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Mining waste equals money

New method that reduces costs as well as environmental risk – sounds too good to be true? According to head of unit Päivi Kauppila, it's not!

Mining companies can achieve significant savings in mining waste management costs, if the properties of tailings are taken into consideration already during the beneficiation process. Waste becomes valuable when it is seen as material for structures in the earth construction in the mining area or as raw material that can be sold.

With this in mind, GTK launched a three-year project called KaiHaMe. The aim of the project was to find out how to minimise the amounts of hazardous mining waste and to decrease the environmental effects of waste disposal. One concrete issue to be solved was how to reduce the amount of arsenic in tailings. And that problem was solved, says GTK's **Päivi Kauppila**, head of the Industrial environments and recycling unit.

"We were able to reduce the amount of arsenic by changing the beneficiation process in a way that allowed us to extract valuable minerals as efficiently as before, while still having control over the properties of the waste produced. We were able to reduce the amount and solubility of the arsenic and sulphide minerals in the tailings."

The research was conducted with gold-copper ore from the Kopsa mine. The ore was subjected to beneficiation tests at GTK's Mineral Processing Laboratory in Outokumpu. The arsenic concentration in the modified tailings was 60% lower than in the tailings produced in the original process. The concentration of sulphur was as much as 90% lower. Their solubility was also significantly reduced.

"Tailings contain different substances depending on their origin, so what we can remove or recover from them varies accordingly," says Kauppila.

Hazardous waste is expensive waste

According to Kauppila, the sulphide minerals that are excavated from bedrock are one of the key factors that make mining waste management so difficult. Sulphide minerals react with air and water and generate acidity. The acidity then dissolves substances harmful to the environment, such as arsenic, from the minerals in the waste. Once the process starts, it is self-sustaining and very hard to stop. In a worst-case scenario it can keep on going uncontrolled for hundreds of years.

Different methods have been developed to control the process – such as waterproof structures for mining waste areas – that aim to prevent the acidic seepage water with high metallic concentrations from spreading to the surrounding environment. Building these waste areas is a large expense for mining companies.

The environmental acceptability of the waste can be increased by removing these harmful and easily reacting substances. The waste will still not necessarily meet the criteria for being classified as inert waste, but it will be closer to it.

"Much more complex and harder to build facilities must be constructed for hazardous waste than for inert waste, which of course means construction costs for storing hazardous waste are much higher."

When a mine is closed, different kinds of cover structures are used, and the layers of soil needed can be quite thick.

Kauppila also notes that the larger the amount and the more hazardous the waste being disposed of is, the larger the amount of the environmental guarantee is, which the mining company must pay to assure that they will take care of the after-care and rehabilitation of the area after the mine is closed.

"Optimising the composition of tailings saves money at very end of the mine's lifecycle, even if the costs of beneficiation rise a little from the optimisation. After all, companies should always have some capital reserved for closing, when there will be no more income from the mine."

Geopolymer – the new star of the circular economy

New raw materials – such as materials needed to produce geopolymer-based products – are an opportunity for mining companies to generate more income. A great example of a geopolymer that is produced by utilising industrial waste is the 'green concrete' commercialised in Australia. Green concrete is a highly durable product made with blast furnace slag and fly ash. It has been used to build intermediate floors for apartment buildings, for example.

Tailings can also include raw material for geopolymers such as porous ceramics. GTK participated in the CeraTrail project, coordinated by the University of Oulu that developed methods to produce products with a wide range of applications. Porous ceramics are used in several industrial applications, such as filters, catalyst supports, insulators and absorpents.

"Producing new raw materials from tailings would maximise the economic benefits from the tailings optimisation. Geopolymer research is a growing field, now that circular economy is generally taken into consideration more and more," says Päivi Kauppila.

Real-life challenges drive research

The idea behind the concept of a circular economy is seeing waste not as a necessary evil, but as a valuable resource. Promoting the circular economy is also a natural way to increase cooperation between different fields of expertise. The circular economy is also one of GTK's future focus areas, and sustainable growth is a keyword in many other industries as well.

"In this project we looked at optimising tailings from gold and base metal mines specifically, and next we want to find new cases to look at. We are also starting a research project called KOVEPRO that aims to study use of tailings in cemented paste backfill."

Environmental management of mines is GTK's field of expertise, firmly supported by GTK's Mineral Processing Unit. Päivi Kauppila is happy that mining companies cooperate in GTK's research.

"Real-life challenges drive research, and we try to produce solutions to those challenges together. All parties benefit from this cooperation and it will have a positive effect on a larger scale as well."

The KaiHeMe project was funded by the European Regional Development Fund (ERDF), the GTK, Boliden Kevitsa Mining Oy, FQM Altona Mining, Kemira Oyj and Endomines Oy. The tools and processes developed during the project are now part of GTK's selection of services.

Only 1% of mining waste is recycled in Finland

Around 124 million tonnes of material was excavated from mines in Finland in 2017. The share of waste-rock and topsoil was 78 million tonnes. Around 46 million tonnes of ore and useful stones from the total volume of excavation were processed, and half of that amount was removed from the process as tailings. Around 88 million tonnes of the total volume of excavation ended up as waste. Ten percent of the waste was reused in mining operations.

Source: Statistics Finland, 2019

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