

Expedition Bjurälven 2023

Compiled by Dmitri Gorski



Cave exploration in the Bjurälven valley in 2023 was performed according to plan and without incidents or accidents. Our focus was on two caves – Festins and Köldhålet. 171 meters of new line was installed and surveyed in these caves. We managed to find a new connection with the surface (a new entrance) upstream in the Köldhålet cave. We also performed an initial survey of diving possibilities upstream the Festins cave.

Bo Lenander, a member of the current expedition crew, discovered the entrance to the Dolinsjögrötan located in the Bjurälven valley in 1979. The first winter expedition to explore the caves in the area was launched in 2007, following several unsuccessful attempts to dive in the Dolinsjögrötan summertime. These attempts were unsuccessful mainly due to very strong current that rips through the cave system summertime, measuring up to 20 knots. During winter, the water is much calmer with hardly any current at all. Another factor in favor of conducting the expeditions wintertime is logistics. All the equipment can be transported to the cave using snowmobiles, minimizing the risk of damaging the fragile vegetation in the protected nature reserve.

In 2008, divers of the second Expedition Bjurälven managed to map some 50 meters of passages in the Dolinsjö cave. Thanks to excellent cooperation with the authorities and continuing support of the local population, diving and exploration in Bjurälven continues. Fifteen years since the first expedition, the total mapped length of all caves in the area, which we someday hope to connect, is 3353 meters. Dolinsjö cave (2432 meters), is Sweden's longest water-filled cave and among the 80 longest underwater caves in the world. Köldhålet is on the 2nd place with its 280 meters.

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 great support from Klättermusen, a Swedish manufacturer of outdoor clothes. Of course, our biggest thanks go to the local people and businesses (Ica Blåsjöfjäll, Restaurant Fjällripan and Ica Gäddede) in and around the village of Stora Blåsjön – who have been putting up with us for over 15 years. Authorities in Jämtland County and Vornaese Sameby are acknowledged for providing their consent and approval to this project.



Figure 1 Henning Victorin, Micke Tilja, David Thor, Stefan Barth, Dmitri Gorski, Mats Fröjdenlund, Robert Staven, Patrik Rylander, Trond Einar Solberg, Anders Thomasson, Per-Erik Thomasson, Øyvind Hegle, Linus Malmgren, Jonas Roos, Ane Mengshoel, Pirre Sandberg, Bosse Lenander, Gunnel Fredriksson, Irena Stangierska. Mariusz Dziobek is behind the camera.

Documentation and media

High-quality photo material was collected this year. National Geographic photographer Irena Stangierska and her team joined Expedition Bjurälven 2023 to record the beauty of the Bjurälven in her pictures. During the expedition week a presentation was made by Bosse Lenander at the local community house in Stora Blåsjön.



Figure 2 Bosse Lenander making a presentation in the community house at Stora Blåsjön

Exploration and mapping

64 person-dives were performed during the expedition in 2023, see Figure 3. This is approximately the same as the years before.

Total dive time and average dive time decreased compared to previous expeditions, see Figure 4 and Figure 5. This can be explained by the fact that Dolinsjögrottan demanded long dives to reach the EOL, while the other caves in the area, like Köldhålet and Festins, are still relatively short.

Table 1 Surveyed cave length, Bjurälven Valley

Cave name	Mapped length [m]
Bjurälvsgrötan	300 (unchanged in 2023)
Dolinsjögrötan	2432 (unchanged in 2023)
Köldhålet	280 (+57 m in 2023)
Spegelgrötan/Semigrötan/D3	162 (unchanged in 2023)
Festins cave	179 (+114 m 2023)

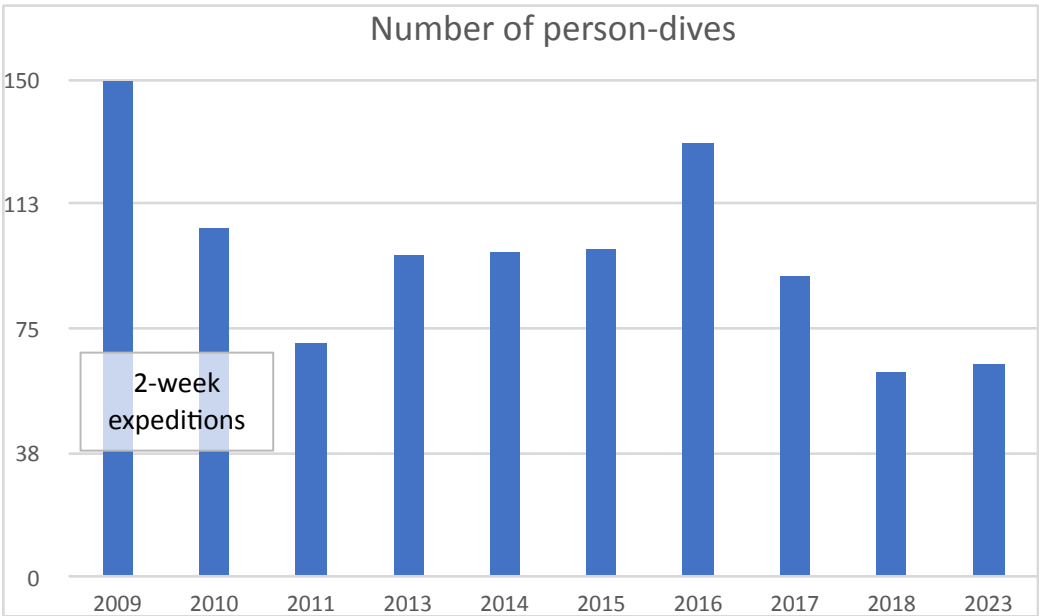


Figure 3 Number of person-dives during all the winter expeditions

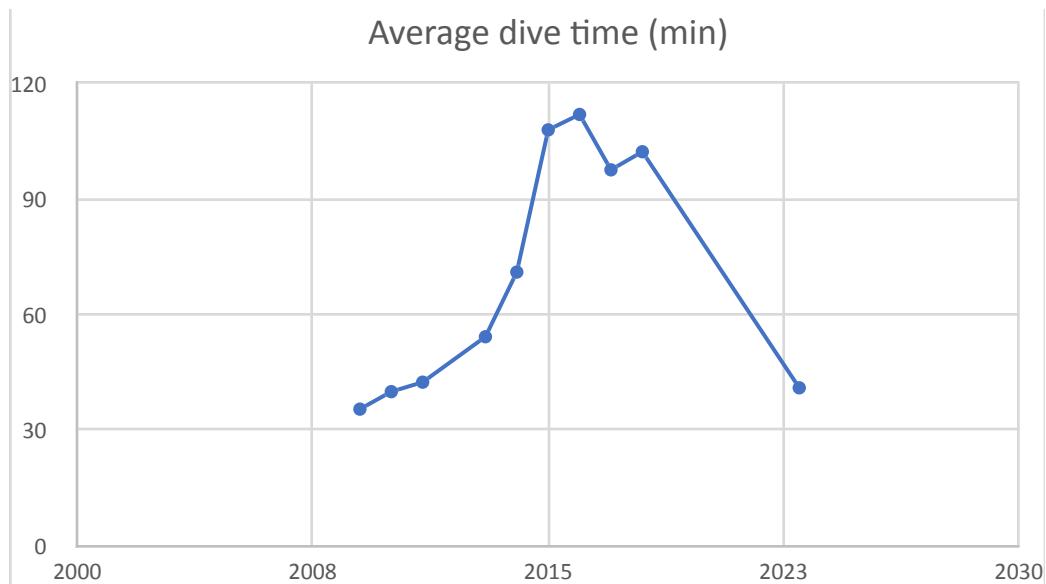


Figure 4 Average dive time during all the winter expeditions

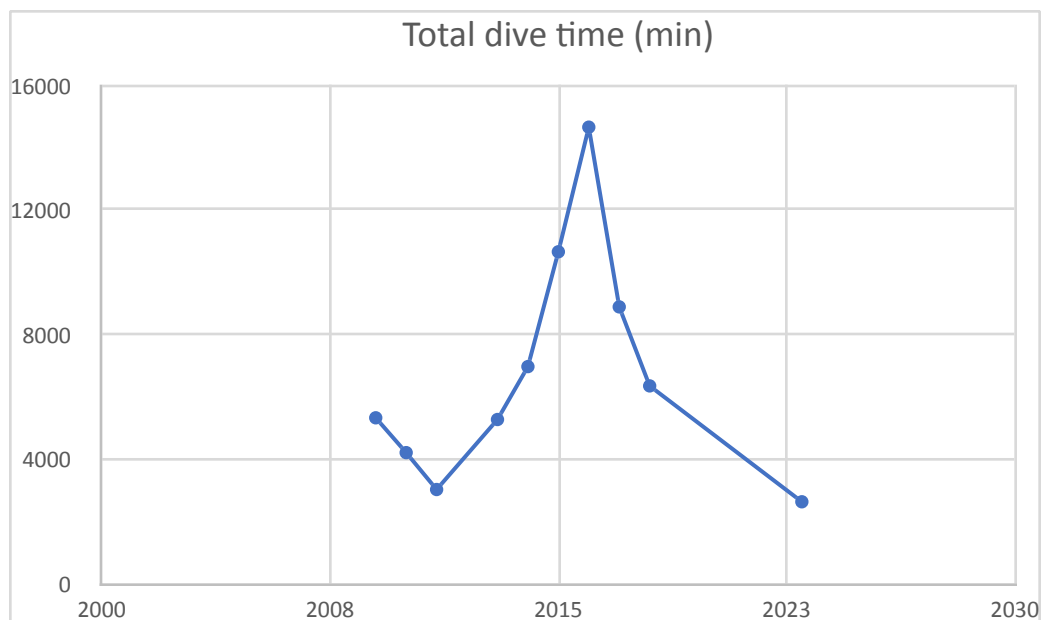


Figure 5 Total dive time during all the winter expeditions

57 meters of passages were mapped upstream in Köldhålet, and 114 meters were mapped upstream in Festins.

Festins cave

By Ane Mengshoel



Figure 6 Ane Mengshoel in the main tunnel. Photo by Irena Stangierska.

You cannot plan for winter expeditions unless you are ready to embrace whatever weather is thrown at you. One year we experienced flooding, another year we experienced mild weather making our snowmobile logistics difficult. In 2023 we were faced with very cold temperatures around minus 20 degrees Celsius and less, but also beautiful sun which warmed up both body and soul.



Due to the very cold weather, the river leading to the Festins cave was frozen; we did not have to build bridges for crossing the river with the snow mobiles. There is always some need to shovel snow in order to make good snow mobile tracks, but the logistics are much easier with stable cold winter weather. The downside is that you'll find that everything freezes within a few seconds, and diesel heater and hot water are needed to be able to use frozen gear. Some years ago, the expeditions had challenges with regulators freezing while diving, but after we started with double filtration on the compressors, this issue was more or less eliminated. The key was to reduce the humidity in the compressed air. However, this year we struggled a lot with the same issue, especially while still being at the surface before descending. We are not really sure why this happened, as the people diving in Köldhålet did not experience the same issues. However, we do know that it was colder in the entrance of Festins due to absence of sun there. We were still able to conduct diving and got some amazing dives throughout the expedition week.



Figure 7 Ane Mengshoel exiting from the cave. Photo by Anders Thomasson.

When we opened camp the first day, we saw that the water level was quite low, and it decreased even more during the expedition week. Last year we could gear up in the water outside the cave, while this year we had to crawl inside the cave in order to reach the water. It was ok for two divers, but quite cramped for three people. The good thing is that we are used to narrow places. There was also more or less no current, which made the visibility poor. As we had to gear up inside the cave, at the top of the sandbank, we always had zero visibility when entering and exiting the cave. The cave dive itself starts in a restriction, which starts at 0.5 metres and ends at 5 metres. Here the visibility got better, and if you avoid using your fins, and rather “walk in the ceiling”, you could keep fair visibility. We placed one safety tank at this place. When we went to the T, we could see the surface at the other entrance, due to the low water level. We were happy to find the main restriction still open after last year's large effort to open it up. We still had to move some gravel, but got through, and could continue to extend the line from last year.

The cave is in general quite narrow. Usually, you can speak about the first, second and third restriction etc., however, this cave switches all the time between “swimmable passages” of a few metres, and then another restriction. It is not always easy to find good tie-offs, and you should pay close attention to how you position yourself when entering, so you choose the same exit strategy. The reward is diving through some beautiful passages where no one has ever been, and you never know what is hiding behind the next turn. We were able to put in 64 metres of new line and survey some old line. The line ends at the beginning of an air chamber, where barely one person fits. We decided that we could not push further due to the lack of space.

Other things worth mentioning; In the first main tunnel, there's a small lead which we were able to put on the map. It is a narrow tunnel with silt/sand, there is a weak current going downstream in it, so the potential for more cave exists (the expected spring is located 200 m downstream). After about 8 m of downward sloping cave tunnel a narrow restriction stops further passage.



Figure 8 Photo of the downstream tunnel. Photo by Robert Staven.

Just inside the main restriction there is also a downstream tunnel, starting off quite wide but a bit low. The tunnels get a bit narrower after a few metres, but the height increases. It does a few turns, but it seems to be possible to continue. However, this is downstream, so visibility is an issue while exploring.



Figure 9 Second downstream tunnel. Photo by Robert Staven.

It is possible the two tunnels merge into a larger passage after a few more metres. The latter lead is most likely to be the best approach.



Figure 10 A small break while disassembling the camp. Pirre pretends it is hot weather. Photo by Linus Malmgren.

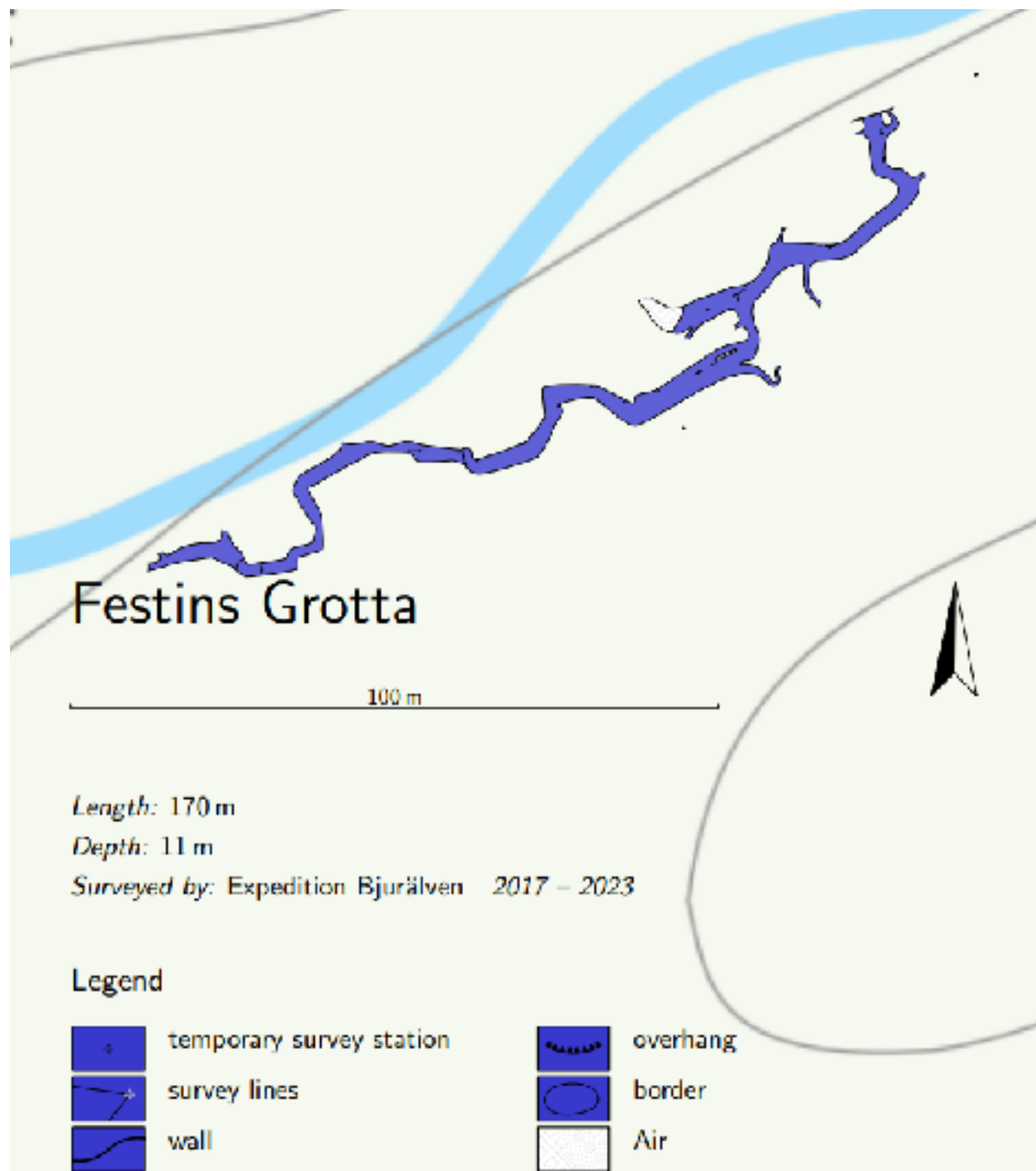


Figure 11 Map of the Festins cave.



Figure 12 Linus Malmgren and Ane Mengshoel enjoying freshly baked buns. Photo by Ane Mengshoel.



Figure 13 Happy divers - Irena Stangierska and Mariusz Dziobek. Photo by Ane Mengshoel.

Köldhålet

By Dmitri Gorski

Köldhålet was given its name because it located at the bottom of a deep doline. The sun almost never reaches there, and it is always much colder at the water level than further up. To get to Köldhålet, a path needs to be built in the snow. The path starts at the base camp and circles downwards around the doline until it reaches its bottom some 20 meters below. The equipment is hauled down using a rope line with pullies. It is almost always current in Köldhålet, and it ranges from mild to wild. The water flowing out immediately disappears into cracks around the cave entrance and the surface of the Doline is usually calm enough for the ice to form on it over the cause of a few hours.



Figure 14 Köldhålet cave starts at the bottom of a deep doline, so all equipment has to be transported down using ropes.



Figure 15 Surface of the spring leading to the Köldhålet cave, frozen over night. Photo by Micke Tilja

We knew from before that there are dry passages on the other side of the sump. One of them is located relatively close to the entrance, it can be reached after approximately 50 meters. From there it is possible to exit the cave altogether if an ice plug at the narrow entrance is removed. The dry tunnel is an ice slope several meters wide and approximately ten meters long.

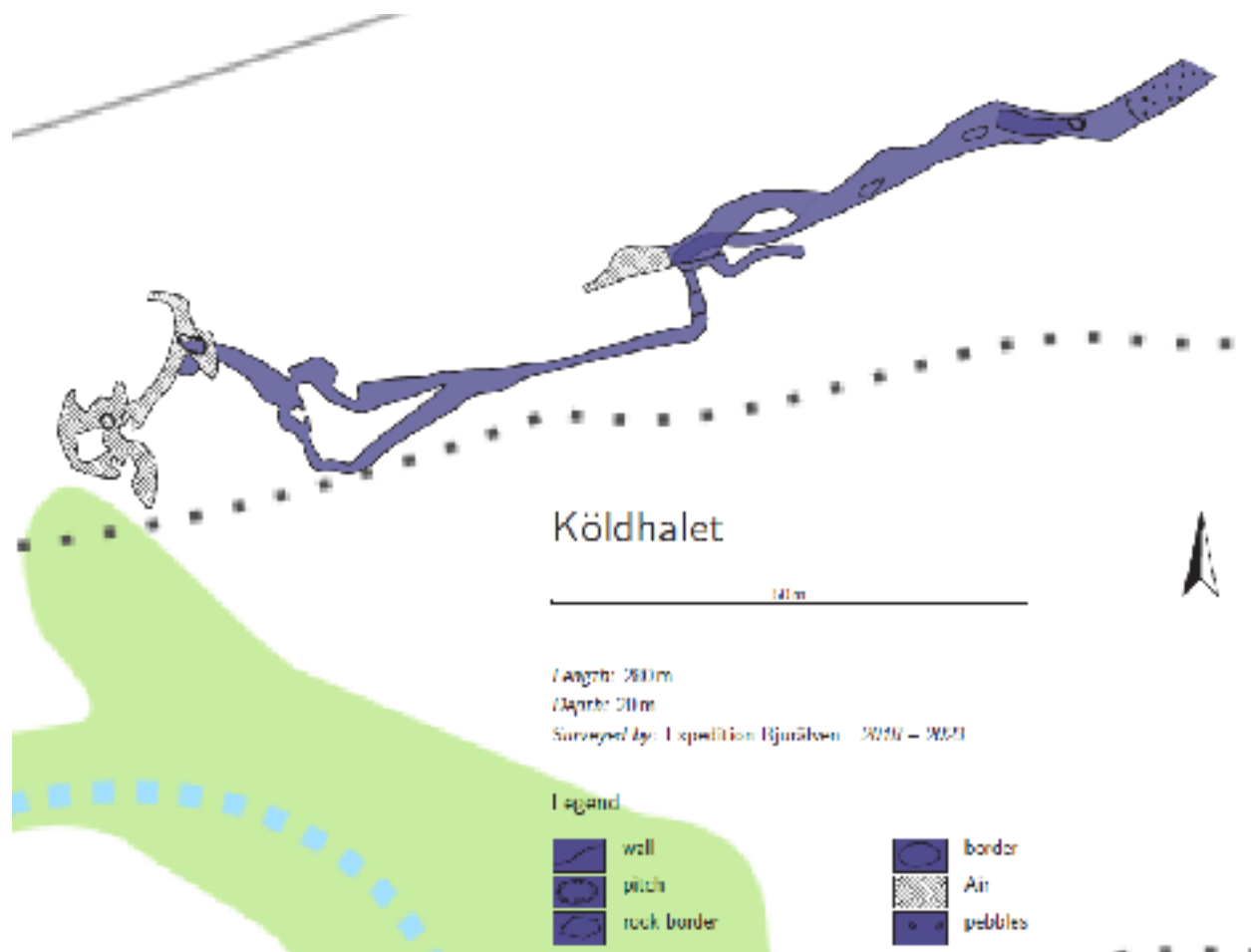


Figure 16 Updated map of Köldhålet

The other dry passage is much further away, and it takes at least a quarter of an hour to get there. On the way divers pass through a section of the cave called “The Shaft” which goes almost vertically from less than ten meters to almost twenty meters. One of the goals this year was to document The Shaft with underwater photography.

Another goal was to reach the furthest dry passage and explore it. On the previous expedition, divers only broke the water surface, but never dislodged their dive gear to explore the dry passage thoroughly. This was done in 2023 and another exit from the cave was discovered. Other than that, the dry tunnel did not lead to any new discoveries, such as another sump.

The divers also mapped some of the remaining uncharted parts of Köldhålet and found a few small pressure tunnels to add to the map. Approximately 57 new meters were added. All in all, Köldhålet is unlikely to hold more discoveries in the future. However, it is a well-known trick of cave exploration to leave a seemingly explored cave for a few years and then come back only to discover another tunnel, missed previously.



Figure 17 Dmitri Gorski at the entrance to The Shaft. Photo by Micke Tilja



Figure 18 Divers entering Köldhålet. Photo by Micke Tilja

Satellite positioning, LiDAR-data, drone mapping and Internet connection.

By Mats Fröjdenlund 2023

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 2023 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, see Figure 19.



Figure 19 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 an 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, see Figure 20.

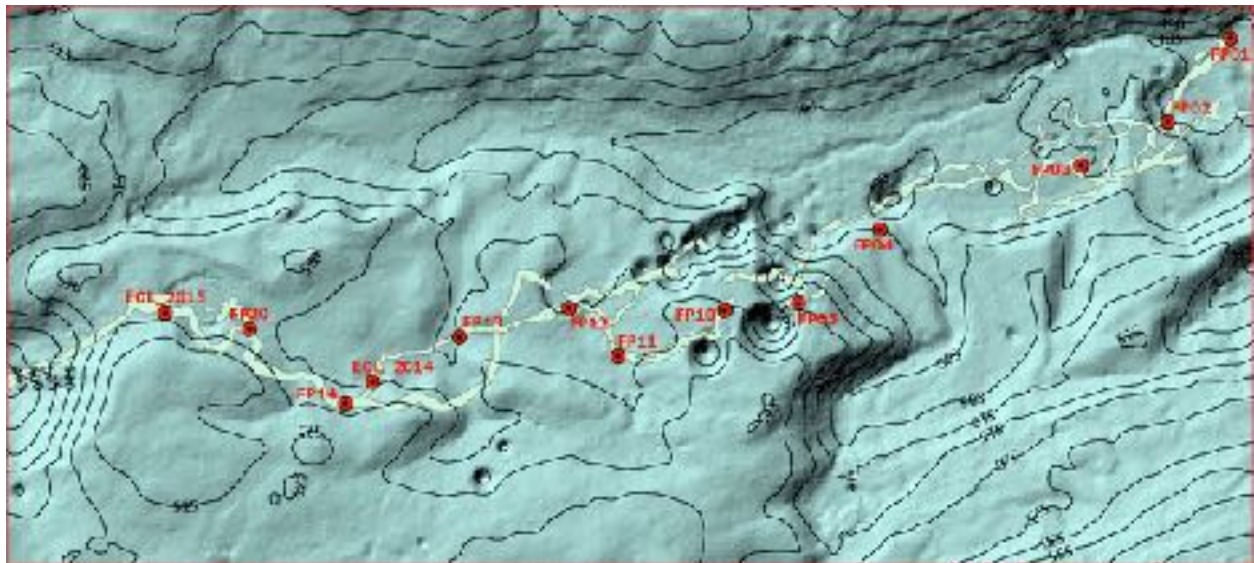


Figure 20 Fix points in Dolinsjögrötan

Twelve new points were measured with the GNSS in 2023 at the Festin cave system and Köldhålet system. The RINEX post process, provided by the Lantmäteriet was very successful and all the 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 third 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, see Figure 21.

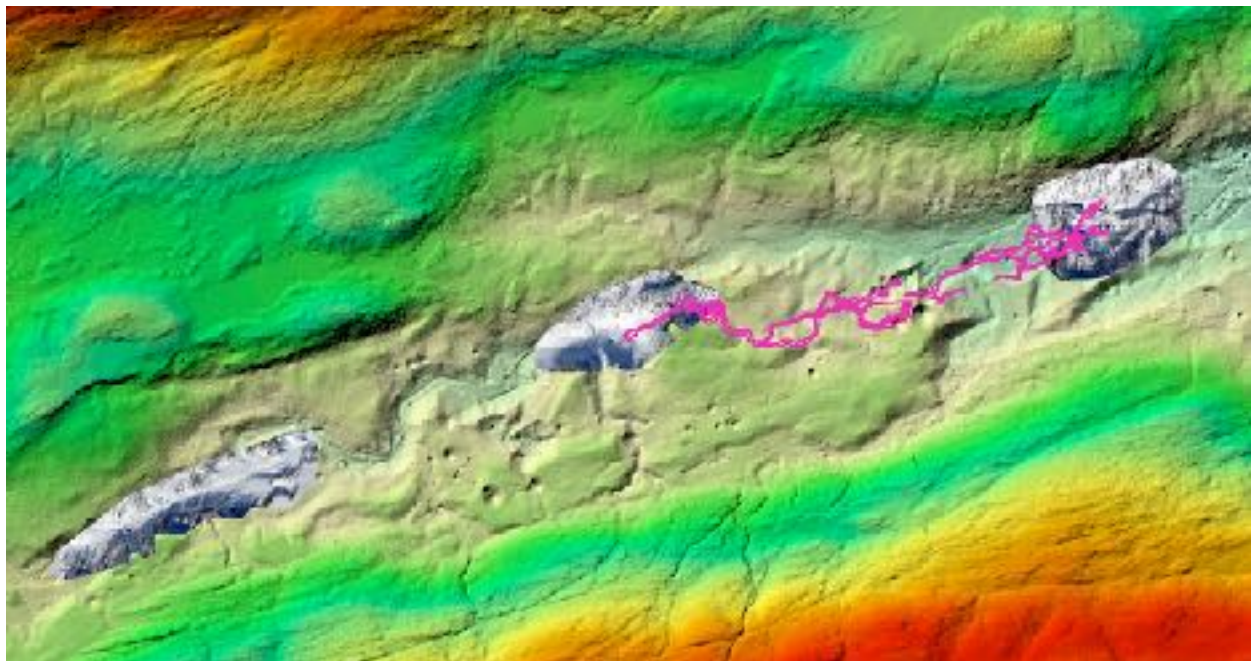


Figure 21 Map, showing LiDAR-data, orthophoto collected from drones and cave map

Handheld LiDAR.

For the second 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.

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 must 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 or StarLink.

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!

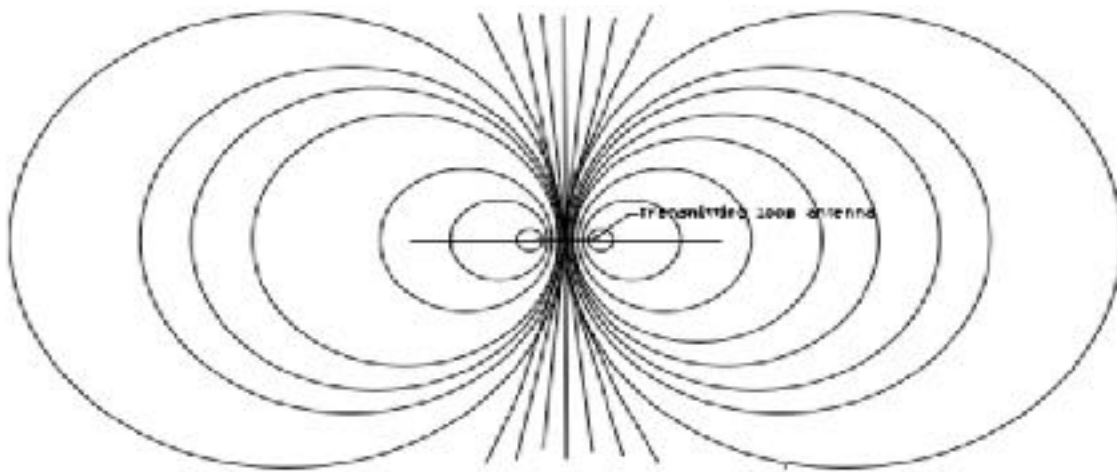


Figure 22 Vertical projection of the electromagnetic field.

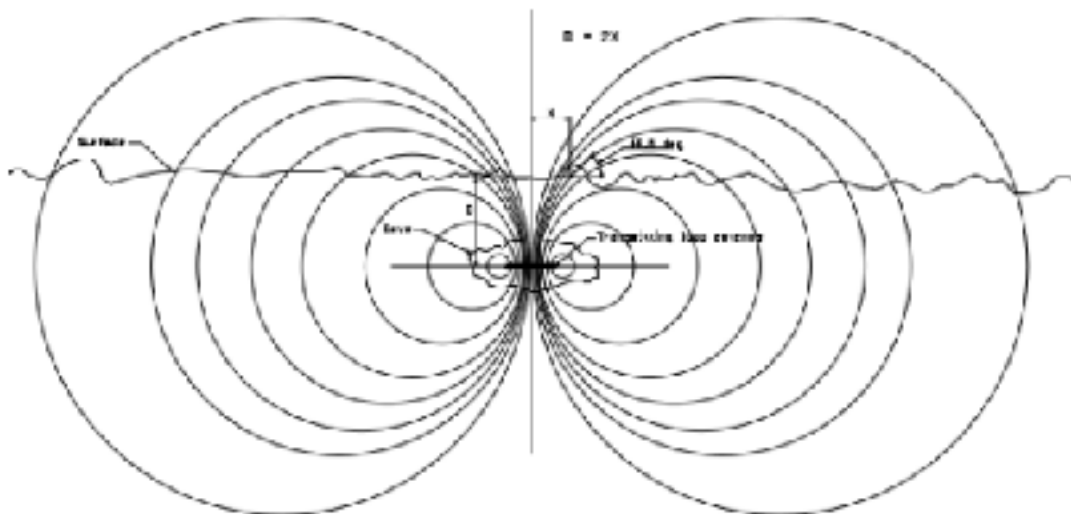


Figure 23 The electromagnetic transmitter is located in a cave and the distribution/angle of the magnetic field on the surface can be measured with a direction-finding receiver.

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, 2023, the work was concentrated to underground waterfilled passages in two different caves. The cave passages are located under a very hilly surface. The big cave tunnels are almost filled up with gravel so there was not much space for the cave divers.



Figure 24 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 – locating ground zero!
3. Morse code **D** = Delayed return from cave – OK.
4. Morse code **SOS** = Problem!

The transmitter M-16P has got a simple built-in receiver to flash a green LED to say that ground zero has been measured. The direction-finding receiver, M-20R, has a 500 x 500 mm frame antenna. This 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 receiver M-16R, is used to flash the green LED in the cave (in M-16P) when ground zero has been located.

In Festins cave one radiolocation was done and in Köldhålet cave five places were located by radiolocation. One of them led to some digging in the bottom of the snow-filled creek and finally

we managed to pass the transmitter through a small hole. The hole was so narrow and long that a handshake was not possible. The divers had to leave the place the same way they had gone into the cave.

[Expedition through eyes of a new member](#)

By Henning Wictorin

Finally, it was time! Pictures and stories from Bjurälven were the reason I started diving in the first place. Now I would get the opportunity to see the cave with my own eyes, and meet the hardened vikings who, year after year, defy the deepest snow, hardest ice and coldest cold the country can muster to continue the exploration of the inside of Sweden. My expectations were titanic, and ended up being surpassed by far.

The environment itself was incredibly beautiful. Granted with clear skies and sunshine every day the weather left little more to ask for. Even just lying in the sled behind the snowmobile, sun in my face and the vale spreading out before my eyes was a new and great experience. The nature surrounding the cave and the camp was dramatic and tempting, every day I planned to build a zipline across the nearest doline but there were always other even more amusing things to do. The cave was fantastic as well. Crystal clear waters, not too tight and the dry chamber was warm and nice and soft.

My own experience during the expedition also turned out as a real jackpot. I got to try exactly everything. First, we spent a couple of dives getting used to the conditions and repairing the old main line. Then, as we reached the end of line, we emerged from the water and explored a previously unexplored dry part of the cave. The next day we equipped a team of divers with a radio transmitter and I got to try the radio location finding device in the field. And what a success! Thanks to the very high precision, and the short distance down to the cavers we could shovel aside some snow, open up a small hole and even get some equipment out from the cave. Circle was complete. I got to join in on the GPS positioning of the fix points. I got to come along and do some surveying both beneath the surface with measuring tape and compass, as well as above using the distoX. I was shown how the points from the survey got transferred to a computer program and turned into a real cave map. I could contribute with some clips for the daily video blog. I got to rig ropes and I got to shovel snow. And to ride snowmobile across the mountains. I really got to try all the things that are part of cave exploration in the Scandinavian mountains. A world class privilege!

But the one thing that impressed me the most, and what I still consider now afterwards is the group of people that are the expedition. I got very well received and everyone displayed great patience and cared for me to have an awesome week. That was something I did not consider too much beforehand, and also that the collective knowledge was huge. The expedition had clearly been executed several times before. A lot of things with the environment were new to me, and the cold brought with it more consequences both in number and severity than I could imagine. But all these problems were already solved. We had hilariously potent diesel heaters that could melt a deep frozen dry suit (with a diver still in it). The power station and the compressor were carried away from camp and buried in the snow to dampen the noise. When my bolt snaps froze stuck someone was already there with warm water in a thermos. We had microwave and a kettle. Extra filters at the compressor to fill our tanks with extra dry air to prevent freezing first stages. We adjusted the snowmobile tracks and we made pathways in the snow that froze over night and turned out super great and solid already the day after. Not to mention all the knowledge about the world outside of Expedition Bjurälven, and I really learned

a ton of other things which are too plentiful to scribble down here. Great many thanks for a super expedition and great many thanks for giving me this opportunity!