Expedition Bjurälven 2022

Compiled by Dmitri Gorski

After several years of covid pandemic, we were finally able to return to cave exploration in Bjurälven valley in 2022! It felt great – we followed up on several existing leads (such as the Festins cave) and checked some new ones (such as the Ice cave). This was not the year when we installed most cave line or mapped most cave passages. But after 3 years away from the project, this was certainly a big success for the team. We would like to express our sincere gratitude to our sponsors Ursuit and xDeep for providing safe and efficient equipment that can take on most extreme conditions. We also received support from Klättermusen, a Swedish manufacturer of outdoor clothes. Of course, our biggest thanks go to the local people and businesses in the village of Stora Blåsjön – who have been putting up with us for over 15 years.

2022 Expedition members: Pirre Sandberg, Micke Tilja, Mats Fröjdenlund, Stefan Barth, Bosse Lenander, Robert Staven, Ane Mengshoel, Øyvind Hegle, Mikkel Stokke, Trond Einar Solberg, Kristian Lyberg, Anders Thomasson, Patrik Rylander, Per-Erik Thomasson, Gunnel Fredriksson, Dmitri Gorski, Marcin Wojturski, Linus Malmgren, Lasse Löfquist, Magnus Strömhäll, Mark Dougherty, Ola Löfquist.

Festins cave

By Ane Mengshoel and Robert Staven

This year our plan was to focus on the Bjurälven cave and the Festins cave. Last year we managed to pass a small restriction in the Festins cave and we learned that the cave continued after it, as we found a bigger passage with current on the other side. This year our ambitions were to follow up this lead. However, we knew that, in order to get further, we would have to remove a decent amount of sand and gravel, both in the entrance of the cave, and in the restriction we went through last year. Even though we did a lot of digging last year, we know that the water which flows in the cave will fill up the same places with new sand. In order to get to the Festins cave, we get special permission to use snow mobiles. We have to negotiate a river crossing, and last time the river was frozen, and it was fairly simple to get to the cave entrance. However, this was not the case this year, and we had to cross the river twice. To cross, we had to build snow-ramps on each side, which delayed establishing the camp for one day. In Bjurälven, a shovel is your best friend. Either for removing snow, making snow mobile tracks, or removing gravel under water! After making the snowmobile track and establishing the camp, we could finally get in the water. As safety is important, the first divers prioritized making the first passage a bit bigger, by shuffling sand to the sides. After this passage, the cave continues for 55 meters before you find a side passage. If you continue straight, you get to the other entrance (i.e. make a traverse). Ifyou go left, you hit the second restriction after a few meters. Before the gravel in that passage is removed, the restriction is about 3-5 meters. The main restriction is at the bottom, and here the current is also stronger. After a couple of days, we finally got enough space to get through. The cave opened up a bit, and we could continue up the slope where we placed a localization beacon which Bosse could localize from the surface. Then we got to a somewhat wider tunnel, where we continued upstream, however, there was a small lead downstream as well. The latter was more or less without current, so we didn't prioritize going there, but it might be something we can check further during the next expedition. We did manage to go a little bit further, but hit another restriction, and this is where the current end of line is. There are still a few leads, but there are narrow passages and fairly tight. It will be interesting to go back next year and see if we can push the cave further. We expect it to be connected to the Meander cave.

Figure 1 On the way to Festins cave


Figure 2 Divers preparing to enter the Festins cave. Linus, Ane and Robert.

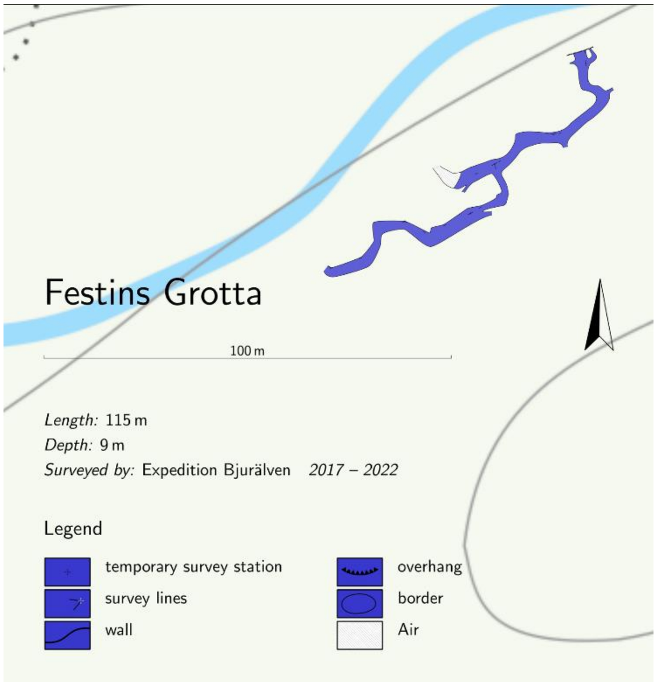

Figure 3 The map of the Festins cave

Figure 4 Happy new cave diver participant ready to enter the Festins cave

Figure 5 Bosse and Gunnel in a deep conversation about the cave area. Sharing a lot of wisdom!

Figure 6 One of the restrictions in the Festins cave

Figure 7 End of line. What can we find further?


Figure 8 The area around the cave entrance.

Figure 9 Mikkel entering the cave

Isgrottan

By Ola Löfquist

Isgrottan (The Ice cave) was visited during the 2022 expedition on March 30th. The Ice cave is located close to the river junction where Lillälven (Little river) merges into the river of Bjurälven. We reached the cave by taking a walk with snowshoes from the basecamp at Festin's cave. The group visiting the cave was composed of Lasse Löfquist, Ola Löfquist and Magnus Strömhäll. If you know the cave surroundings in summer conditions, the cave is quite easy to locate in the winter. It lies in an opening in the forest on a plateau with steep slopes around it. The ice cave has two entrances, but the connection between them is currently constricted by ice. The entrance which lies furthest away from the summer pathway is the one which gives access to the lower parts of the cave. Next to the entrance stands a solid tree which is perfect to rig the rope in.

Figure 10 The cave entrance opened, and rope rigged in the nearby tree.

About 30 meters of rope allows access to all the known parts of the cave. Rig the rope in the tree and abseil down with SRT gear. The cave does not necessarily require a full cave suit since it's fairly clean, and mainly covered in ice. It is recommended to wear crampons (all year around), or stay connected to the rope at all times. It is very slippery and there is a fair bit to fall down. Since the last visit during the 2019 expedition, a couple of cubic meters of ice have melted away. Last time, you had to go through a squiggly route through ice tunnels to reach the bottom of the known cave. But in 2022, the former ice roof had melted away, and you could abseil more or less straight down to the bottom. By estimate, 2-3 cubic meters of ice have disappeared since last visit. Previously the rocky bottom of the cave was barely accessible, but now it is easy to reach. During the visit in 2019, a reindeer skeleton was encountered in a corner where it had slid down in a funnel of ice. This year, the ice around it was completely gone, and it was easy to get a close up look.

Figure 11Reindeer skeleton at the bottom of the cave.

It is hard to estimate how much ice is left in the cave, since you don't know the exact shape of the cave behind the ice. A rough estimate for the current visible ice is 10-30 cubic meters. In the roof, there are a lot of scallops and formations which indicates the two cave entrances are old swallets. Further down in the cave, the walls are sharp and edgy and there is a lot of debris in the bottom, which indicates that frost-wedging has torn down the cave, and potentially also blocked the continuation. To know the answer, more ice has to melt. And with the warmer climate, the cave is probably worth a new visit in just a few years.

Data and telecom

By Mats Fröjdenlund

GNSS

Starting in 2011 we have been performing electromagnetic direction finding of the cave divers and surveying of fixed points in the cave system. From 2014 these fixed points have been marked out in the cave using stainless steel trays (markers) labelled FP01 (Fix Point 01), FP02, and so on. Using the electromagnetic direction-finding equipment, we have been able to obtain relatively accurate points on the ground surface directly above the fixed points. Also, the depth from the surface (or the snow surface) down to the fixed point has been obtained. To make a 3D and georeferenced cave map the ground surface elevation, the depth of the cave and its X and Y coordinates are required. For this purpose, the Swedish National Land Survey/SWEPOS (*https://swepos.lantmateriet.se*) during the expedition in 2013, 2014 and 2015 kindly lend us both GNSS equipment (Global Navigation System Satellite = GPS, GALILEO and GLONASS) and communication equipment with connection to the SWEPOS correction services. It is possible to get a position in the reference system SWEREF 99 with uncertainty in the centimetre level. Our problem has been that the expedition site is out of reach for mobile Internet communication. In 2022 our equipment again consists of a Leica Viva GS15 rover on a 2.0-meter-high carbon fibre pole and a Leica CS10 field computer, kindly provided by the Swedish Lantmäteriet.

Figure 12 GNSS equipment from Leica provided by the Swedish Lantmäteriet

Our GNSS equipment was used to measure the points, located using the tracking device, invented by Bo Lenander. The measurement information from the field computer was transferred to a XML file with X, Y and Z values. We also included the depth value and time for the measurement. To visualize the points on the aerial photo or the terrain model we were using the GIS software *ArcGIS Pro*® from Esri.

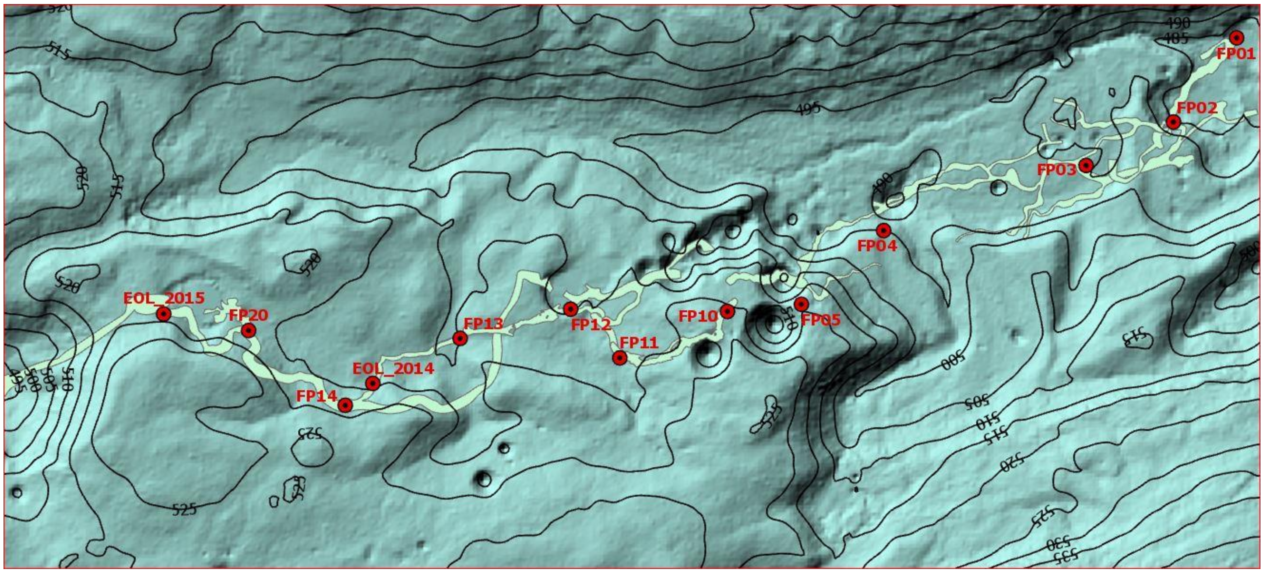

Figure 13 Fix points in Dolinsjögrottan

Three new points were measured with the GNSS in 2022 at the Festin cave system. The RINEX post process, provided by the Lantmäteriet was very successful and 2 of the 3 points had an accuracy better than a few centimetres.

LiDAR-data and Drones.
2017 we managed to get the new LiDAR data from the Swedish National Land Survey (kindly sponsored by Esri Sweden). This means that we now can measure the depth of all dolines (sinkholes) using GIS and build a 3D surface model over the terrain and incorporate the 3D map over the caves in the same model.

A *DJI Mavic 2 Pro* drone were used for the second time to collect orthophotos from the areas of the Festin cave system. The photos were processed in photogrammetry software *ArcGIS Drone2Map*® and the output was 2D Orth mosaic, elevation data such as DSM and DTM and 3D data. The result was amazing, and we will continue to collect data from drones.

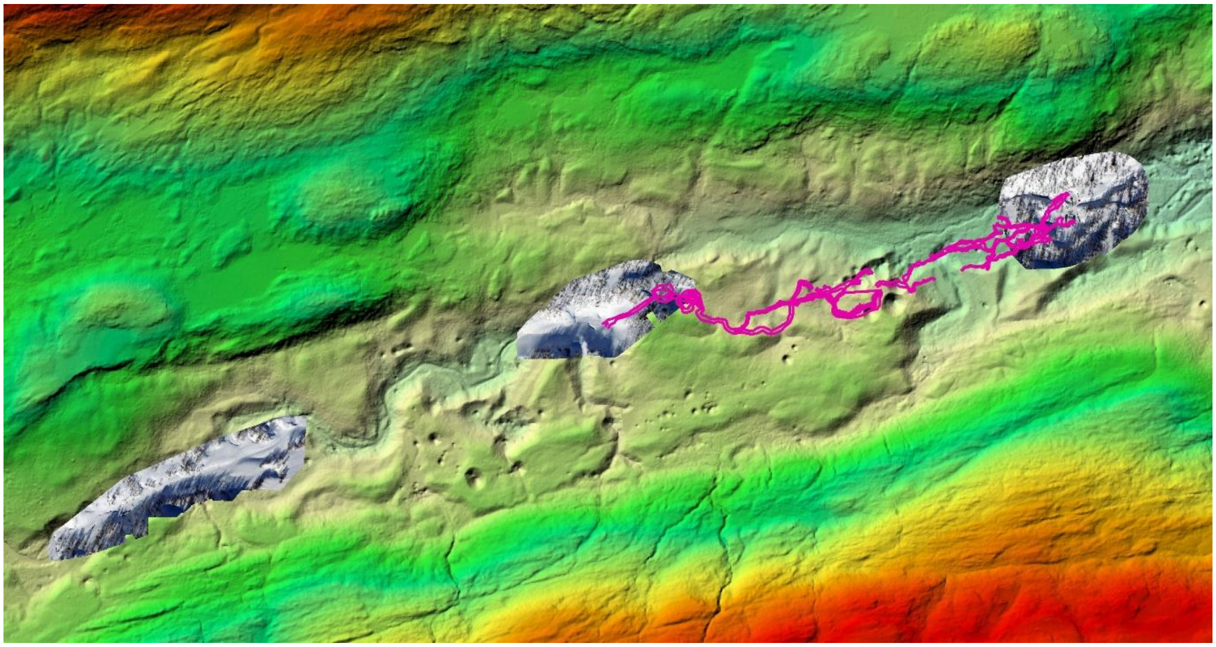
Figure 14 Map, showing LiDAR-data, orthophoto collected from drones and cave map

Handheld LiDAR.
For the first time in the Expedition, we tried to use the built in LiDAR sensor in an iPhone 13 Pro. The result was a 3D model of the cavern above water. Due to limited time and lack of proper lights the result was quite poor, but the technique looks promising. We use the 3D app called Scaniverse but also Polycam, 3D Scanner and other apps could be used.

Test sample: https://sketchfab.com/3d-models/festin-ingang-vattenyta-823c717edd4d4339aebaa98934a73c5f or https://sketchfab.com/3d-models/festin-cave-outlet-3a0c2e4e3d67495a9e1a0236081d359e

Internet connection
The terrain, valley with high mountains around, makes it impossible to get in contact with the Internet through 3G or 4G even with directional antenna. In case of emergency, we have to send one person to Leipikvattnet with VHF-radio as relay station. It´s also possible to use satellite phones e.g., inReach to the Iridium network.

Electromagnetic direction finding

By Bo Lenander

On demand from the surveying cave divers electromagnetic direction finding, or radiolocation, has been used to find the point on surface that is located directly above the electromagnetic transmitter in the cave. The transmitter gives a vertical pulsating magnetic field that can be detected on the surface above the cave. The pulsating magnetic field is vertical in a position directly above the transmitter (ground zero) and also in the very weak return field, far away from ground zero. Figure below shows vertical position of the electromagnetic field. Note the high concentration (strength) in the field directly above the transmitter in comparison with that in the far field. In the return far field the vertical field direction is found everywhere in the same height level as the transmitter – but very weak!

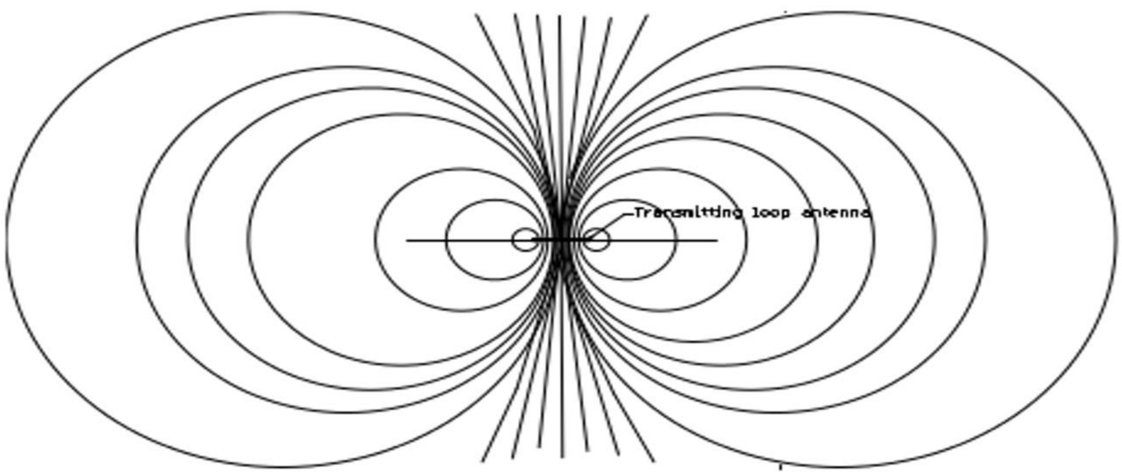

Figure 15 Vertical projection of the electromagnetic field.

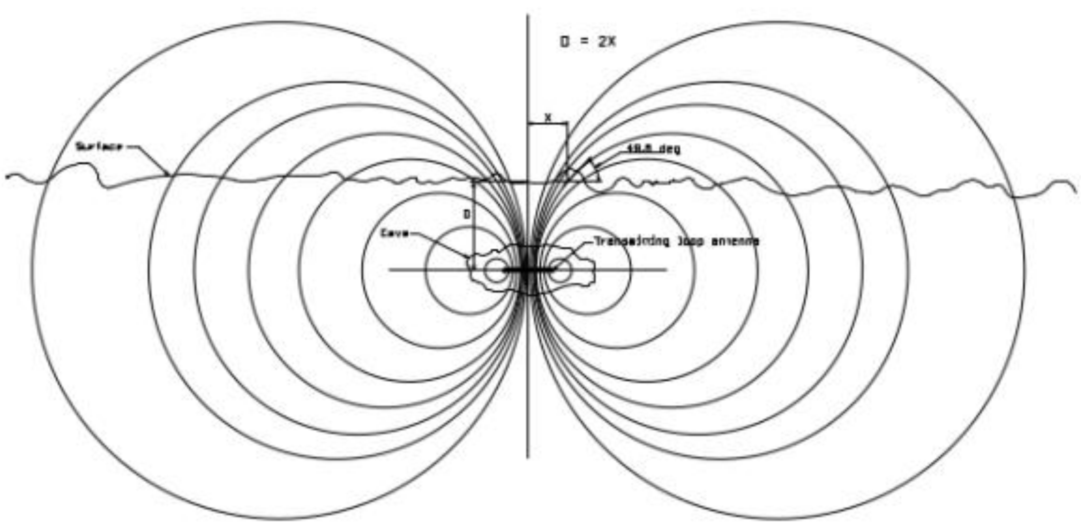

Figure 16 The electromagnetic transmitter is located in a cave and the distribution/angle of the magnetic field on the surface can be measured with a direction-finding receiver.

If the terrain above the cave has deep valleys there is a high risk of finding the vertical far field in the *height level of the transmitter!* This year, 2022, the work was concentrated to an underground waterfilled passage, almost parallell to the small creek. This cave passage is located under a very hilly surface and due to the weather, snow structure and snow depth there was a high avalanche risk (we saw one falling over one of the cave entrances!). In this situation it is important to be very careful! As the water surface was almost visible from the cave entrance and the divers could use their depth gauges we decided not to measure the vertical distance from the surface to the transmitter in the cave. We just located ground zero. The big cave tunnels were almost filled up with gravel so there was not much space for the cave divers. Therefor the locating demand was only one fixpoint. This ground zero was in a very steep terrain.

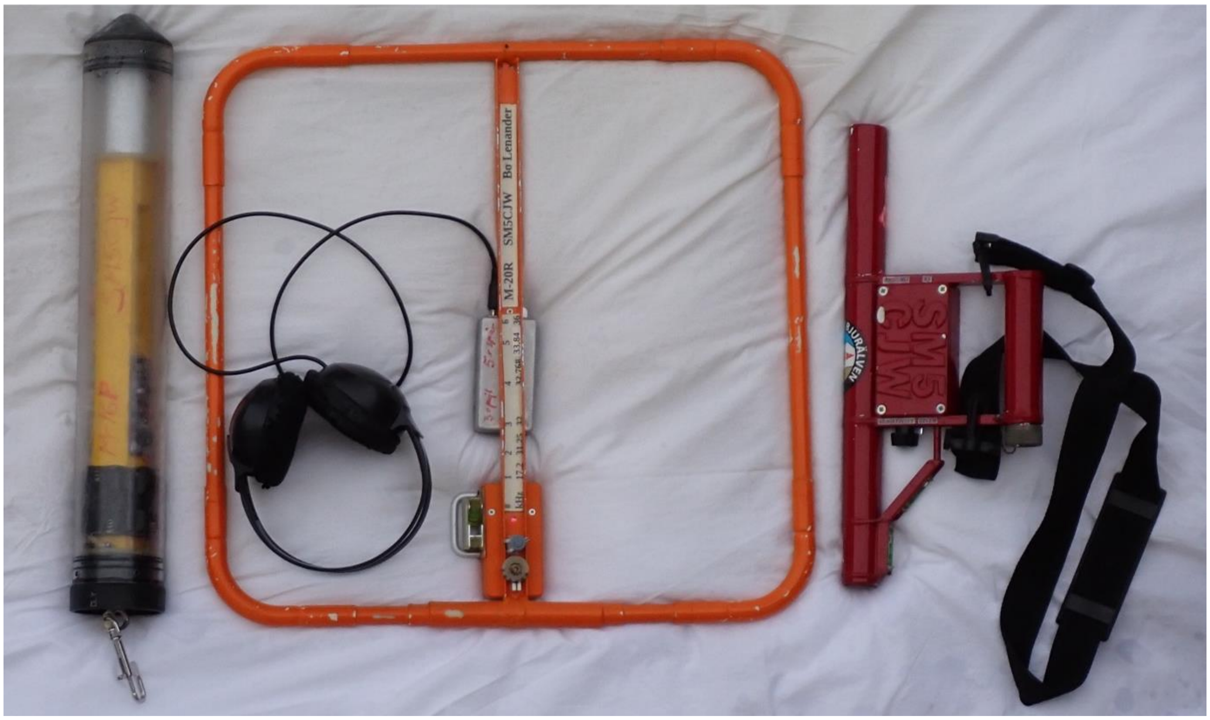

Figure 17 Direction finding equipment: Transmitter M-16P, Receiver M-20R and Transmitter/receiver M-16R.

The direction-finding equipment, designed and built by Bo Lenander SM5CJW, was a transmitter M-16P and a receiver M-20R working at 32 kHz. The maximum range for this setup is about 300 m vertical distance. The transmitter M-16P has a selector switch so four different codes can be transmitted:

1. Short pulses = All OK – swimming to next fix point.
2. Long pulses = At the fix point – locate ground zero!
3. Morse code **D** = Delayed return from cave – OK.
4. Morse code **SOS** = Problems!!!

The transmitter has got a simple built-in receiver to flash a green LED in the transmitter to say that ground zero has been measured. The direction-finding receiver, M-20R, has a 500 x 500 mm frame antenna. The receiver is a superheterodyne with 9 MHz IF and 400 Hz IF band width. The receiver has also been used on several occasions listening to the world heritage electromechanical transmitter SAQ at 17200 Hz!!! A separate transmitter, in M-16R, is used to flash the green LED in the cave when the ground zero has been located.

To give the rock a body

By Gideonsson/Londré - an artist duo living in Kallrör, Jämtland.

We were drawn to the expedition because of our deep interest in the experience of time and how it’s manifested in our bodies and surroundings. Previously we had investigated the experiments of different biological time rhythms in caves performed in isolation by the French speleologist and chronobiologist Michel Siffre. We are also fascinated by the karst landscape and had visited Bjurälven previously in summertime to get lost in the sinkholes in the limestone. How carbonic acid has corroded the stone for a long period of time as a sort of water clock. Invited to observe the expedition, we arrived just as all the hard work with digging the entry points to the caves was done and the two base camps were already put up. The group we met seemed welded together by the previous day's collective effort of hard work. We were really taken by how much preparation was needed to just be able to dive and all the practical solutions made for the expedition to function. How this infrastructure and supporting structures have been developed through time by the collective experiences from previous expeditions i.e. the year when the whole base camp was flooded and dragged into the river. To walk around camp was therefore a truly aesthetic experience, to see all the solutions to different challenges posed by the landscape and surrounding conditions, a result of accumulated experiences and collaboration within the group. We could go on and on about these creations, but there’s no room for it here. Instead, we would like to continue with the set goal of the expedition, to map new parts of the cave.

When the first diver entered the water, standing there in the -22 degree air, there was something magical about it. The diver went down under the surface and into the small opening of the cave leaving a circle of air bubbles on the water surface. The body had disappeared into the rock, and we were left standing watching a blank surface. It was hard for us left above the surface to know how to behave. The reserve diver was laying still in the snow, waiting.

The air bubbles were a recurring topic in our conversations with the group, bubbles that wander, that tell when something different is happening, the bubbles that flow in the ceiling. You talk about the ceilings of the cave, the halls, the floors, rooms and pathways instead of above or below ground. Did the cave even exist before it was mapped out? We listened to stories about the expansions and withdrawals of previous expeditions: new meters of cave that were brought into existence and some clogged.

A big part of the diver’s task was to put out new rope in the cave, replace damaged rope or parts that've been destroyed in the streams. The rope ran like a timeline inside the rock body, thin and kind of inconspicuous looking, and followed the movement of the water that slowly hollowed out the stone. The rope looked almost like nerve fibers, as if the diver wanted to embody the limestone by putting it there. To give the rock a body.

A very familiar sound rang out from the big tent, the sound of a microwave oven. What initially seemed like a weird thing to bring to this quite remote situation, just followed the rules of this ingenious solution-oriented expedition. Since you all couldn’t be underwater at the same time, you also had to eat at different times. All these different time rhythms that were manifested in the different stomachs and also within the cave. And what was then more practical than to bring hundreds of frozen pierogies and a microwave oven.