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# The X-Mine Project Streamlines Exploration and Extraction

*The new X-ray analysis device will help geologists do their job a lot better. Photo: Orexplore*

BY: ALARIK HAGLUND

Stefan Sädbom, Senior Exploration Geologist and chairman of Lovisagruvan and Orexplore, talks about the X-Mine research project, where both Lovisagruvan and Orexplore are partners. The project focuses on using real-time mineral X-ray analysis to make mining more efficient and sustainable.

Stefan Sädbom wants to start by giving some background on why the X-Mine project exists and why the European Union, who finances the project through the research and innovation framework programme Horizon 2020, believes it's important.

"People use more metals than they did a hundred years ago. A large amount of these metals can be recycled. You can't destroy an element once it's been created. This also applies to the metals used in devices like smartphones," says Stefan Sädbom, but he also


*Four drill samples can be analyzed simultaneously. Photo: Orexplore*

adds that the recycling has to be worth paying for.

"Right now, it can actually be cheaper to buy some of the elements needed to build a smartphone from a mine than to recover them from secondary sources," reveals Stefan Sädbom.

With a growing global population, increased per capita use of metals and a less than perfect recycling system, Stefan Sädbom points out that we still need to mine primary metals, derived directly from ore.

"New discoveries of metals are harder and harder to make, the grades are often lower and the ore bodies are often deeper, explains Stefan Sädbom.

## Dependence on Import

Stefan Sädbom also adds that while the European Union consumes almost 25 percent of all mineral raw materials produced on earth, we only produce between three and five percent. "This dependence on import makes our manufacturing industry vulnerable," comments Stefan Sädbom. "The only way to become more self-sufficient is to be more efficient in recycling and to develop more of the mineral deposits that actually do exist in Europe."

He says the first step is to explore and make an inventory of where metals exist and then decide where the societal gain of mining is largest compared to preservational values.

"Metals aren't evenly distributed across the earth," explains Stefan Sädbom. "For example, Sweden is one of Europe's largest producers of gold, zinc, lead, iron, copper and silver, but we have no production of the more unusual metals."

One of the goals of the X-Mine project is more efficient exploration.

"Exploration is incredibly difficult. Roughly one in every thousand exploration permits results in a mine. Any tools we can develop to increase efficiency are a good thing," says Stefan Sädbom.

Another important goal of the X-Mine project is more efficient ore extraction.

"The deposits we find are not likely to have a very high content of metals. If that had been the case, we would already have found them. This means we must develop methods that make it possible to extract deposits with a lower content of metals," explains Stefan Sädbom.

## Time-Consuming Work

Today, Stefan Sädbom describes that exploration is a long and very involved process for geologists.

"We start by looking at the bedrock to try to figure out what parts of it have undergone potentially ore-forming processes. This geological mapping effort helps us recognise where to collect samples," says Stefan Sädbom, adding that because only a few percent of the bedrock is exposed, they need to examine the small patches available to them very carefully. "Using samples from the exposed bedrock, we try to understand if there are any indications that we should collect more, or deeper, samples by using methods like diamond drilling," continues Stefan Sädbom.

He then explains that they examine the core samples from the diamond drilling and send interesting sections to be crushed, ground and sent on to laboratories for analysis to find the content of different elements in the material.

"When the results of the analysis are returned after tree or four weeks we might realise that we should have drilled another 20 metres, but by then the drill is long gone, the area has been restored and the weather is too cold. Next year, we return to drill another 100 metres, just to be safe, and go through the whole process again, but this time we might discover that we should have drilled further to the right or to the left. And this keeps going over and over again until we understand what's down there," explains Stefan Sädbom. "If you can cut down on the time spent on exploration, you can save a lot of money by getting production started earlier or by not wasting money on a worthless project."

## Huge Operation

The way it's handled today, Stefan Sädbom describes that extraction is also a huge operation.

"When we find an interesting mineralisation, it happens that it occurs in the form of narrow veins or beds. These may be too narrow for any machine or mining equipment. This means it's necessary to extract the part of the bedrock containing the interesting metal along with large amounts of gangue on both sides. Since we can't risk losing any of the metal, all the excavated material needs to be transported to the surface, crushed and processed in a mineral processing plant," explains Stefan Sädbom. "If the value of the metal in the narrow veins is lower than the cost of processing the veins and gangue it's not an economically feasible operation."

He points out that the explosives they use, the drilling and the transportation of material costs a lot of energy and creates large holes in the bedrock. They also end up with large amounts of waste to be managed.

"It works, but the further down we have to go to extract the metals, the more difficult and expensive it gets," says Stefan Sädbom. "If we could make all stages of the operation more efficient, we could make it economically feasible to go deeper and to extract metals even when the content is lower."

## X for X-Ray

Stefan Sädbom informs that the X in X-Mine stands for X-ray fluorescence (XRF), where an element hit by X-rays returns radiation with a wavelength specific to the element in question, making it possible to identify the composition and elemental concentration of the material being examined.

"X-ray fluorescence has long been used to analyse the surface of rocks and the beam has at most been able to penetrate less than a millimetre. But now, methods of sending X-rays have been developed that can make a rock transparent to X-rays, allowing them to penetrate all elements lighter than lead. Now, we can also get signals from most elements from sulphur, with atomic number 16, to bismuth, with atomic number 83. So today, we have the technology to see through a core sample, which is called tomography, and get signals from inside the sample," says Stefan Sädbom.

According to Stefan Sädbom, one of the many great things about this technology is the ability to see where different minerals are located in a core sample and directly pinpoint veins of interesting metals and determine their metal content, without having to destroy the core sample.

"All I do is place the sample in a tube, put it in a device for analysis and wait between 10 and 60 minutes for every meter," says Stefan Sädbom.

He also points out that the core samples can be analysed on-site while the drilling is still in progress, revealing if you need to keep drilling or if you need to drill somewhere else instead.

"This is an incredible improvement of the efficiency of the exploration and it gives me as a geologist in-depth knowledge of how the metals and minerals are distributed in the rock in three dimensions," exclaims Stefan Sädbom.

## Sorting

The technology behind the X-Mine project's X-ray analysis device for core samples was originally developed by Orexplore. Stefan Sädbom saw the first prototype of the device in 2012 and the first commercial version was unveiled by Orexplore in Perth in Australia on May 1, 2018.

According to Stefan Sädbom, the X-Mine project is currently working on a next-generation version of the device that can detect a lower content of metals and on using the device to demonstrate

# X-MINE

Elemental analysis
3D structure
Mineralogy
Texture

## Penetrative X-Ray analysis and 3D-tomography of geological materials for improved efficiency in exploration and mining.

The X-MINE project is a unique cooperation between partners active in mineral exploration, mineral production, geological mapping and experts in development of highly advanced analytical instruments and process solutions. Focus is on:

* Penetrative XRF-scanning and 3D-tomographic imaging and assaying of exploration drill core

* Utilization of tomographic imagery and structural information in local-, to regional, 3D geological modelling

* Implementation of penetrative XRF-tomography and assaying in sorting of ore from waste rock.

# Digital mineral analysis and 3D visualization for the mining industry

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*Stefan Sädbom, Senior Exploration Geologist and chairman of Lovisagruvan and Orexplore. Photo: Orexplore*

how better 3D geological models can be created as exemplified by four different mines, including Lovisagruvan in Sweden and mines in Bulgaria, Cyprus and Greece.

However, as fantastic as he thinks it is to be able to analyse core samples using X-ray technology and create better 3D geological models, Stefan Sädbom claims they aren't stopping there. The same technology could also be used in a sorting plant to analyse all the material extracted from a mine and separate rocks containing metal from gangue.

"This way, we still have to bring the material up from the mine, but we don't have to crush and process everything. We can focus our efforts on the material that actually contains metals, says Stefan Sädbom.

## New Partner

Stefan Sädbom estimates that around 45 people from 15 different partners in several different countries are working on the X-Mine project, from the people building the thumbnail-sized sensors for the analysis device to the people 3D modelling several square kilometres.

"The latest partner is the Polish/Norwegian company Comex," says Stefan Sädbom. "Today, Comex manufactures sorting equipment that uses magnetic sorting, certain forms of X-rays or optical sorting. The company's role in the X-Mine project will be to build a sorting machine utilising the project's X-ray analysis device."

## Not a Replacement

While he believes the new X-ray analysis device will help geologists do their job a lot better, Stefan Sädbom views it as one more tool in the geologist's toolbox and not primarily a replacement for anything else.

"I won't stop using conventional analysis methods," adds Stefan Sädbom. "On the contrary, I think I will use them more since I will find mineralized parts of the core sample that I couldn't see with the naked eye."

He also adds that they want to be able to analyse core samples at the same rate they are produced by the drill.

"This corresponds to around one metre every ten minutes," explains Stefan Sädbom.

At this speed, he says they won't, at the moment, be able to achieve the same precision as conventional analysis methods and the material will still need to be analysed conventionally. However, he also adds that the current version is the first ever commercial version of an instrument of this kind and that their research is already achieving promising results that will further develop the tool. ■

*Kevin Rebenius, Orexplore. Photo: Orexplore*


*The technology behind the X-Mine project's X-ray analysis device for core samples was originally developed by Orexplore.*

### FAKTA

**Lovisagruvan**

Lovisagruvan is a small zinc-lead-silver mine located about 250 kilometers west of the Swedish capital Stockholm in the core of the historical Bergslagen mining district. The deposit was discovered in 1985 and full-scale underground mining under the current regime started in 2005.

**Orexplore**

Orexplore is a research and development performing equipment supplier providing novel X-ray technology for immediate and accurate analysis of non-organic materials, primarily minerals. Orexplore's initial products target the mining industry, covering brownfield exploration, grade control and greenfield exploration.
Located in Kista outside of Stockholm, Orexplore started as a Swedish company, but is now fully owned by the Australian drilling company Swick Mining Services.

**Euro Mine Expo 2018**

Stefan Sädbom will be present at Euro Mine Expo 2018 in Skellefteå on June 12 to 14. Together with other representatives from the X-Mine project, he will be hosting the presentation Penetrative X-Ray analysis and 3D-tomography of geological materials for improved efficiency in exploration and mining on June 12 between 13:00 and 14:00. He will also be available for questions along with other representatives from Orexplore in booth number 214 and other representatives from the X-Mine project and Lovisagruvan in booth number 215.