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LKAB develops new technology for producing strategic minerals from mine waste

LKAB is now investing in pilot plant facilities and, together with environmental services company Ragn-Sells, will industrialise an innovative technology for upgrading mine waste from iron ore production. This may result in LKAB producing *phosphorus* and *rare earth metals*, which in the EU are classed as strategic minerals that are of particular importance to the industry.

Phosphorus is used mainly in the production of mineral fertilizers. Within the EU there is currently only one producer that mines its own resources; all other production is dependent on imported material. LKAB can establish production corresponding to more than five times Sweden's annual demand.

Rare earth metals are now produced almost exclusively in China, which accounts for about 95% of production. The EU is 100% import-dependent.

"LKAB's ores contain the phosphate mineral apatite, as well as rare earth minerals. It has not been profitable to extract these from waste materials and they are part of the material that is currently deposited in sand tailings ponds. Together with Ragn-Sells, we are creating conditions for industrialising a profitable extraction process. We will then build full-scale plants, where the tailings sand can be recirculated and processed into strategically important minerals without the need to develop new mines," says Jan Moström, LKAB's President and CEO.

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LKAB is an international and high-tech mining- and minerals group that mines and upgrades the unique iron ore of northern Sweden for the global steel market. Sustainability is core to our business and our ambition is to be one of the industry's most innovative, resource-efficient and responsible companies. The group had sales of more than SEK 23 billion in 2017 and employs about 4,100 people in 13 countries. Other group business include industrial minerals, drilling systems, rail transport rockwork services and property management.

An important component is the KMAP process, which has been developed by EasyMining, a subsidiary of Ragn-Sells. The process utilises the patented CleanMAP technology, which is a very energy-efficient way of producing pure ammonium phosphate, phosphorus fertilizer, and is better than any comparable technology. Via a chemical process, phosphates are separated from the toxic fluoride and arsenic, which are thereby removed from the ecocycle. Rare earth metals can also be separated from the mine waste.

Initially, two pilot facilities are planned: one plant in the orefields to produce an apatite concentrate and one plant, possibly in Uppsala, to upgrade the concentrate. Both plants will be commissioned in 2019 and will operate until 2020. During this period we will begin dialogue with supervisory authorities and other stakeholders with an aim to locating production in Norrbotten adjacent to our existing logistics system.

"We are pleased to be able, together with LKAB, to take the first step towards extraction of more resources from what is now considered mine waste, since we must be particularly careful with material that has been removed from the Earth's crust," says Lars Lindén, Group CEO, Ragn-Sells.

LKAB has a longstanding tradition of maximising resource utilisation by upgrading residual products and commercialising them via operations within the Special Products Division, headed up by Leif Boström.

"We now use both highly upgraded iron ore and residual products from LKAB's production, such as mixed ores and waste rock, to create products for industrial use, for example, ballast. Now our goal is to have a full-scale plant for production of ammonium phosphate and rare earth metals within five years," explains Leif Boström.

For LKAB, this production is important in many ways, according to President and CEO Jan Moström.

"LKAB takes great responsibility for minimising our environmental impact and ensuring that all resources from mine operations are utilised to the greatest possible degree. In addition, this generates income streams that make LKAB stronger and less sensitive to fluctuating business cycles, since this market does not have the same cycles as the iron ore market," concludes Jan Moström.

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Facts

CleanMAP
CleanMAP technology enables extremely energy-efficient and cost-effective production of very pure technical-grade ammonium phosphate. Cadmium content in the ammonium phosphate product is below 1 mg Cd/kg P; i.e., the product is significantly purer than the purest phosphorus fertiliser on the market. CleanMAP technology can be integrated into processes for phosphorus extraction from virgin or recovered material, e.g., sewage sludge or, as in this example, tailings sand from LKAB's production, via the adapted KMAP process.

KMAP
The process has been developed for processing apatite from LKAB's mine waste. The process can handle both types of apatite produced by LKAB in Kiruna and Malmberget and, in addition to phosphorus, it can extract rare earth metals. The process separates the arsenic and fluoride contained in the apatite; i.e., theses substances do not end up in the phosphorus fertiliser.

Phosphorus
There is a shortage of phosphorus. Europe's only phosphate deposit, in Finland, produces barely enough phosphorus to meet 10% of European demand. Owing to the shortage, phosphorus has been included on the EU's list of critical raw materials. Without access to phosphorus fertiliser, the agriculture industry would produce only about half as much food as we need. The world's largest phosphate deposit is in northwestern Africa, but it contains high levels of the heavy metals cadmium and uranium. LKAB's phosphorus product will be free from heavy metals and radioactive substances and will reduce dependency on imports from countries in geopolitically challenging regions.

Historical note:
Hjalmar Lundbom, LKAB's first General Manager, was tasked with finding mineable phosphate in Kiruna, which was when he discovered iron ore.

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