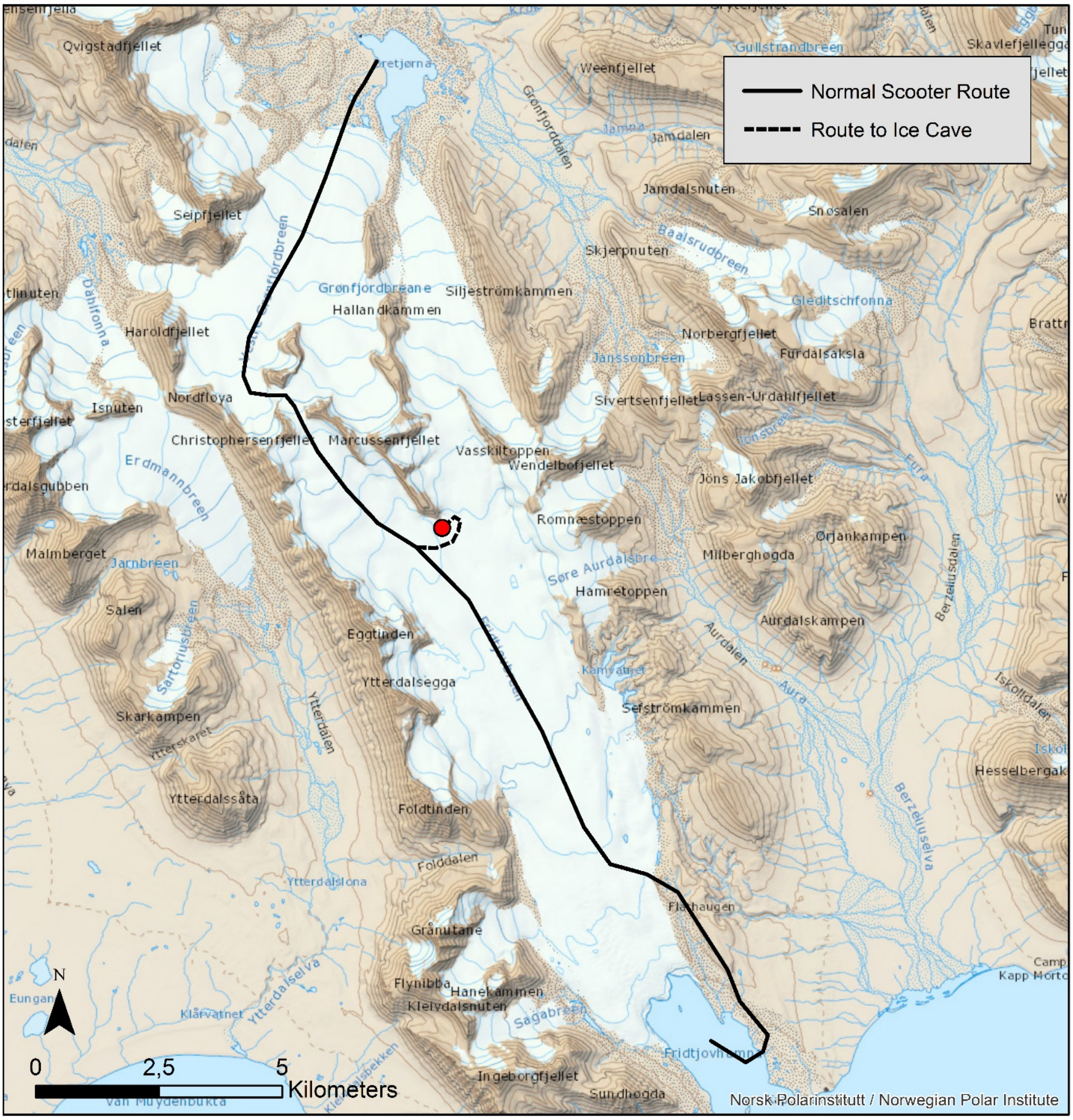


Figure 2: The black line marks the normal route to follow when driving on Vestre Grønnfjordbreen and Fridtjovbreen. The position of the avalanche is marked with a red dot. The dashed line indicates the route that the group drove towards where the avalanche occurred. The purpose of the detour was to look at an ice cave / formation at the foot of the mountain.

4 Weather

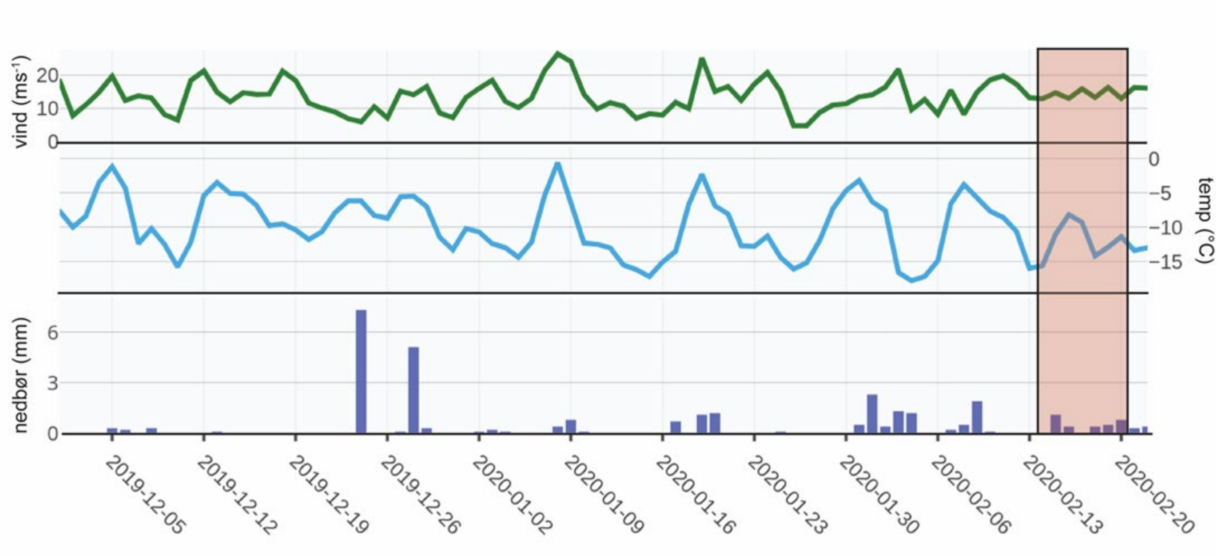


Figure 3: Precipitation, temperature and wind during the period from December 2019 to 20th February 2020. Measurements from the weather station at Isfjord Radio, 25 km north west from the avalanche. (Graphic: H. Hancock, UNIS).

Low temperatures and relatively little precipitation characterized the fall and winter up to and including February on Svalbard. Measurements at Isfjord Radio, which is 25 km northwest of the avalanche area, show temperatures well below zero during this period (figure 3). Corresponding weather conditions were also experienced in the area around Longyearbyen and Nordenskiöld Land which has a daily avalanche forecast from NVE.

In the week before the accident, approximately 30 cm of fresh snow fell in the Grønfjordbreen area (west of Nordenskiöld Land, figure 5). Between the snowfall and the day of the avalanche, there have been several periods of strong winds from the northeast and west-northwest. On the evening of 16.02.2020, observations from Isfjord Radio show that the wind picks up and shifts from east to north-northeast direction. It can be assumed that the same was true for the Fridtjovbreen area. The wind calmed down in the morning of 18.02.2020 before shifting to west-northwest and increasing in the afternoon. The measurements show that there has been a strong wind mainly from the west-northwest in the last 48 hours prior to the time of the avalanche.

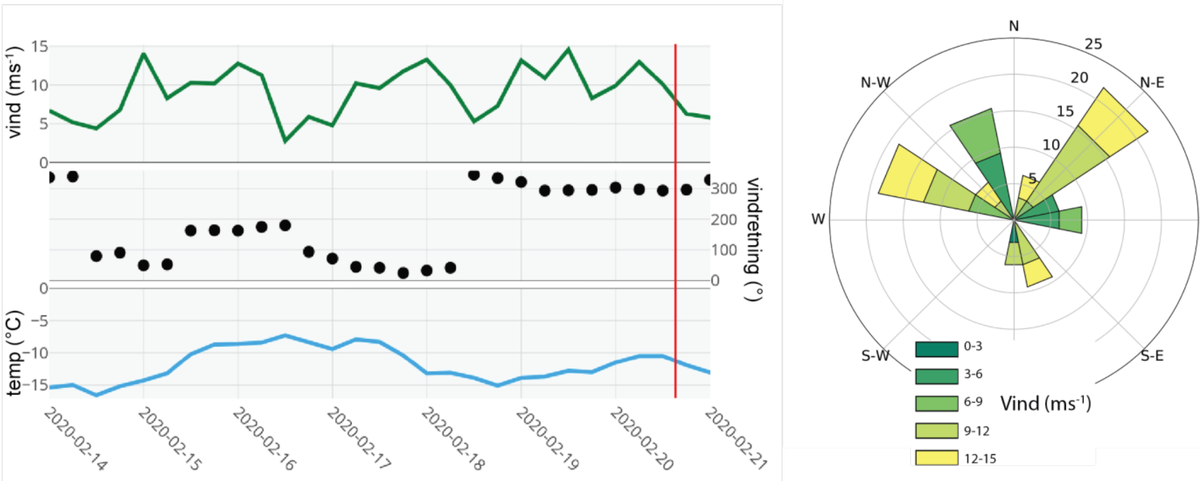


Figure 4: Observations from Isfjord Radio for the week leading up to the avalanche. Measurements are at 6 hour intervals. The red line indicates approximately the time when the avalanche occurred. (Graphic: H. Hancock, UNIS).

5 Snowpack and avalanche warning

The area where the avalanche occurred is west of the border from the forecasting region Nordenskiöld Land, which has daily forecasts on varsom.no (forecast with the details for the day of the accident, see appendix 1):

> *"Until 20 February, the snow cover within the region varies, but in general there is less snow than normal. Prolonged cold and little precipitation means that some cold hard snow is moved around by the wind. For example, in the mountainside there will generally be little or no snow, while gullies / depressions /sheltered areas can have relatively large amounts of snow. Areas where snow accumulates are often terrain traps.*
>
> *Persistent weak layers in the snowpack have been observed in several places. How easy it is to influence these layers varies in the region, but it requires a large additional load. In some places, however, it may be possible for a snowmobile driver or skier to affect the layer when the wind slab is soft / thin.*
>
> *Strong wind from the west 19.02."*
>
> *(https://www.varsom.no/snoskredvarsling/varsel/Nordenski%C3%B6ld%20Land/2020-02-20)*

Snow conditions and avalanche problems are associated with prolonged cold and a thin snow cover through December, January, and February. This has resulted in a high temperature gradient in the snowpack, which in turn has led to the development of several faceted layers. Persistent weak layers present an avalanche problem in the avalanche warning for Nordenskiöld Land throughout most of January and February 2020.

Figure 5: Photo taken on 16 February in the evening 2-3 km from the avalanche location in the pass at Marcussenfjellet on Fridtjovbreen. Approximately 30 cm of loose unbound snow on the glacier (Photo: Sara M. Cohen).

Information from a group that was on a snowmobile trip on Fridtjovbreen on 16 February shows that there was around 30 cm of fresh snow in the area (figure 5). They describe that there was more snow in the west of the region than in the vicinity around Longyearbyen. This fresh snow was taken by the wind over the next few days, and wind slabs built up on most slopes with east-south-west aspects due to changing wind directions and a lot of snow available for transport. The largest accumulation of snow onto the lee side slopes seems to have been in the 48 hours before the accident.

The danger level was at danger level 2 in the days before and on the day of the accident. Danger level 2 indicates moderate danger level for the Nordenskiöld Land forecast region.

Two avalanche problems were prevalent in the region these days:

- Wind slabs, poor bonding between layers in the wind slabs. Applicable for slopes with northerly aspects via east to south.
- Persistent weak layer, faceted snow at the base. Applicable to all slope aspects.
- In the days before the avalanche, a persistent weak layer of faceted grains over the crust layer had been reported in all aspects

Avalanche assessment for Thursday 20.02:

"Updated notice, Thursday 20.02 at 10:00: Strong winds from the NW will create unstable wind slabs in lee areas which are often separate from areas with crust and little snow. Recent wind transported snow will settle in lee side formations where it will be natural to travel by snowmobile and ski. These can often be terrain traps and a good safety margin is encouraged. Cold temperatures mean that wind transported snow will stabilize slowly. Be aware of persistent weak layers in the snowpack. The weak layer can locally be high up in the snowpack and be possible to influence where the wind slab is soft / thin, but there probably needs to be a high additional load." Source:

https://www.varsom.no/snoskredvarsling/varsel/Nordenski%C3%B6ld%20Land/2020-02-2

The snowmobile patrol that traveled out to the avalanche on 20 February came to Vestre Grønfjordbreen, approximately 5 km from the avalanche. Before returning, they took a snow profile on the glacier. In the area, danger signs were observed as fresh wind transported snow and there was a clear "whumph" in the snow as one got off the snowmobiles. The profile showed a clear layering in fresh wind slabs, over newly forming faceted snow, 0. 7mm, which was on top of very hard and old wind slabs. (regobs.no/Registration/215492)

The conditions on the glacier as the snowmobile patrol turned around are described by the crew as: good horizontal visibility in the area, no ongoing snow drift or significant precipitation and wind from the west-northwest direction.

Snow profiles taken at the avalanche the next day (21 February) and nine days after (29 February) show wind slab over faceted snow lying on a thin crust layer and facets at the base (figure 6 and figure 7).

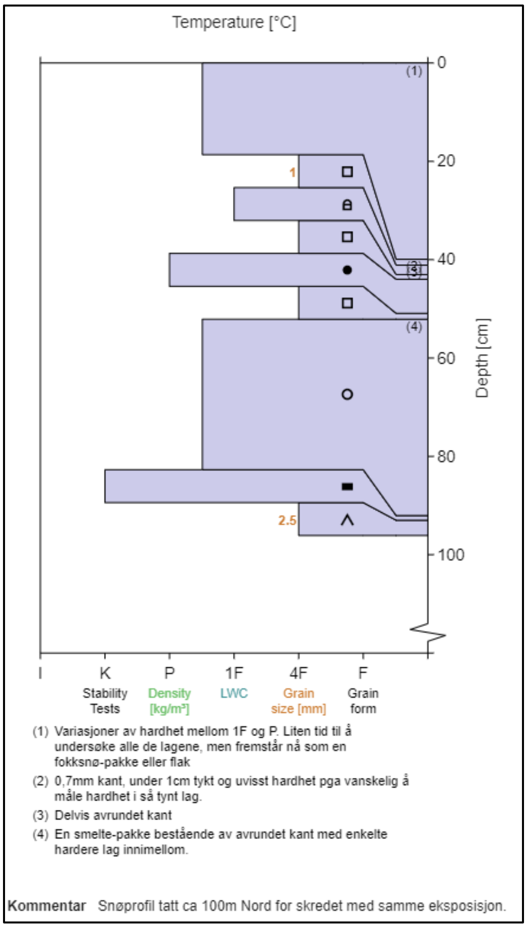
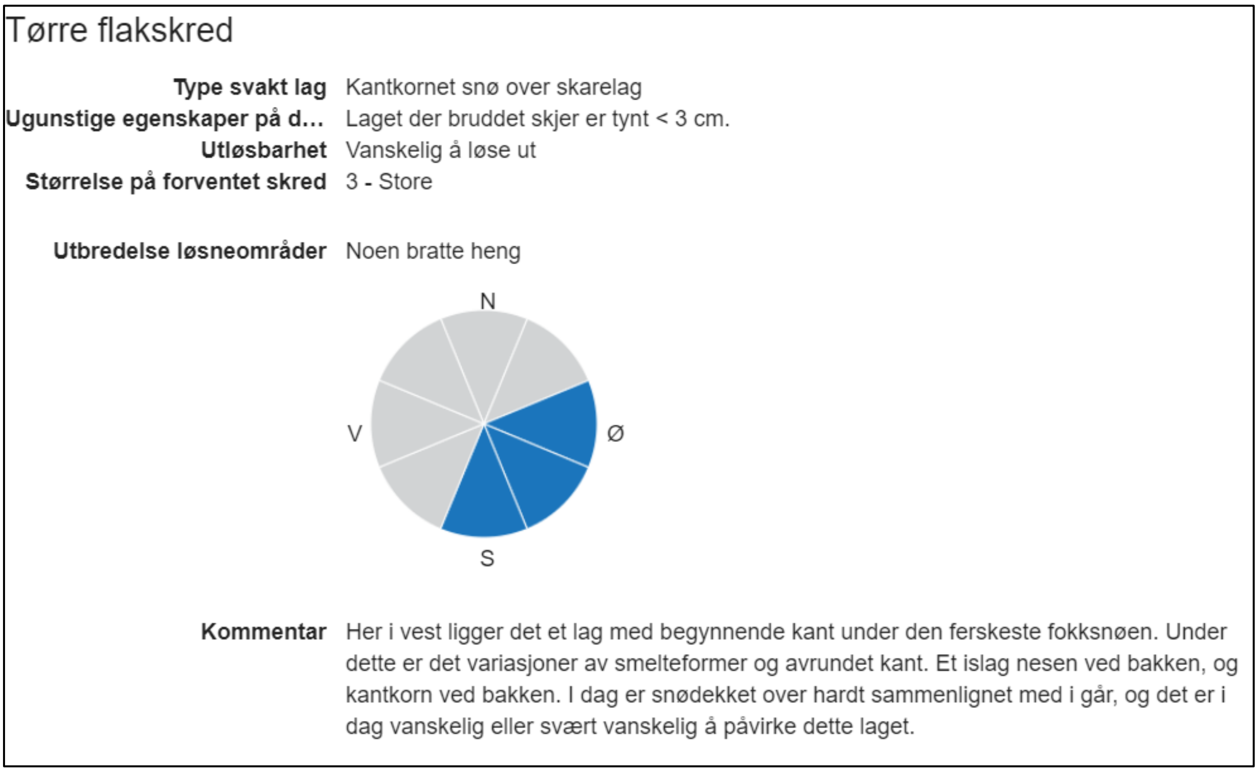


Figure 6: Snow profile taken on 21 February next to the avalanche in the same aspect. The profile shows a wind slab lying over a faceted layer over crust. At the ground there is depth hoar. (regobs.no/Registration/215644).


Tørre flakskred

Type svakt lag Kantkornet snø over skarelag
Ugunstige egenskaper på d… Laget der bruddet skjer er tynt < 3 cm.
Utløsbarhet Vanskelig å løse ut
Størrelse på forventet skred 3 - Store

Utbredelse løsneområder Noen bratte heng

Kommentar Her i vest ligger det et lag med begynnende kant under den ferskeste fokksnøen. Under dette er det variasjoner av smelteformer og avrundet kant. Et islag nesen ved bakken, og kantkorn ved bakken. I dag er snødekket over hardt sammenlignet med i går, og det er i dag vanskelig eller svært vanskelig å påvirke dette laget.

Figure 7: The avalanche problem with faceted grains as described on 21 February, the day after the avalanche. Observation made next to the avalanche in the same aspect. (regobs.no/Registration/215644.

6 Avalanche and terrain

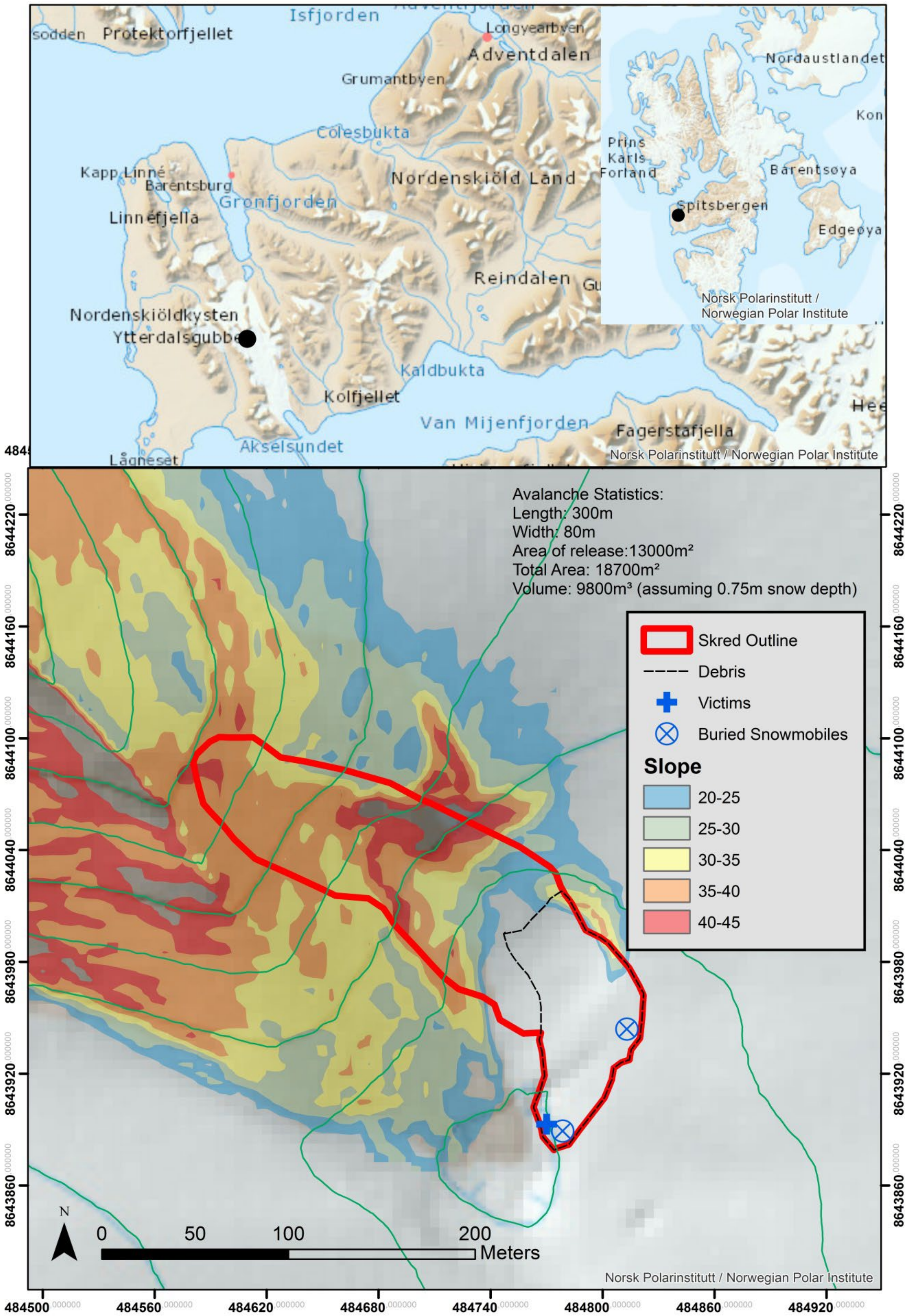


Figure 8: The outline of the avalanche (red line) and the avalanche debris (black line) drawn onto a steepness map. Area of avalanche debris is measured with a GPS, outline of the avalanche path is calculated based on inspection, photos and maps. (Graphic: Sara M. Cohen, UNIS).

6.1 Description of the avalanche

The avalanche was a dry slab avalanche of size 3 – large. It went from about 500 masl with aspect to the southeast and stopped at 450 masl in a depression on the glacier. The fracture is estimated to be between 0.5 meters and 2 meters tall (figure 9). The avalanche has a length of 300 meters from the crown to the avalanche runout. Because of the terrain formation with an abrupt transition between the mountain and glacier, the runout makes a turn to the southwest. The release area is estimated to have an area of 13.000 m² and the avalanche mass has an estimated volume of just under 10.000 m³ (figure 8). The blocks in the avalanche debris were mainly between 0.5-1 m³ with some blocks up to 2 m³. Due to the terrain, there has been a build-up of avalanche debris towards the east, somewhat smaller avalanche debris towards the avalanche runout where the two dead were found.

Figure 9: Photo taken the day after the accident. In the foreground you can see some of the snowmobiles that were partially covered by the avalanche. The crown is at most estimated at 2 m to the north and between 0.5-1 m to the east. The avalanche has gone all the way to the base in most of the avalanche path. (Photo: Sysselmannen of Svalbard).

Observations from the area and investigations of the snowpack show several avalanche problems. On the day of the avalanche there was most likely poor bonding between layers in the fresh wind slabs. A profile taken the day after the avalanche (figure 6) shows that there were two persistent weak layers of facets in the snowpack, one towards the base and one above a crust layer higher up in the snowpack which was covered by a fresh wind slab. Faceted grains are a persistent weak layer that can cause fracture propagation over large distances. Remote release of avalanches by loading the snowpack in the valley bottom will be possible when such layers are present in the snowpack.

It can be assumed that the wind slabs formed the days before the accident has added additional load to the facets in the snowpack in the slope. The wind slabs have most likely formed a continuous layer from the base of the mountainside and up into the slope. The large additional load from the snowmobiles that drove close to the mountainside further loaded the snowpack, so that one or more of the weak layers collapsed.

The avalanche had several step-downs and appears to have occurred both on facets over the crust layer and on facets at the base (figure 9).

Based on this, it appears most likely that the group has triggered the avalanche remotely when they drove under the mountainside and into the runout area.

6.2 Terrain

The terrain is a glacier with mountains on both east and west sides of the glacier. The terrain is open and clear. The group and the avalanche victims were hit by the avalanche in the runout area.

The release area is a steep slope between 35-40 degrees with southeast (SE) aspect. The avalanche path has a dip shape (from west to east) with a gully formation in the middle and the terrain is steepest in the middle of the avalanche path. The runout area has an abrupt transition from steep to flat terrain and a depression between the mountain and glacier. The avalanche debris have gone all the way to the base of the mountainside. The depression below the mountainside can be described as a small dip or valley (meltwater channel between mountain and glacier) and is lower in the terrain than the surrounding glacier. The dip is 15 degrees from east to west towards the open meltwater channel / ice cave in the glacier. The runout area can be described as a terrain trap, as there is an abrupt transition from steep to less steep terrain and will result in a collection of avalanche debris in the terrain (figure 10).

The general terrain for the trip can be described as KAST class 1 – simple terrain (https://www.varsom.no/snoskredskolen/skredterreng/kast-klassifisering-av-snoskredterreng/kast-terrengklasser/). The local terrain where the avalanche took place can be described as KAST class 3- complex terrain. The track follows close to the mountainside, one drives in runout zones, under large release areas with steepness above 35 degrees and in terrain traps. You are exposed and travel in avalanche terrain. Navigation on glaciers becomes difficult if you do not have visibility and can assess the distance from the mountainside.

Figure 10: Drone image from 29 February, taken south and overlooking the avalanche path from the release area. To the right is the ice cave. Crosses indicate where the dead were exhumed. (Drone photo: Kjetil Slettnes).

7 Learning points

7.1 Traffic in avalanche prone terrain with a snowmobile

When traveling by snowmobile, one covers large areas in a short time and moves quickly between different types of terrain. It requires a continuous assessment of the terrain and snow conditions. This requires good visibility in the terrain and to the mountainsides. Checking avalanche warnings and trip planning where one checks if the trip is in or near avalanche terrain will be good preparations.

When driving in valleys and glaciers, the plan may be to keep a distance to avalanche terrain, but due to poor visibility, incorrect navigation or passing a single point in the terrain, one can get close to runout areas or drive close or up to steep slopes. When driving a snowmobile, one will often search for terrain that has good snow conditions such as river valleys, as such formations collect a lot of snow and it will often make it easy to drive a snowmobile there. One must remember that these are terrain traps where the consequences of an avalanche can be great.

A trip that is not initially planned in avalanche terrain can then quickly change to travel in avalanche terrain. When driving a snowmobile special attention should be paid when the avalanche problem indicates that it is possible to remotely trigger an avalanche. This is typical when you have a persistent weak layer in the snowpack and / or continuous wind slabs from the valley base and up a steep slope. Loose snow in the terrain has been moved by wind creates wind slabs on the slopes. Fresh slabs will be easier to release than older ones. The slabs can be soft so that it easy to affect weak layers underneath, and fresh slabs can also have greater stresses than older ones. Keep a distance to runout zones and avoid traffic or staying in terrain traps and remember that traffic with a snowmobile always gives a large additional load on the snowpack.

7.2 Companion rescue equipment

When traveling on a snowmobile all participants should be equipped with companion rescue equipment (transmitter/receiver, shovel and probe), and have training in how to use this equipment. One moves fast and is exposed to many types of terrain during a trip. Incorrect navigation or poor visibility can lead to driving into runout areas or under steep slopes. Experience shows that when organized rescue arrives, the chance of survival has dropped dramatically due to the time it takes for rescue resources to reach the accident site. Time is of the essence, and companion rescue is the best chance of survival if buried. This is ever more important when one is far away from rescue resources and outside mobile coverage, so that quick notification is made more difficult.

7.3 Communication equipment

When travelling outside of mobile coverage on Svalbard, it is strongly recommended to have communication equipment that transmits via satellite, so that you can report accidents without unnecessary loss of time. General recommendation is a satellite telephone and emergency beacon transmitter. Garmin Inreach can also be used, but it has limitations in that one can only send text messages, but it allows one to get a position to the recipient. Accident notifications should be made directly to rescue resources to avoid misunderstandings and loss of time.

7.4 Little snow and moderate avalanche danger

Most avalanche accidents occur at danger level 2 (moderate) and danger level 3 (significant). The number says nothing about avalanche problems and where to find them. The accident occurred outside of the region, which has a daily warning, but the avalanche warning gives an indication of avalanche problems that probably apply in areas close to the region. Everyone who travels on a trip can register and contribute with observations of snow conditions in the areas they travel (www.varsom.no). In turn this will contribute to better avalanche warnings with a better description of variations in the region.

Up to the day of the accident, the snow season in Nordenskiöld Land had been characterized by a winter with little snow and long periods of cold temperatures. This means that there are local variations in how much snow lies in different valleys and glaciers. With generally little snow in the terrain, one must remember that single slopes can have a lot of snow and conditions are very local.

The week before the accident, there had been some fresh snow and there was up to 30 cm of loose snow on the glacier in the area. There were strong winds from the north in the days before the accident, loading snow onto slopes with southerly aspects. Strong winds are avalanche builders, and when observing such conditions, one should be extra careful. When driving in terrain traps or runout areas, one must make sure they have visibility towards release areas, so that it is possible to make an assessment of the surrounding terrain. When the avalanche problem indicates that it is possible to trigger avalanches remotely, one should avoid traveling in runout areas and avoid traveling through and stopping in terrain traps.

Appendix 1. Avalanche warning 20 February

(https://www.varsom.no/en/avalanche-bulletins/forecast/Nordenski%C3%B6ld%20Land/2020-02-20)

Highest danger level per day:

2	2	2	2	2	2	2	2	2	2	2	2	2
10.02	11.02	12.02	13.02	14.02	15.02	16.02	17.02	18.02	19.02	20.02	21.02	22.02

2 Moderate

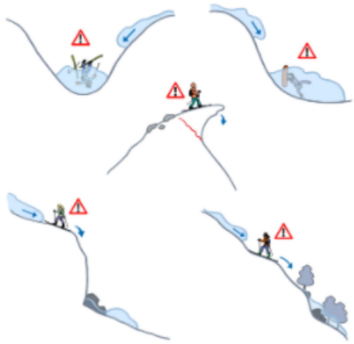
Published: 2020-02-20 10:20 AM

Be careful in areas with fresh windslabs, they are often present in terrain traps.. A persistent weak layer of facets may be triggered, especially where the snow cover is thin.

Advice

Aviod terrain steeper than 30 degrees and runout zones where the avalanche problem is present. Remote triggering is possible.

NB: Identifying the avalanche problem is very difficult.



Avoid terrain traps.

Avalanche problems

Wind drifted snow (slab avalanches)

Poor bonding between layers in wind deposited snow

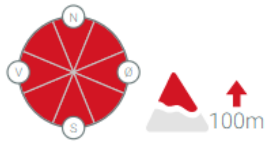
Read more about the avalanche problem

Avalanche size: 2 - Medium
Trigger/release: Low additional load
Distribution: Isolated steep slopes
Probability: Possible

Persistent weak layer (slab avalanches)

Buried weak layer of faceted snow near the ground

Read more about the avalanche problem



Avalanche size: 2 - Medium
Trigger/release: High additional load
Distribution: Specific steep slopes
Probability: Unlikely