MATERIA

4–2025 | Lokakuu

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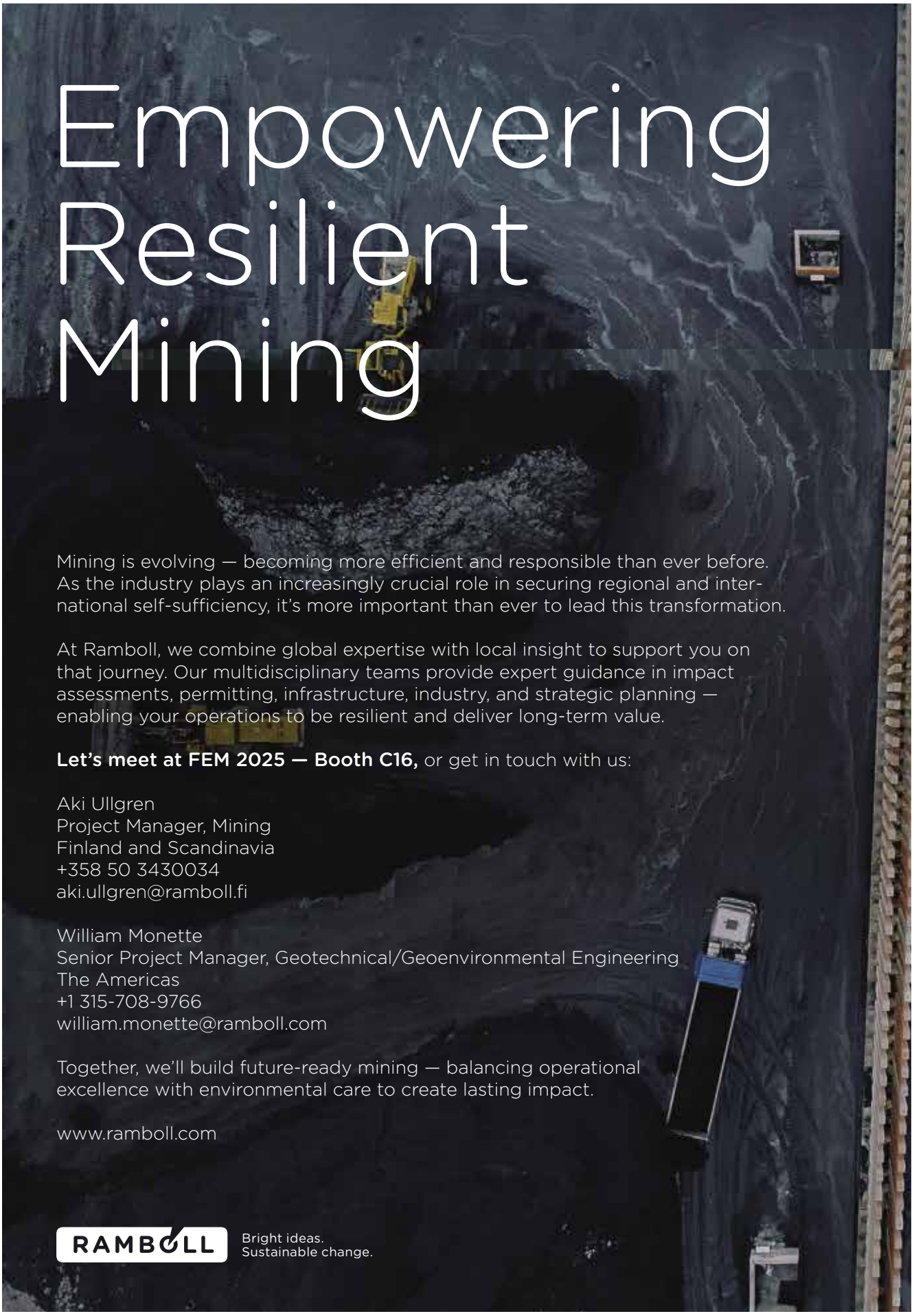

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MATERIA-LEHTI kattaa teknologian alueet geofysiikasta ja geologiasta lähtien ml. kaivos- ja prosessitekniikka ja metallurgia sekä materiaalien valmistus ja materiaalitekniikan erilaiset sovellutukset. Osa lehden artikkeleista painottuu alan ja yritysten ajankohtaisiin asioihin. Tiede & tekniikka -osa keskittyy tutkimuksen ja kehitystyön tuloksiin. Materia magazine covers all areas of technology in the mining and metallurgical field, from geology and geophysics to mining process technology, metallurgy, manufacturing and various materials technology applications. Part of the magazine focuses on what's happening in the field and the companies involved while the R&D section concentrates on the results of research and development.

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TAITTO Punamusta,
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KANSI: VTT:n uusi toimitusjohtajan Kalle Härkki
KUVA Leena K. Vanhatalo.

Dear reader!

You are holding in your hand the fourth issue of the MATERIA-journal. MATERIA is the official publication of The Finnish Association of Mining and Metallurgical Engineers (Vuorimiesyhdistys-Bergsmannaföreningen r.y.). The Finnish Association of Mining and Metallurgical Engineers has been the official media partner for the FEM-conference for over a decade, and due to the partnership, this issue is being handed out at the FEM 2025 conference and exhibition. As the event is highly international, we decided with the editorial staff to make this issue more suitable for the international participants of the conference. A careful reader will notice that this time we have quite a lot of articles in English. As a part of the partnership, the next issue of MATERIA-journal will contain the conference report.

In addition to international content, the issue contains also other articles from the area of mining and metallurgy as well as the regular columns of the journal.

Hyvä lukija!

Kädessäsi on MATERIA-lehden vuoden neljäs numero. MATERIA on Vuorimiesyhdistyksen jäsenlehti. Vuorimiesyhdistys on toiminut FEM-konferenssin (Fennoscandian Exploration and Mining conference) virallisena mediapartnerina jo ainakin vuosikymmenen. Osana tätä yhteistyötä tämä lehti jaetaan FEM 2025-konferenssin osallistujille. Koska tapahtuma on kansainvälinen, päätettiin lehden toimituksessa tehdä tästä julkaisusta paremmin kansainväliselle osallistujakunnalle soveltuva. Tarkkaavainen lukija varmaan havaitseekin lehdessä olevan runsaasti englanninkielistä sisältöä. Kuten tapana on ollut, julkaistaan seuraavassa MATERIA-lehdessä artikkeli konferenssitapahtumista.

Luonnollisesti lehdessä on myös vakiopalstat ja kattavasti sisältöä eri puolilta vuoriteollisuutta. ▲

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M2	30.3.	8.5.
M3	1.6.	10.7.
M4	14.9.	23.10.
M5	9.11.	18.12.

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Materia FEM 2025 Editorial

The Fennoscandian Exploration and Mining Conference (FEM) has taken its place as one of the most important events in the mining industry. It is more popular than ever, and it was sold out before the end of August.

Mineral exploration is the foundation of the mining industry and the first step in the whole value chain. Without exploration there would not be new discoveries and mines, and the metals and minerals that fuel our societies would remain in the ground. As the world accelerates toward a low-carbon future, the role of exploration has never been more critical. The energy transition, space technology, and increased inputs in the defence industry depend on securing reliable supplies of critical and strategic minerals. The solution begins with exploration.

Consequently, significant EU and national funding instruments and grants should be directed for early-stage exploration. In addition, regional modern high-resolution geophysical and geochemical surveys are needed, and existing geodata should be freely available.

At the same time, the exploration sector is confronting a unique set of challenges. Statistics indicate that discoveries are becoming ever harder to make. Geoscientists must search deeper, undercover, and in frontier regions that require new geodata, new technologies, new models, and new partnerships. This is driving a wave of innovation: machine learning applied to geoscience data, advanced geophysical tools, and sophisticated geochemical methods that can detect subtle signals of mineralization. These topics will also be presented at FEM 2025.

However, innovation on its own is not enough. The industry must also meet rising expectations for environmental stewardship, social responsibility, and governance. Investors, regulators, and communities alike are demanding higher standards of sustainability. Exploration and mining companies are responding by reducing their carbon footprints, adopting renewable energy in remote projects, and embracing circular economy concepts. Perhaps most importantly, there is a growing emphasis on building respectful, mutually beneficial relationships with local communities which is now as essential as the geology itself.

Another key priority is the future of the workforce. As the demand for critical minerals grows, so does also the need for skilled geoscientists, engineers, and technicians. Attracting young talent into the sector is vital, particularly as experienced professionals retire.

The FEM 2025 conference brings all these threads together. It is a forum for sharing knowledge, showcasing innovation, and building the partnerships that will define the future of exploration and mining. By connecting prospectors, researchers, industry leaders, investors, service providers, regulators and government representatives, we create the conditions for discovery and responsible development.

The challenges before us are significant, but so are also the opportunities. The active exploration and mine development in Fennoscandia will determine not only the future of the mining industry in the region. They form also an important part of energy transition, mineral resource security as well as of the national security of supply and defence. This conference is more than a meeting—it is a chance to shape that future together. ▲

IAIN HENDERSON, TERO NIIRANEN, JUHANI OJALA

Iain Henderson

Tero Niiranen

Juhani Ojala

Titanor Project in Kokkola Region - Building Europe's Supply of Critical Titanium

Titanium is one of the strategically most important raw materials of our time. Classified by NATO, European Union, USA, and several other countries as a critical and strategic metal, titanium is crucial in industries ranging from aerospace and defense to construction and healthcare. At present, the European Union operates no active titanium mines, leaving the continent heavily dependent on imports from Asia and Africa. This dependency represents not only an economic vulnerability but also a strategic risk, particularly in the light of increasing global competition for secure supply chains.

Titanor Oy, a Finnish company based in Kokkola, is developing one of the most extensively studied and advanced titanium projects in Europe. The ilmenite deposit under Titanor is not a new discovery - it has a history spanning more than five decades.

A Project with Deep Roots

The ilmenite deposit was first discovered in 1971 through regional aerogeophysics. Systematic exploration was carried out by the Geological Survey of Finland (GTK) between 1992 and 1997, followed by project development under Kalvinit from 1997 to 2012. During this period more than 25 kilometers of core drilling were completed, alongside test mining of 23 000 tonnes and pilot-scale processing of ilmenite concentrates.

A scoping study in 2012, prepared by Stantec (former Engenium), confirmed the technical and economic potential of the resource, outlining an open-pit mine producing 1,6 million tonnes of ore per year, with an underground option available. At planned full scale, the mine would produce 250 000 tonnes of ilmenite concentrate annually—equivalent to over 10% of EU demand—and an additional 50 000 tonnes of iron concentrate, with a mine life exceeding 20 years. Today, Titanor has assumed full ownership of the project and is advancing it toward construction.

Titanor board Markus Ekberg (left), Harri Takanen and Mikko Sopanen visit at Titanor project's drill core archive.

Geological Foundation

Titanor's ilmenite project is located in Western Finland, about 75 kilometers from the Kokkola Industrial Park, and within five kilometers of the national highway grid. This infrastructure provides an all-weather connection to the Port of Kokkola, ensuring efficient logistics for future exports.

Geologically, the project sits within the Central Finland granitoid complex, a Paleoproterozoic domain dating back 1,9 billion years. The mineralization occurs within layered gabbro intrusions that host ilmenite-magnetite ores. Five distinct mineralized intrusions have been delineated so far, each ranging from 0,5 to 1 km in width and 1–3 km in length. The ores occur in both massive and disseminated layers, while post-emplacement faulting and dyke intrusions have shaped the structural geology of the deposits. This robust geological framework underpins Titanor's confidence in the long-term viability of the resource.

Titanium Market Dynamics and Rising Demand

Titanium and its derivatives are in growing demand worldwide. Titanium metal is prized for its strength, light weight and corrosion resistance, making it indispensable for aerospace, defense and medical implants. Even

more significant is titanium dioxide (TiO_2), the pigment used in paints, coatings, plastics and packaging, as well as in sunscreens and industrial coatings.

Global demand is expected to grow at a rate of 4–8% annually through 2035, expanding the market from $12 billion today to $21 billion. Drivers include urbanization, construction and the expansion of aerospace and defense industries. For the EU, where consumption is high but domestic production limited, projects like Titanor are essential for securing future supply.

Ilmenite prices reflect this tightening market. Over the past decade, prices have more than doubled, rising steadily from around $150 per tonne in 2015 to $330–360 per tonne in 2025. With supply constrained and demand rising, analysts expect further upward pressure.

Ilmenite By-Products Enhance Value

Processing ilmenite yields more than titanium dioxide. Titanor's project also envisions the production of iron concentrate and iron sulfate ($FeSO_4$). The latter is increasingly used in water treatment and purification, wastewater management and as a soil amendment in agriculture. As demand for sustainable environmental solutions grows, iron sulfate represents a significant value-added by-product of ilmenite.

Titanor is also exploring apatite recovery for fertilizers and use of country rock for construction materials, reducing both the project's footprint and the EU's reliance on imported raw materials.

Titanor Path Forward

Titanor is now entering a new phase of development that will include several key activities. First, an Environmental Impact Assessment (EIA) will be carried out, covering multi-seasonal ecological surveys as well as social and health impact assessments. In parallel, a feasibility study will be undertaken, focusing on updating JORC models, refining the mine design and evaluating projected costs.

The company will also advance development projects, including research on by-product opportunities in apatite and the sustainable use of country rock materials. Titanor will develop its commercial strategy, working with industrial partners and progressing customer offtake agreements.

Strong Leadership and Local Ownership

Behind Titanor is a leadership team with deep expertise in mining and finance. Markus Ekberg, MSc Geology, founder and Chairman of Titanor, brings decades of interna-

Background in Mining and Metallurgy

Kalle Härkki appointed as the new President and CEO of VTT Technical Research Center of Finland

Doctor of technology Kalle Härkki has a strong background in research and management in the mining and metallurgical industry in Finland and globally. He started as the new President and CEO of the largest and most wide-ranging technological research institute in Finland, VTT on August 13th, 2025. Materia-journal visited VTT to interview the new CEO and to get an insight into his feelings and visions on the new task.

Personal viewpoints

On the day of the interview the new CEO of VTT met us in one of the meeting rooms on the first floor of VTT headquarters. Earlier on the same day he had received the title of professor belonging to his new position. He was very enthusiastic about his new task and felt like coming home to VTT as research organization environment and Otaniemi, Espoo are so familiar to him.

VTT is a comprehensive research organization with a wide range of fields of expertise. The wide experience of the new CEO in the

VTT's new President and CEO Dr.Tech. Kalle Härkki

Curriculum Vitae

Kalle Härkki

Nationality: Finnish

Year of Birth: 1969

Place of Birth: Otaniemi, Espoo

Education

1997 Helsinki University of Technology
Doctor of Science, Metallurgy/
Material Science

1993 Helsinki University of Technology
Master of Science, Metallurgy/
Material Science

Work experience

08/2025–
VTT Technical Research Centre of Finland Ltd./CEO

Board memberships in several SME industry companies.

10/2021 to 08/2025
Resand Oy / CEO

11/2016 to 06/2020
Outotec Oyj / Executive Vice President – President of Metals, Energy & Water Business Unit

06/2013 to 11/2016
Outotec Oyj / Executive Vice President – President of Minerals Processing Business Unit

04/2010 to 06/2013
Outotec Oyj / Executive Vice President – President of Services Business Area

11/2008 to 04/2010
Outotec Oyj / Senior Vice President – Services and After Sales

07/2005 to 12/2008
Outotec Research Oy / CEO

01/2003 to 07/2005
Outokumpu Oyj / Manager –Sales and Marketing

01/2001 to 01/2003
Outokumpu Oyj / Manager - Production

02/1998 to 01/2001
Outokumpu Oyj / Development Manager – R&D

Hobbies

Triathlon, golf, cottage vacation

management of both research organizations and international enterprises helps to adopt the new role. The work environment differs from the earlier ones, because the guidance of the state-owned company comes from the ministry. It will be interesting to see, how decision making goes in this system.

When asked about his personal observations after a couple of days he told he felt like a conductor put ahead of the symphony orchestra with the baton in his hand but without any preparation, as there are several important things going on in the organization and it's like jumping in a moving train. In VTT the number of both domestic and international operators is high, and the political sector has also to become acquainted. EU- dimension brings along its own interesting opportunities.

Target in technology leaps and advanced ecosystems

VTT aims to foster significant technology leaps with the greatest possible impact to enable the prosperity and growth of Finland. The priority areas of research are related to both systemic and technological global challenges as well as to technological and societal turning points.

Currently VTT concentrates on working on eight globally significant challenges. In systemic side carbon neutrality, productivity leap and the resilience of society are important research areas. In technological side VTT fosters quantum technology leap, super-performing materials, superior digital systems and the utilization of synthetic biology and energy technologies. Especially in quantum technology VTT sees many potential development areas, and the aim is to create a forerunner ecosystem, Finnish Silicon Valley, in this area.

The research lives in time and during its 80-year existence VTT has always focused on solving problems related to societal, technological, industrial and business challenges and turning points. The requisites of the world and enterprises change. This autumn VTT is starting the process for creating a new strategy to clarify how it can help its customers to renew their business and to become forerunners in advanced and efficient ecosystems. The work starts by surveying the greatest current and future challenges.

In global scale particularly technology-based growth companies have created economic growth and enhanced productivity. Finland has special competence in many disruptive technology areas and VTT wants to be involved in strengthening the prowess of these areas. Examples are, e.g., quantum technologies, semiconductors and microelectronics, health technology, defense and dual-use technologies as well as bio- and space technologies.

VTT is a limited liability company that is fully owned by the Finnish state

VTT was incorporated ten years ago and is still a fully state-owned company. This company form is fit also for research depending on goals. It allows commercial operations and enables the real corporate structure. Company form also sets the legal framework for company management, as the tasks of the board of directors and of the operative management are defined in the law. Company form also facilitates international activities.

The financing of VTT (296,4 M€ in 2024) consists of government subsidy (ca 33%), contested public co-financing (ca 41%) and commercial research (ca 23%). The government subsidy is mostly used as self-financing share in domestic or international research projects. About one half of the business comes from international collaboration.

Challenges and possibilities

VTT sees that the greatest and future challenges can be tackled, and this brings business opportunities for companies as well as opportunities for the country to grow. Economic growth in Finland requires both renovation of the traditional industry and creation of new technology-based growth areas. Without RDI (Research, Development and Innovation)-collaboration no growth can be obtained. VTT believes that RDI is the key for companies to renew and grow and sees great growth opportunities in the challenges it is seeking solutions to.

VTT sees that wide collaboration and ecosystem with companies, universities and research institutes are the key in solving massive challenges. VTT is a significant partner in creating together with collaborators effective technology innovations and solutions, which bring sustainable growth to enterprises and society, and prosperity to Finland. The collaboration of all interested parties is a big possibility, and internationality has a big role in this. The challenges are so great that no one can solve them alone.

VTT as a societal influencer

The aim of VTT is to help the Finnish society to renew. As a sovereign and unbiased research institute the task of VTT is to promote the utilization and commercialization of research and technology in business and

VTT Technical Research Centre of Finland in numbers (year 2024)

Founded in: 1942 (with the Finnish name Valtion teknillinen tutkimuslaitos)

Current company form: State-owned limited liability company

Number of employees: 2 386, of which:

- 87% with university degree
- 32% with doctorate or licentiate degree
- 60 different nationalities

Number of customers: 1 105, of which 940 domestic and international private sector customers

Total revenue: 296 M€, of which:

- net turnover 190 M€, of which 49% from abroad
- government grant 95 M€
- other operating income 11 M€

Result of the financial year: 2,8 M€

Equity ratio: 75,2%

Number of scientific articles: 598

Number of invention notices: 233

Number of spin-offs: 3, totally over 50

Patent families: 457

Greenhouse gas emissions: 5 612 CO_2 equivalent tons

Examples of spin-offs originated in VTT:

Spinnova: Produces durable and sustainable textile fibers from wood or waste.

EniferBio: The future of soya free aquaculture is waiting just behind the corner. EniferBio's PEKILO® P65 is sustainable fish food used in aquaculture.

Volare: Makes circular thinking a part of lipids and proteins production. Produces high quality ingredients for feed, pet food and cosmetics.

Solar Food: Transforms green electricity and captured carbon dioxide into edible calories.

CooliBlade: Supplier of thermal management solutions for the most demanding applications of high power electronics

OnegoBio: Epochal biotechnological company producing animal-free protein-protein via precision fermentation

Infinited Fibre: Transforms cellulose-containing waste into new and versatile textile fibers

The Warming Surfaces Company: Superfast, super thin and light digital heating technology, which transforms the surfaces of our habitat into smart heating surfaces

Carbonaide: The technology developed by this company enables the production of carbon dioxide neutral or even carbon dioxide negative high durability concrete

Paptic: Produces fiber based and recyclable material for replacing plastic packages

Semiqon: Develops quantum processors for the era of millions of qubits

Steady energy: Revolutionizes the energy landscape via carbon free technology and LDR-50 nuclear reactor for district heating

society. In close collaboration with private sector and other research organizations VTT promotes the ability of its customers to create and upscale innovations and grow sustainable business. VTT also helps domestic partners to get involved in international networks. Start-ups create new growth companies and economic growth. Deep-tech startups have an increasing role in creating growth overall, and VTT plays an important role in that area, as well.

Spin-offs and start-ups

VTT generates new deep-technology companies in growth areas. All together over 50 new spin-off companies have been founded thus far. VTT stays as an owner of its spin-off companies. During the years 2020-2024 31 spin-off companies originated in VTT accessed 10,5% of the total venture capital collected by all Finnish start-up companies.

VTT LaunchPad is a business incubator which commercializes VTT´s research and technology into spin-off companies by bringing together VTT´s researchers and IPR-knowledge, best business competence and financiers. In 2024 Financial Times included VTT LaunchPad in its list of leading European business incubators.

Internationality has a big role

Research is international by nature. Of the annual turnover of VTT 49% comes from abroad. VTT is actively involved in EU´s research projects and is, e.g., on 15th place among the 21 800 research operators getting money from EU.

Finland and VTT need international experts and currently the about 2 400 persons employed by VTT represent 60 different nationalities. The network of international customers and associates is extensive.

Internationality brings along possibilities to increase commercial activities and to develop and strengthen capabilities. By participating in substantial projects VTT develops its own expertise and looks for the best talent in international experts. The financial yield generated by international collaboration is used for own research and infra development.

The importance of technologies and RDI as tools in geopolitical and economical competition has increased. In the current geopolitical situation the RDI actors must carefully assess, which candidates can be considered as reliable partners.

Universities are significant partners

Universities are important for VTT, e.g., from the recruiting viewpoint. When pursuing for the future success of Finland we should think of the whole ecosystem via developing and increasing the expertise in universities, research institutes and in companies.

The central aim of the national RDI policy is to increase, develop and confirm the collaboration through the whole Finnish RDI system. VTT has strategic partnerships, e.g., with Aalto university. In collaboration the common utilization of research and technology infrastructures is important, and this must be further fostered.

Universities play a role in the basic research for revealing and understanding the backgrounds of different phenomena and developing expertise in this area. The task of VTT is to carry out applied research for developing further the ideas coming from the basic research and for enhancing the maturity of technologies to make them usable in business life.

VTT plays a significant role in increasing the readiness and maturity of ideas and technologies between the basic research and companies over the "Death Valley". There the risks and investments are high, as the new solutions and technologies are tested and scaled for ensuring their usability in real life and business. By offering expertise, infrastructure and collaboration networks VTT helps researchers and companies to cross over this stage and to become forerunners in their own areas.

Kalle Härkki is slightly concerned about the domestic development of expertise. It is essential to highlight the importance of expertise created at higher education levels. It is also a question of resilience and security of supply. The positive competence development must be started already in elementary school by increasing the role of basic skills in mathematics, physics and chemistry in education that forms a strong base for excellence already from the start.

To find the needed experts VTT must look also abroad. The competition for experts is heavy especially in niche areas like quantum technology. The reputation of VTT as an employer has developed positively and VTT gets good applicants for its open positions.

VTT and the mining and metallurgical industry

Many technologies which are strong in VTT are also applicable in mining and metallurgical industry. Especially the cross-disciplinary expertise of VTT is here important. In some specific areas like filtration and hydrometallurgy VTT has developed its own comprehensive expertise.

During the last years VTT has invested strongly in mining research and development. Three years ago a new research professorship was established in the research area Circular Economy of Energy Metals. Circular economy, utilization of side streams in mining industry and hydrometallurgy are the central research areas, and the aim is to study the material streams as comprehensively as possible.

VTT develops solutions enabling the production and recycling of metals and minerals from more challenging ores and surplus materials by more sustainable ways than the current practices. Closing the material cycles, efficient processes, new raw materials and the materials designed for a specific purpose are the tools under development. The research concentrates on technologies maximizing the value of raw materials.

CEO Kalle Härkki is familiar with the research world.

An interesting example of the diversity of materials research in VTT is our Integrated Computational Materials Engineering (ICME) concept VTT ProperTune®. Using advanced multiscale modelling we can create microstructurally accurate materials and loads under realistic conditions. VTT ProperTune® can be used for tailoring, developing and optimizing materials for specific uses: wear parts in mining and ore processing, battery materials for electric vehicles, etc. It can replace expensive, time-consuming testing and shorten the development time by an average of 50% while cutting the development costs by the same amount.

The research mentored by VTT and better recovery of metals create investments and new business possibilities for technology developers, material producers and users. A good example of this is the spin-off Hypermine Oy established in 2025. Its hyperspectral ore identification sensor developed by VTT can hundredfold the accuracy of decision making, increase profits by 10% and reduce the use of water and energy.

Finally

When asked what the new CEO of VTT would like to say to the readers of Materia-journal, the answer is short, sharp and to the point: Let Finland rise! ▲

TEXT: TUOMO TIAINEN
FOTOGRAPHS: LEENA K. VANHATALO

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AFRY is committed to following mining and metals industry principles targeting to minimise negative environmental, social, and economic impacts associated with mining and minerals processing activities. It promotes resource efficiency, minimising waste, and embracing recycling and circular solutions.

Welcome to meet us at the exhibition stand in the Fennoscandian Exploration and Mining conference (FEM) in Levi, Finland on 28 – 30 October 2025.

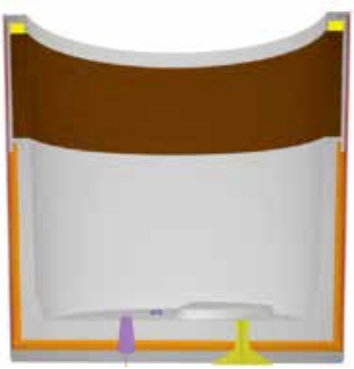
Tulenkestävät vuorausrakenteet metallien valmistusprosesseissa

Metallien valmistaminen ja yleisesti korkealämpötilaprosessit vaativat tulenkestäviä materiaaleja suojaamaan prosessin erilaisia rakenteita. Raudan, teräksen ja muiden metallisulien käsitteleminen ei ole mahdollista ilman tulenkestäviä vuorauksia. Tulenkestävät materiaalit tyypillisesti määritellään materiaaleiksi, jotka säilyttävät fysikaalisen muotonsa ja kemiallisen koostumuksensa korkeissa lämpötiloissa. Materiaalin on kestettävä vähintään 1500 ^{0}C:n ja tulenkestävän eristysmateriaalin vähintään 800 ^{0}C:n lämpötilaa. Kemiallisesti tulenkestävät materiaalit jaetaan kahteen pääryhmään runkoainemateriaalinsa perusteella: alumiinioksidi- ja magnesiumoksidipohjaisiin materiaaleihin. Runkoaineiden lisäksi tulenkestävät materiaalit sisältävät tyypillisesti myös sideaineita, lisäaineita ja huokosia. Tässä artikkelissa avataan hieman, millaisia erilaisia tulenkestäviä vuorausmateriaaleja prosessikohteissa käytetään.

Tulenkestävillä materiaaleilla on erilaisia käyttömuotoja, jotka voidaan jakaa kolmeen pääryhmään:

- Tiilet
- Massat ja rakenneosat (ts. monoliittiset materiaalit)
- Eristysmateriaalit

Metallien valmistuksen prosessikohteisiin valitaan tulenkestävä vuorausrakenne, joka koostuu yhdestä tai useammasta edellä mainitusta käyttömuodosta. Usein vuorausrakenne sisältää useampia kerroksia, joista jokaisella on oma tehtävänsä. Vuorauskokonaisuuden valinta vaatii syvällistä materiaali- sekä prosessituntemusta. Tulenkestäviä materiaaleja kuluttavat kemialliset, termiset ja mekaaniset rasitukset, jotka kaikki tulee ottaa huomioon kestävän ja turvallisen rakenteen aikaansaamiseksi. Metalleilla on usein tarkat puhtausvaatimukset, jolloin tulee tuntea vuorausmateriaalien vaikutukset metallin puhtauteen. Lisäksi täytyy ottaa huomioon prosessikohtaiset materiaalien asennukseen liittyvät vaatimukset. Tällaisen kokonaisuuden suunnittelu vaatii tyypillisesti tiivistä yhteistyötä tulenkestävien materiaalien valmistajan ja metallinvalmistajan välillä. *Kuvassa 1* on esimerkki senkkavuorauksen useamman komponentin vuorauskokonaisuudesta.



Kuva 1. Senkkavuorauksen monikomponenttikokonaisuus kuvattuna skemaattisesti

Tulenkestävässä vuorausrakenteessa sulaa metallia vasten on kulutusvuoraus, jonka tehtävänä on toimia mahdollisimman inerttinä kerroksena sulaa metallia vasten sekä kestää siihen kohdistuvat rasitukset vaurioitumatta. Kulutusvuoraukseen kohdistuu termisinä rasituksina merkittävän korkeita lämpötiloja sekä voimakkaita lämpöshokkeja, kun esimerkiksi sulaa kaadetaan käsittelyastiaan. Vuorauksen lähtökohtainen lämpötila voi olla merkittävästi sulaa alhaisempi. Mekaanisina rasituksina kulutusvuorauksen täytyy kestää sekä sulan kaadoista aiheutuvia iskuja että metallisulien virtauksien aiheuttamaa eroosiota. Kemiallisia rasituksia ovat esimerkiksi reaktiot sulan metallin, kuonan, kaasujen tai atmosfäärin kanssa. Kulutusvuoraukseen kohdistuvat vuorauskokonaisuudessa suurimmat rasitustekijät, jolloin sen materiaalin ja valmistusmenetelmän valinta muodostuvat rakennetta ajatellen kriittisimmiksi. Kulutusvuoraus on vuorauskokonaisuuden komponentti, joka haastavien olosuhteiden takia kuluu eniten ja joudutaan vaihtamaan tai korjaamaan ensimmäisenä. Tyypillisesti kulutusvuorausmateriaalit koostuvat korkealuokkaisimmista tulenkestävistä raaka-aineista. Materiaalilla on tyypillisesti erittäin korkea tulenkestävyys ja korkea kuumalujuus.

Useammasta komponentista koostuvassa vuorausrakenteessa kulutusvuorauksesta seuraava kerros on tyypillisesti taustavuoraus. Taustavuorauksen rasitusvaatimukset ovat merkittävästi kulutusvuorausta alhaisemmat, ja sen tehtävä on toimia turvakerroksena, joka pystyy kestämään sulaa vastaan, mikäli kulutusvuoraukseen aiheutuu vaurioita, ja metallisula pääsee tunkeutumaan sen läpi. Lähtökohtaisesti taustavuoraus ei kuitenkaan joudu sulakontaktiin. Toinen taustavuorauksen merkittävä tehtävä on lämmöneristävyys. Taustavuoraus huolehtii omalta osaltaan prosessin lämpötaloudesta estäen kulutusvuorauksen lämmönhukkaa, jolloin myös sulasta metallista lämpöä pääsee karkaamaan mahdollisimman vähän. Taustavuoraukset kestävät prosessissa usein pitkään ja taustavuorauksen elinkaaren aikana vaihdetaan tyypillisesti yksi tai useampi kulutusvuoraus. Materiaaliteknisesti taustavuoraukselta vaaditaan kulutusvuorausta alhaisempaa tulenkestävyyttä ja lujuutta, mutta niiden on oltava kuitenkin sellaisella tasolla, että ne kestävät mahdollista hetkellistä sulan metallin kontaktia vastaan.

Taustavuorauksesta seuraava ja yleensä viimeinen vuorauskerros on prosessiastian metallivaippaa vasten oleva eristysvuoraus. Eristysvuorauksen tehtävänä on nimensä mukaisesti estää prosessista aiheutuvaa lämmönhukkaa eli pitää astian sisällä olevan metallin ja vuorauksen lämpötila mahdollisimman korkeana ja stabiilina. Eristysvuorausmateriaalit ovat yleensä tiiliä, villoja ja kuituja, joilla on alhainen lämmönjohtavuus ja korkea huokoisuus. Eristysmateriaalit eivät kestä korkeita lämpötiloja, joten eristysvuoraus ei kestä kontaktissa metallisulaa vastaan.

Erilaisten vuorauskerrosten lisäksi vuorauksia paikkaillaan usein erityyppisillä kor-

jausmateriaaleilla, joiden tehtävä on paikata vuoraukseen aiheutuneita koloja ja kulumia. Korjausmateriaali on tyypillisesti koostumukseltaan lähellä korjattavan pinnan materiaalin koostumusta. Merkittävä tekijä korjausmateriaalin toimivuuden kannalta on oikean asennustavan valinta. Erilaisia asennustapoja ovat esimerkiksi valaminen, ruiskuttaminen ja slammaaminen. Valintaan vaikuttavat korjattavan kohteen olosuhteet, sijainti sekä käytettävissä oleva laitteisto. Korjaamista voidaan suorittaa prosessista ja materiaaleista riippuen joko kuumaan tai kylmään pintaan. Tyypillinen korjauspraktiikan ongelma on, että korjaukset kestävät tyypillisesti prosessiolosuhteissa tavalliseen vuoraukseen nähden verrattain heikosti. Korjausten avulla on kuitenkin mahdollista pidentää vuorauskampanjoiden pituuksia. Korjausmateriaalien käyttötarvetta ja korjaamisesta saatuja hyötyjä tulee arvioida prosessikohtaisesti. *Kuvassa 2* on esimerkki senkan kulutusvuorauksen korjaamisesta ruiskuttamalla.

Tulenkestävän vuorausrakenteen suunnittelu vaatii prosessin, materiaalien ja niiden välisten reaktioiden syvällistä ymmärtämistä. Jokaisella vuorauskerroksella on omat, erilaiset tehtävänsä, mikä asettaa materiaaleille omat vaatimuksensa. Tyypillisesti huolellisen suunnittelun lisäksi onnistuneen kokonaisuuden aikaansaaminen vaatii useita tulenkestävien materiaalien testejä, joissa voidaan todeta vuorauskokonaisuuden toimivuus. Lisäksi pienetkin muutokset prosessissa voivat aiheuttaa merkittäviä muutoksia tulenkestäviä materiaaleja rasittaville olosuhteille ja täten muuttaa vuorauskokonaisuuden uudelleen suunniteltavaksi ja testattavaksi. *Kuvassa 3* tulenkestävien materiaalien valmistaja tarkastelee vuorauksen toimivuutta asiakkaan prosessissa. ▲

TEKSTI: MIKAEL NIVALA

Kuva 2. Senkan vuorauksen korjaaminen ruiskuttamalla

Kuva 3. Tulenkestävien materiaalien testaaminen vaatii tarkkaa seurantaa.

Promoting national dam safety standards and sustainable mining practices through GISTM

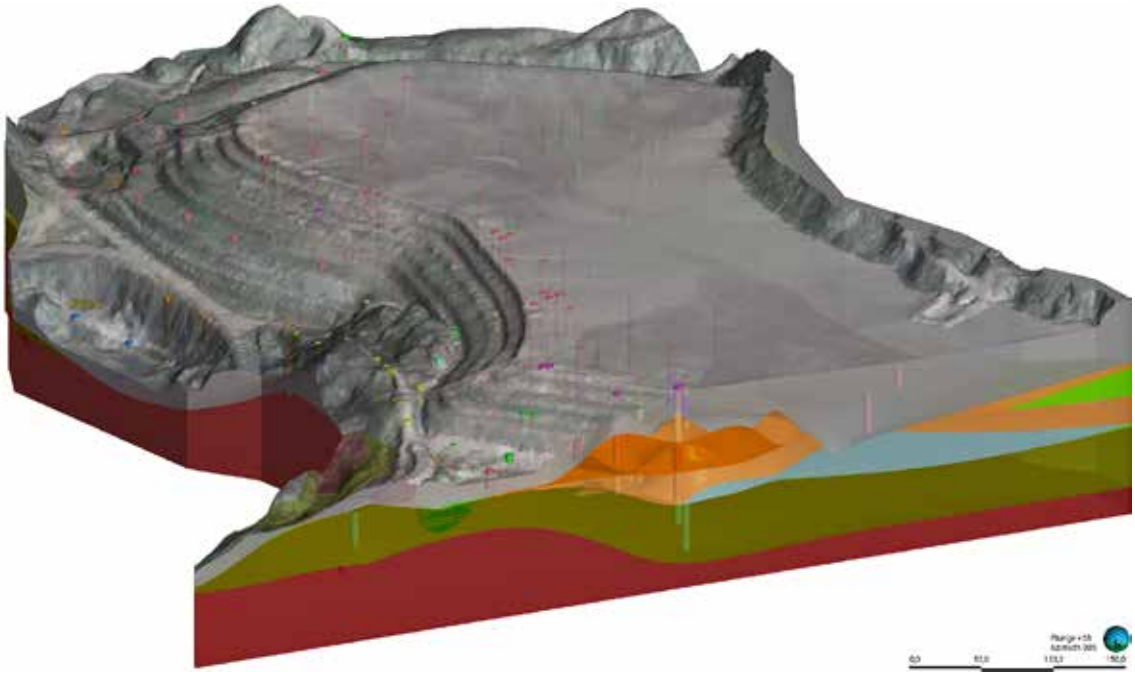
An internationally recognised and applied standard, GISTM can position mining companies to streamline the permitting process across different localities. Finnish mining explorers and operators should take note – integrating GISTM from the start could prove strategically important.

The Global Industry Standard on Tailings Management (GISTM) was developed to improve tailings dam safety, minimise risks, and protect communities and the environment. Released in 2020, the standard was developed in response to a series of catastrophic failures like the Brumadinho dam disaster of 2019. The goal of GISTM is zero harm.

The International Council on Mining and Metals (ICMM) comprising of global leading mining companies, United Nations Environment Programme (UNEP), and the Principles for Responsible Investment (PRI) assembled a multidisciplinary panel to create global guidelines for mining operations to ensure safety.

For mining companies to access funding and reasonably priced insurance, and win permits for their operations, GISTM is fast becoming a prerequisite.

In Finland, dam safety standards are governed by laws such as the Dam Safety Act and guidelines from the Ministry of the Environment. Even though the Finnish dam safety practice can be considered to be relatively comprehensive, comparing Finnish standards to GISTM reveals insights that



Leapfrog model from one of the Boliden operated Tailins Storage Facilities (TSFs), created by Ramboll, shows the tailings surface, classified layers within the tailings, and foundation layers of the TSF, along with CPTu drillhole data on material properties. In TSF closure planning, creating accurate models is crucial for adhering to GISTM standards, as they ensure safe and effective mitigation of risks like seepage and structural failure. By integrating detailed material properties, these models guide robust and sustainable closure designs that protect communities and the environment.

can enhance local dam safety practices. Integrating GISTM from the outset would ensure that safety, environmental protection, and community engagement are embedded throughout all stages of mineral operation.

Advanced risk assessment and management

GISTM utilises advanced risk assessment methodologies, including regular evaluations of potential failure modes and consequences. It mandates a thorough risk assessment for tailings facilities, ensuring stringent safety measures for those with significant potential impact.

Finnish standards, too, state that dam operators must conduct risk assessments based on national guidelines, considering factors such as dam location, design, materials, and historical performance. Authorities can draw on the GISTM to enhance competence in dam stability calculations, which will improve the accuracy of risk assessments and the determination of thresholds for catastrophic failure risks.

Strengthened governance and accountability

Finnish standards place accountability primarily on dam operators, with oversight provided by governmental bodies such as the Ministry of the Environment. GISTM creates a more thorough accountability structure, by including an appointed accountable executive separate from day-to-day operations and responsible for tailings facility safety and compliance.

Under GISTM, a responsible tailings facility engineer is required for each site under operation. The standard also requires an independent reviewer or independent technical review board to review implementation of the standard through the lifecycle of the tailings facility.

Following GISTM guidance to strengthening governance with dedicated roles and accountability measures provides a significant way to enhance Finnish practices.

Importance to lenders and insurance companies

From the perspective of lenders and insurance companies, adopting GISTM is increasingly seen as mandatory.

The stringent standards and comprehensive management practices associated with GISTM reduce the risks of catastrophic failures, making projects more attractive for both funders and insurance providers. Financial institutions and insurers view compliance with GISTM as a sign of responsible management and risk mitigation, resulting in more favourable loan conditions and insurance premiums for compliant projects.

For lenders, evaluating alignment with GISTM is the priority when seeking to grant green loans – loans adhering to certain environmental, social, and governance (ESG) standards – in mining. Lenders regularly audit and evaluate projects they have funded to assess their adherence to these standards and determine whether they can lend more, without breaching their ESG policies. In these ways, GISTM adherence could improve access to capital and deliver favourable lending and insurance conditions for mine operators.

Greater stakeholder engagement

GISTM requires robust engagement with stakeholders, including local communities, ensuring transparency and inclusivity in decision-making processes.

Under this standard, public reporting of risks and performance is mandatory. While Finnish standards encourage stakeholder engagement, it does not need to be as extensive and is less integrated with tailings management.

GISTM requires in-depth human rights due diligence to assess the likely impact of any mine project on affected local communities. Stressing the importance of meaningful engagement, the standard requires project-affected people to be involved in decisions affecting public safety and the integrity of the tailings facility. Under Finnish practice, these processes are generally covered under Environmental Impact Assessment.

Robust emergency preparedness

GISTM mandates that dam operators have detailed Emergency Response Plans (ERPs) and conduct regular drills involving local communities and emergency services. These plans must be reviewed and updated annually. Finnish standards also require ERPs, but the frequency and extent of updates and drills can vary. Harmonising Finnish protocols with GISTM's stringent preparedness measures can ensure a proactive approach to managing emergencies.

Training and capacity building are critical components, including comprehensive educational programmes for staff, simulated emergency response drills, practical training with advanced monitoring equipment, and continuous professional development.

Innovative approaches brought by GISTM

GISTM promotes the use of cutting-edge technologies for real-time monitoring, such as drones equipped with high-resolution cameras and sensors and satellite-based systems tracking surface movement to detect early signs of instabilities.

The mining industry has started to adopt real-time monitoring systems and predictive analytics utilising sensor networks to continuously gather and analyse data, enabling pre-emptive measures. The use of InSAR (Interferometric Synthetic Aperture Radar) technology provides precise measurements of ground movement, allowing early detection of risks.

Environmental and social considerations are deeply integrated into GISTM, including sustainable tailings management, reducing water usage through recycling and treatment processes, and ongoing community engagement programs to enhance transparency.

GISTM brings strategic advantages

GISTM governs all aspects of dam safety standards and mining practices, and expands the accountability structure, promoting advanced safety and monitoring measures at every stage.

Applying GISTM from the outset is beneficial for every stage of mineral exploration and mine operation. While Finnish standards do offer protections and assurances, they are not as robust and holistic as GISTM. Furthermore, GISTM is internationally recognised and applied; adopting it can bring mining companie strategic advantages, especially in streamlining governance, safety practices and permitting processes across different locations. ▲

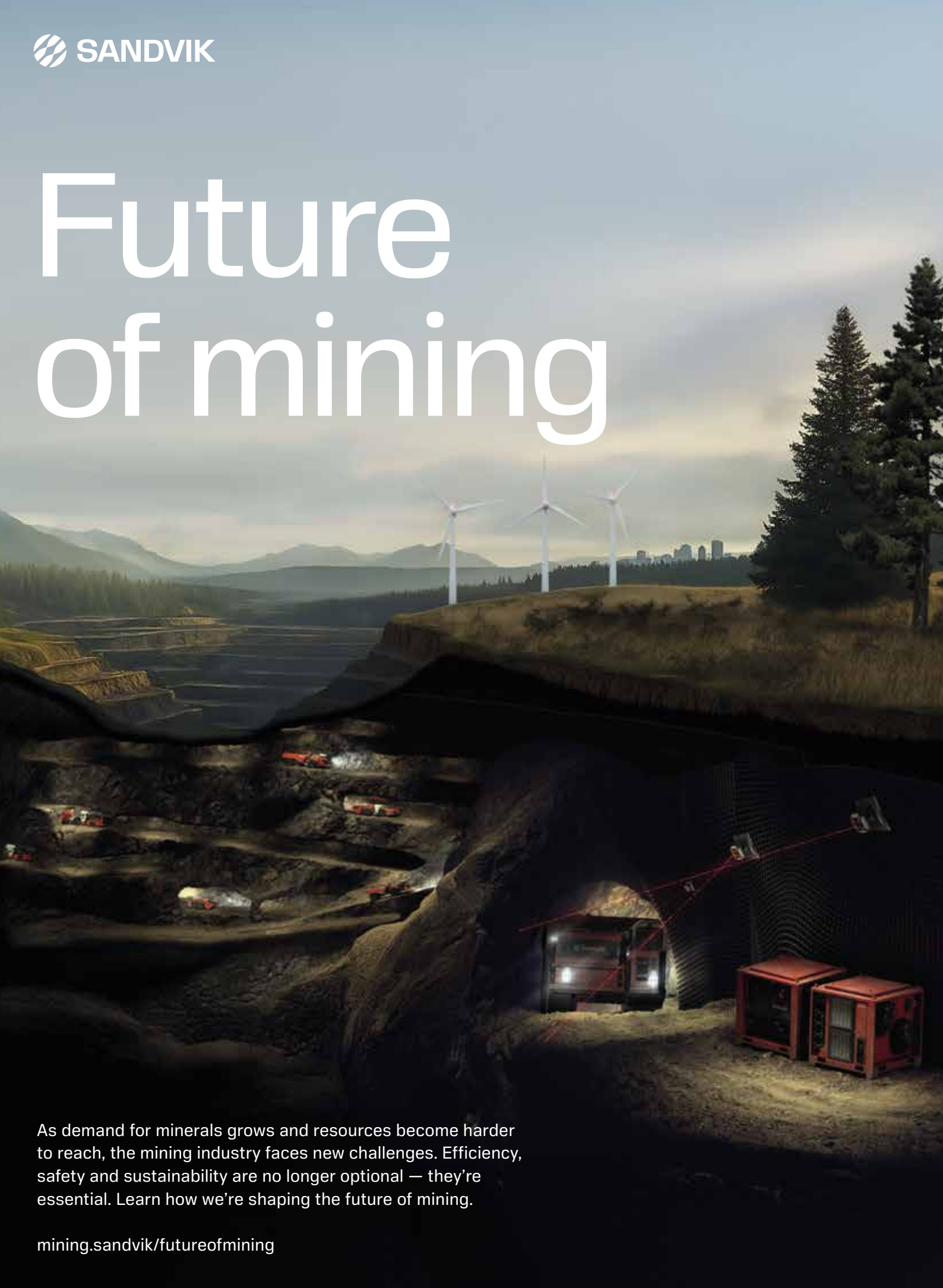
WRITERS: AKI ULLGREN & NATHAN GAASENBEEK, RAMBOLL

Project manager Aki Ullgren has 15 years of experience in the mining and exploration industry. He specialises in developing and implementing strategies to improve operational efficiency and risk management, with expertise in dam safety, GISTM, mine water management, rock mechanics and geotechnical modelling.

Leading consultant Nathan Gaasenbeek has more than 25 years of experience in providing environmental and technical solutions focusing on the mining industry. He has managed and contributed to numerous mining consultancy projects both in Finland and internationally.

SANDVIK

Future of mining



As demand for minerals grows and resources become harder to reach, the mining industry faces new challenges. Efficiency, safety and sustainability are no longer optional — they're essential. Learn how we're shaping the future of mining.

mining.sandvik/futureofmining

Flue gas emission monitoring and process control as a pillar of sustainable industry

The metal and mining industry is among the most energy-intensive and emission-heavy sectors globally. Processes such as ore processing, enrichment and smelting generate flue gases that contain a variety of harmful pollutants. As environmental regulations tighten and sustainability has become a strategic priority, flue gas emission monitoring and process control have become essential elements of responsible industrial operations. These technologies help to ensure regulatory compliance, improve process efficiency, reduce operational costs, and to support long-term environmental goals.

Understanding flue gas emission monitoring

Flue gas emission monitoring refers to the continuous measurement of pollutants released from industrial stacks during combustion or chemical processes. In the metal and mining sector, typical emissions include sulfur dioxide (SO_2) from smelting sulfide ores, nitrogen oxides (NO_x) from high-temperature combustion, particulate matter (PM) from dust and ash, carbon monoxide (CO) from incomplete combustion, heavy metals such as mercury and arsenic, volatile organic compounds (VOC) from chemical treatments, and carbon dioxide (CO_2) from combustion and chemical reactions.

Reliable and continuous measurement is essential for effective emission monitoring. In many industries, this is achieved using Continuous Emission Monitoring Systems (CEMS), which provide real-time data on pollutant concentrations and flow rates. These systems form the foundation for data-driven environmental management.

Integrating emission data with process control systems

Emission data collected through CEMS can be integrated into process control systems to enhance operational performance. Adjusting combustion parameters based on real-time data improves fuel efficiency and reduces unnecessary emissions. Similarly, precise control of reagent injection in flue gas treatment systems ensures effective pollutant removal while minimizing chemical consumption.

Monitoring also enables early detection of equipment failures, such as broken filter bags or malfunctioning scrubbers, helping to prevent unplanned downtime and costly repairs. Predictive maintenance strategies can be built around emission data, allowing operators to anticipate wear and tears before it leads to system failure.

In addition to operational benefits, integrated emission monitoring simplifies compliance reporting and environmental audits. Automated data logging and analysis streamline documentation for authorities, helping companies to meet environmental standards and demonstrate transparency to stakeholders.

CO_2 capture technologies for a low-carbon future

Beyond emission monitoring, industries are adopting technologies that actively reduce greenhouse gas emissions. Carbon dioxide capture is one of the most effective strategies for reducing industrial emissions and it plays a key role in decarbonizing sectors such as power generation and steel, cement and chemicals production.

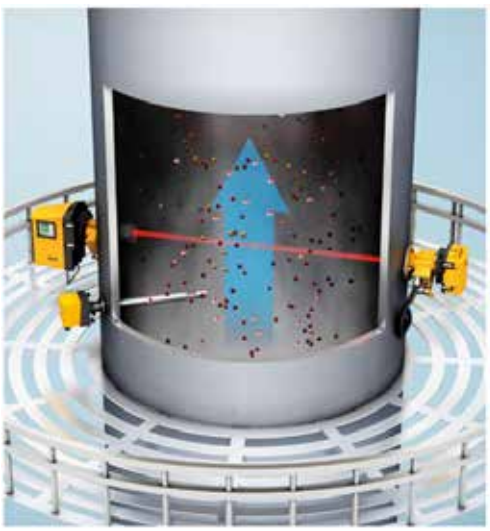
Accurate and continuous measurement is essential throughout the carbon capture, utilization, and storage (CCUS) value chain. From monitoring solvent quality and reaction conditions to controlling process parameters, ensuring safe transport and long-term storage, instrumentation provides the data needed to maintain performance, safety, and compliance. In chemical absorption processes, for example, pH and conductivity measurements are critical for maintaining solvent effectiveness and water purity. Flow, pressure, temperature, and level monitoring help to ensure stable operation and enable precise control of capture and compression stages.

Driving industrial sustainability forward

As industries accelerate their transition toward low-carbon operations, the importance of precise and integrated measurement technologies continues to grow. To support this transition, Endress+Hauser and SICK started a strategic partnership in the field of process automation in early 2025. This collaboration strengthened Endress+Hauser's portfolio with high-performance solutions for emission and process monitoring, particularly in the areas of gas analysis and flow measurement.

Thanks to this partnership, customers now benefit from a broader range of technologies available from a single source, along with deeper expertise in emission measurement. Endress+Hauser is committed to help industries in meeting their sustainability goals with confidence and precision. ▲

TEXT: TIMO VÄLIKANGAS
PHOTOS: ENDRESS+HAUSER



In situ and extractive gas measurement for emission monitoring

Mining industry can lead on biodiversity work

The mining sector is navigating a rare opportunity: meeting the world's growing demand for minerals while actively restoring and enhancing the landscapes it touches. Many operators have already shown leadership—restoring wetlands, funding conservation partnerships, planting native habitats, and including biodiversity in site plans. The challenge now is to scale those successes, connect them across landscapes, and use new tools so that biodiversity becomes a measurable business advantage rather than an afterthought.

Reimagining aftercare —mines as biodiversity assets

Mine closure and reclamation need not be mere obligations. Premeditated aftercare can convert former mine areas into valuable habitats—meadows, wetlands, or deadwoodrich forests that support species and ecosystem services. Such outcomes create value and also strengthen local acceptance creating cultural benefits that support the local economics and communities.

Safety first—and nature matters

Many mining companies already put safety at the centre of operations; aligning that culture with biodiversity goals multiplies benefits. Ecological solutions—stabilized covers, restored riparian buffers and engineered wetlands—reduce erosion, manage stormwater and cut dust emissions, all of which lower operational hazards. In short, investing in nature improves also operational safety, investing in a safer, more resilient mine.

Industry under vast transformation

The mining sector in Finland and globally is undergoing a major transformation. The green transition is pushing demand for critical minerals, while public expectations for sustainable land use are rising.

Historically, mining has caused habitat loss and fragmentation as well as hydrological changes. Traditional mitigation—water protection, dust control, reclamation—remains necessary but is increasingly insufficient. The next step is a net-positive mindset of integrating biodiversity objects across the project life cycle with the aim to leave operational sites in an improved ecological state as compared to the conditions prior to mining.

Regulatory context – a window of opportunity

New policy frameworks, such as CRMA, aiming at securing critical materials, increa ingly recognise environmental safeguards.

Authorities may prioritise and create fast tracks for projects that go beyond compliance and demonstrably enhance biodiversity. In practice, plausible rapid assessments showing how a project can deliver measurable biodiversity improvements can both strengthen permit applications and create exemplars for the sector. In the green transition, biodiversity is not a side issue but a core element of sustainable competitiveness and social licence to operate.

The mining industry has a unique opportunity to become a pioneer in biodiversitypositive development – tools exist for accomplishing it!

Quantifying ecosystem service benefits and valuations is necessary to support payments for ecosystem services, conservation financing or biodiversity offset markets.

Measuring biodiversity – moving toward transparency and comparability

Biodiversity was long seen as difficult to quantify. Today, consistent metrics and spatial data make transparent assessment possible. Standardised approaches can describe baseline biodiversity, forecast impacts of design choices and calculate net change under different scenarios. Integrating these metrics into planning turns biodiversity commitments from narrative into auditable outcomes, satisfying regulators, investors and communities alike.

Metrics such as Finland's Ryty approach and the UK Biodiversity Metric enable consistent assessment of how much biodiversity a site currently supports, how planned interventions will change that level, and whether actions deliver a positive net benefit for nature. Sitowise Smartlas enables one to integrate biodiversity metrics and produce automated site-level biodiversity net gain (or loss) estimates from spatial data layers. Scenario modelling during impact assessment allows teams to compare mine layouts, waste placement and aftercare strategies for their biodiversity outcomes and tradeoffs. Identifying priority sites for offsets or compensation, and linking them to durable restoration projects,hepls to ensure that gains are real and sustained. For mining companies, these tools turn biodiversity commitments from reputational claims into measurable

outcomes that can be reported, audited and improved over time.

From mitigation to netpositive outcomes

Responsibility in mining has traditionally focused on minimizing harm—protecting water, controlling dust and noise, and reclaiming land after closure. While these remain necessary, many companies are now shifting toward a netpositive paradigm—not only reducing impacts but leaving nature in a better state than before operations began. A genuine netpositive strategy asks for three shifts:

- Early integration: consider biodiversity at siting and design stages, not just at closure.
- Landscape thinking: plan restorations that contribute to connectivity and regional priorities.
- Longterm assurance: secure funding, governance and monitoring for decades beyond closure.

These shifts turn singlesite wins into landscape scale impact that benefits species resilience, ecosystem services and community wellbeing.

Sustainable solutions

Circular solutions that reuse waste rock and tailings as secondary materials reduce new land disturbance and unlock opportunities to design new habitats. Collaboration with local communities, research institutes and conservation organisations is crucial to co-design solutions that support both livelihoods and ecosystems.

High-quality, up to date data endorses good decisions. Remote sensing and AI can map habitat quality, detect invasive species spread, and model flood or fire risk under different climate scenarios. Combined dashboards—bringing together satellite data, field surveys and community observations—allow adaptive management and transparent reporting.

Field teams and local citizens are also valuable data sources. Enabling simple mobile reporting for staff and residents turns everyday observations into a continuous monitoring stream and strengthens stakeholder engagement. Participatory monitoring connects safety and stewardship—workers and residents report observations that matter for both people and ecosystems.

Human factor – key to success

We can restore what we have changed in nature, but it is more difficult to rehabilitate the human mind. Whilst there are new tools and approaches to measure our actions in nature, the most difficult game for the mining industry to play is not with the authorities but with the communities. The emotional bond people form with places is fragile and slow to rebuild when broken.

Narratives matter

A former quarry turned birdrich wetland used by local schools, a tailings cover transformed into blooming meadows that bolster pollination for neighbouring farms, or a restored riparian zone that reduces flood risk—these are concrete outcomes people recognise and defend. When communities and employees see transparent biodiversity actions that also reduce local hazards (flooding, erosion, dust), their confidence in the project increases.

Engagement, meaningfulness and positive emotions, for example, on accomplishments or pursuit of goals and purpose beyond oneself—create happiness. Publish methods and monitoring openly, let stakeholders see and contribute to progress; this can play a huge role for securing local acceptance. Companies that go beyond compliance—and can prove it with data—strengthen community support.

The way forward – lead by doing

Many companies already include biodiversity in strategy, from site action plans to conservation partnerships. The next phase is to weave these efforts into coherent, measurable programmes that scale across operations and landscapes. Practical steps include compiling existing wins, choosing standard metrics, piloting high ambition restoration projects, securing long term funding and publishing auditable results.

Biodiversitypositive mining requires commitment, collaboration and courage. Where companies combine measurable goals, data-driven planning and durable restoration investments, the industry can build scalable models for other sectors—strengthening permits, investor confidence and social licence while genuinely contributing to nature's recovery. ▲

SITOWISE – Redefining Smartness for Mining Industy
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ARTICLE: ALIISA WAHLSTEN, HELI NUKKI, EERIKA TAPIO, PHOTOS: HELI NUKKI

PHOTO: JUKKA BRUSILA.

CINTEM - methods for integrating mining projects in the circular economy

The Circularity-Integrated Mining (CINTEM) project aims to increase the recovery rate of extractive waste and to improve resource efficiency by integrating circular economy into the mining project already at the planning stage. The project presents a new way to plan a mining project.

Over 90% of mined material in metal mining ends up unused as waste rock or tailings. At the same time the need for minerals and metals is growing because of the ongoing green transition. This will significantly increase the generation of mineral waste from metal mining unless we address the issue. Despite the massive volume of mining waste and costly waste management, the utilization of side streams such as tailings in the mining industry is still in its infancy. Yet, mining waste holds value.

"The circular economy must be considered already in the planning stage of the mining project. The idea is to increase utilization of not only metals but all minerals like industrial minerals and other mineral materials of the deposit. All this combined with new business models based on industrial symbiosis makes the CINTEM project unique", explains research professor **Tommi Kauppila** from Geological Survey of Finland, GTK.

Reducing mining waste by geological knowledge

The European Commission launched the Critical Raw Materials Act (2023) for promoting a more sustainable and circular critical raw materials economy. One of the EC's targets is to require member states to recover critical raw materials from mining waste. The CINTEM project goes beyond this target by providing a new way to approach mining projects.

The CINTEM project promotes the utilization and co-productization of side streams with a new type of data and planning model. This new model helps to improve recovery rates, reduce environmental risks, and increase financial benefits.

"The core of the CINTEM project is to provide new tools, new approaches and new operating models for early-stage geological research of mining operation. Our goal is to reduce mining waste before it is even generated. This is possible if we have a better geological knowledge of the deposit and of the ways to utilize its whole potential", explains project manager **Aleksi Salo** from GTK. "Naturally, the mining company investigates what kind of valuables the deposit contains and strives to utilize everything they can exploit. In the CINTEM the aim is to develop and test the capability to cost effectively collect relevant data and model a deposit for circular economy", Salo continues.

Mining waste contains many valuable recoverable materials. For instance, the market value of the metals in one single tailings deposit could be hundreds of millions of euros. However, the waste streams can rarely be used as they are. The obstacle of utilizing unsegregated mining waste lies often in the processing and impurity management costs that can be too high for economic processing. Better geological understanding and pursuit for utilizing all mineral materials of the deposit enable to plan the infrastructure and processes in advance, already in the design phase of a mining project, thereby reducing costs.

In this first year of the CINTEM project one of the focus areas is to find the best practices of early-stage geological research to provide sufficient information on the whole deposit for holistic mineral reserve estimation, facilitating investment decisions and designing circular mining projects. Geological data for research is collected from two case study areas Sokli and Hannukainen.

GTK brings geological expertise to the project, which enables this new type of data and planning model. With sufficient geological data it is possible to make better deposit models enabling circularity. A digital twin of the mineral deposit is an improved geological model, which includes more information about the deposit, not only about the ore and main commodities but also sufficient data about the wall rocks, and other mineral materials.

New business model

Comprehensive geological knowledge of the deposit does not alone guarantee exploitation according to the principles of the circular economy. Mining industry is based on the linear economy. The operating mining company recovers the valuables it is focused on and sells the raw material to another company which makes products. The rest of the mined material usually ends up as a waste, even though it is known that the deposit holds also other valuable and useful minerals. There is a need for new ways of thinking about the economics of the mining ecosystem. Could we, for instance, get some ideas from the forest industry? In bioproduct factories there are many companies working at the same site using different fractions of wood with the goal to use 100% of wood material.

The CINTEM project is introducing a new business model based on industrial symbiosis. "We haven't got a tradition of having multiple operators at the same site at the same time in the mining business, but it is not usually reasonable for the mining company to expand its business outside its business model. So, why not ally with other companies? In other words, we need to create an ecosystem of companies with different business models utilizing the same deposit at the same site", Kauppila explains.

These companies could operate in different fields of industry, not only recovering raw materials but also making products. Often the mine is situated in a remote place, which makes it expensive to transfer raw materials for manufacture. If the product can be manufactured on the site, it would be more profitable. The companies working at the same site could range from traditional recovery of metals to construction industry, carbon dioxide capture, or producing ceramic materials, for instance.

"We have a specific work package for the study of new business models led by experts. To make these models work we need business expertise and new kind of thinking spanning several industry sectors", Kauppila continues.

The CINTEM project also investigates how side streams can be utilized in the manufacture of various products, for example for the needs of the construction industry. Other aims are to study and develop technologies and processes for recovering the remaining value metals from the side streams as well as for the management of material flows at the mine site.

International cooperation

The international aspect is important for networking and competence development. The CINTEM project involves international cooperation with, for example, Chile and Australia. The Chilean project partner, a sister organization of GTK, launched also its own project in which Finnish actors involved in RDI work together with the Chileans.

The CINTEM project also involves researcher exchange. Research scientist **Dandara Salvador** from GTK is working for six months as a visiting researcher at the Global Centre for Mineral Security, Sustainable Minerals Institute (SMI) – University of Queensland, Australia working with the OreSand team. The OreSand project focuses on circularity of the sand fraction of the processing waste and has a broadly similar idea to the CINTEM project. "Together with the OreSand team, we are investigating how circular mining initiatives like CINTEM align with existing circularity frameworks. We are also examining how policy instruments in different jurisdictions, specifically Finland and Queensland, encourage or hinder the adoption of these approaches. Additionally, we aim to support mining projects in making informed early-stage decisions about circularity. Using process simulation-based Life Cycle Assessment (LCA), we assess the potential of circular strategies to guide more sustainable choices from the start and maximize positive impact", Salvador tells about her work at Queensland university.

Salvador considers researcher exchange important. "Engaging with international research institutes allows us to combine strengths and tackle complex challenges like mining waste. Moreover, mining is a global industry, and solutions containing international perspective must be developed. Working with the OreSand team has been especially valuable. Their work has already been applied in industrial scale, demonstrating how circularity practices can be successfully adopted".

...to be continued

"The CINTEM project has only just begun, but it is already clear that there is a demand for this type of research. It seems that there is a global momentum for projects like CINTEM. Around the world there are also other projects focusing on circular economy in the mining business. By cooperation we can make this work", Kauppila says.

It is very likely that the project will be continued, going deeper into the topic once the original CINTEM is completed. "I have received several contacts from interested parties who would be willing to join CINTEM," Salo tells. Striving for the circular economy, sustainable mining, and more profitable mining businesses do not have to be mutually exclusive options.

The CINTEM project

The CINTEM is a Co-Innovation project funded by Business Finland. The two-and-a-half-year project coordinated by Geological Survey of Finland (GTK) began in the beginning of 2025. The CINTEM consortium consists of four universities and research institutes, seven companies which are involved in their own development projects and three companies which are participating with in-kind investments. ▲

The CINTEM consortium:
Geological Survey of Finland (coordinator)
VTT Technical Research Centre of Finland
LUT University
University of Oulu

The companies involved in their own development projects:
Tapojärvi Oy
Hannukainen Mining Ltd
Sokli Ltd
AFRY Finland Ltd
Betolar Ltd
Lateral Engine Ltd
IMA Engineering Ltd

Companies participating with in-kind contribution:
Weeefiner Ltd
Normet Ltd
LKAB Minerals Ltd

TEXT: KRISTINA KARVONEN, GTK

Cut downtime and costs in mining operations with premium fasteners

Investing in premium stainless steel fasteners in mining is not just about durability – it's about enhancing safety, maximizing uptime and reducing long-term costs in one of the world's most demanding industries.

The mining industry faces severe challenges related to corrosion and durability, which can impact equipment, safety and profitability. Using premium stainless steel fasteners that provide corrosion resistance and high strength is essential to ensure safe and reliable mining operations.

Unlock nearly a century of fastener innovation with premium solutions

Several Nordic mining companies are already using premium stainless steel fasteners to promote safety, maximize uptime and reduce long-term costs. Such premium stainless steel fasteners are manufactured by our company BUMAX AB, which has its roots in the Åshammar Bolt Factory. It was established in 1899 and was one of the very first companies in the world to produce austenitic stainless steel fasteners in 1926. We were incorporated into the Bufab Group in 2000 and employ today around 75 people.

All BUMAX® fasteners are manufactured at our factory in Åshammar, central Sweden. The Bergslagen region is the traditional heart of Sweden's world-leading mining, engineering and metallurgic industries. Rich in iron ore, Bergslagen has mined iron and other metals ever since the Middle Ages and today boasts several world-class steel companies such as BUMAX, Sandvik, SSAB, Ovako, Outokumpu and Uddeholm.

Premium stainless steel fasteners deliver results in the mining sector

Nordic mining companies use the BUMAX®

Five reasons to choose premium stainless steel fasteners in mining applications

1. **Superior corrosion resistance** – With mining equipment and infrastructure often exposed to moisture, acidic or alkaline conditions, salt and abrasive materials, choosing corrosion-resistant fasteners can reduce the risk of failure and costly downtime.
2. **Enhanced mechanical strength** – Heavy loads, vibrations and harsh mechanical stresses in mining operations require high-strength fasteners to provide durability and load-bearing capacity to maintain structural integrity.
3. **Longer service life and reduced maintenance** – Stainless steel fasteners last significantly longer, minimize maintenance intervals and part replacements, which enhances safety and reduces total life cycle costs.
4. **Safety and reliability** – Premium stainless steel fasteners can help to avoid the failure of a critical mining application. This can reduce the risk of equipment breakdowns or safety incidents.
5. **Resistance to temperature and wear** – Some grades of premium stainless steel also withstand extreme temperatures and wear, making them ideal for mining equipment exposed to friction, heat or thermal cycling.

88 and 109 fastener product ranges, which are made of A4/316L materials with high strength equivalent to class 8.8 and 10.9. These grades also offer high corrosion resistance due to their higher molybdenum content (minimum 2.5%), unique manufacturing processes and sourcing of the highest quality European raw material.

High-performance stainless steel fasteners can potentially offer mining customers cost-effective alternatives to traditionally more expensive nickel and titanium alloy grades, as well as a higher performance alternative to more commonly used coated high tensile carbon steel fasteners. One of the key differentiators for most of our fasteners is that they are cold formed and thread rolled. Cold forging provides a superior product with increased strength, excellent ductility and enhanced fatigue resistance. Roll threading involves extruding material with threading dies to form a thread that is stronger and more resistant to fatigue. We also begin the process of strain hardening earlier in the production to further increase strength and fatigue resistance.

Customers working in particularly acidic mining environments sometimes use BUMAX® DX 129 or SDX 109 to provide additional corrosion resistance as well as even higher strength. DX 129 is a duplex stainless material grade developed to be an especially high-performing all-rounder, with corrosion resistance considerably higher than A4/316L, very high strength (equivalent to 12.9) and better ductility (approximately 35% greater than 12.9 carbon steel). SDX 109 is a super duplex grade that provides even higher corrosion resistance than our standard duplex grade.

Fastener solutions for the most demanding mining applications

The latest generation of BUMAX grades offer fastener solutions for customers with even more demanding mining applications. We have developed BUMAX® DX 149, which offers a tensile strength of at least 1,400 MPa and yield strength of at least 1,260 MPa, while still retaining excellent ductility. This means that DX 149 can allow companies to downsize fasteners by providing smaller dimensions with excellent mechanical properties and high strength.

A recent development is the expansion of our BUMAX® SA (Super-Austenitic) range, with the addition of a new super high-performance grade.The SA range is based on a series. This new range is based on a series of advanced stainless alloys that can surpass the performance of super-duplex materials and compete with the likes of expensive nickel alloy grades. These material options offer high mechanical strength and super-high resistance to pitting, crevice corrosion and stress corrosion cracking, even at elevated temperatures. These grades can offer mining customers superior resistance to extremely corrosive environments.

The sustainability advantages of stainless steel fasteners

As stainless steel is strong, durable, corrosion resistant and recyclable, stainless steel fasteners have low maintenance costs, a long life and are easy to recycle at their end of life. These properties make stainless steel fasteners an ideal and more sustainable choice for a variety of demanding mining applications.

The BUMAX factory was one of the first fastener manufacturers in the world to obtain an Environmental Product Declaration (EPD) for some of its product range. The EPD for BUMAX® 88 and 109 helps customers to make informed decisions, based on their Life Cycle Analysis (LCA) environmental footprint. ▲

TEXT: ELINA LEIVO, NORDIC BUSINESS DEVELOPMENT MANAGER AT BUMAX AB

Elina Leivo

Nordic Business Development Manager, M.Sc. Eng, Lic. Tech.

Elina is an expert in fastener and material science who has been at BUMAX AB since 2017. Through her deep technical expertise in premium stainless steel fasteners, she helps customers in a wide range of industries to find innovative, high-performance fastener solutions tailored to extreme environments. Elina is a member of Vuorimiesyhdistys (Bergsmannaföreningen r.y., Finnish Association of Mining and Metallurgical Engineers).
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About BUMAX

BUMAX® is a Swedish brand, known for producing premium fasteners that include "The World's Strongest Stainless Steel Bolts". It has manufactured stainless steel fasteners at its own facilities in Åshammar in central Sweden since 1926.

With expertise in the high performance and safety of critical bolting applications in harsh environments, BUMAX has a long history of supporting customers in a range of industries – from science and space industries to automotive and marine. Many of the engineering and technical challenges faced by the mining sector are well known to BUMAX. Bolting applications in corrosive conditions have long been a core element of the company's R&D focus, driving its manufacturing capabilities and innovative solutions.

Scale-up testing of cellulose-based sustainable frother formulations for mineral flotation:

CellFroth - from laboratory to pilot

1. Introduction

Sustainable flotation reagents emerged as a research topic of interest ca year 2000. Since then, the number of published manuscripts on flotation with keywords such as green flotation, green collectors, biosurfactants and bioflotation has been steadily increasing (Oulkhir *et al.*, 2023)). Nowadays research on bio-based reagents is being conducted globally in multiple groups, each with their own specific approach.

Even though biochemicals are the topic of an increasing number of research manuscripts, apart from some well-known reagents such as carboxymethyl cellulose, dextrin, starch and fatty acids (Oulkhir *et al.*, 2023; Pawliszak *et al.*, 2024), industrially used reagents are still largely dominated by conventional, fossil-based chemicals with various levels of detrimental environmental impact.

Some of the reasons typically mentioned for the resistance of industry to implement safer, greener alternatives include aspects such as: i) conventional reagents work and have a proven track record; ii) they are cost-efficient; iii) they have a reliable production source and they are abundantly available as many flotation reagents are produced from the side streams of crude oil beneficiation value chain (Álvarez *et al.*, 2018; Michaux, 2024); and iv) a failed implementation of new chemicals is expensive as it comes in the form of lost product and profit. Additionally, many existing operations have less strict permits, meaning that profit is a bigger driving force than sustainability beyond current permits and a generally acceptable degree of HSE aspects.

Considering that the mining industry is often regarded as one of the most disliked industries in terms of public acceptance (Eerola, 2024), the community at large should have an increasing incentive to improve the sustainability of mining operations both in terms of social license to operate and to contribute towards local and global sustainability goals. Furthermore, as the development of new reagents takes a significant amount of time (5-10 years) and money (5-10 M$) (Nagaraj and Farinato, 2016), it is evident that there is a need to accelerate development of sustainable reagents towards industrial operations. This is especially true if sustainability goals such as the EU green deal (*The European Green Deal - European Commission,* 2021) are going to be met. Achieving such goals would likely mean phasing out of fossil fuels to a significant degree (Michaux, 2024), which consequently leads to a lack of reliable production source for many of the conventional reagents. Therefore, it is essential to explore alternative chemicals, produced from renewable sources, that have a proven and reliable track record in industrial use.

In an effort to contribute towards these ambitious goals, the authors have developed novel, cellulose-based frother formulations, collectively called "CellFroth". In previous studies CellFroth has demonstrated similar froth products with faster kinetics and more robust flotation performance in varied conditions in comparison to conventional frothers in batch laboratory-scale experiments. The improved performance was addressed to the unique synergistic effects of polymer-surfactant (PS) mixtures at the air-liquid interface. A comprehensive description of this research is compiled into a doctoral dissertation thesis (Nuorivaara, 2021).

While such results seem promising in isolation, their relevance for the mining industry at large is yet to be tested. It is well known that even the scientific premises from laboratory to industrial scale operations are fundamentally different, and that flotation is notorious for having a large variety of identified scale-up knowledge gaps. Evidently, the scale-up implementation of a novel flotation reagent requires diligent and persistent experimental research and development so that these challenges can be appropriately addressed.

In this article the authors present a study on the scalability of a novel bio-based PS-mixture used as a flotation frother in the processing of a Cu-Ni-containing ore. Three flotation campaigns are presented, sequentially moving from laboratory-scale to a continuous miniplant operation as follows:

1) Single stage laboratory flotation in a 4 l flotation cell
2) Two stage flotation (roughing and cleaning) in 12 l and 4 l flotation cells
3) Continuous miniplant campaign with 30 kg/h feed throughput

Throughout the experimental procedures, the performance of CellFroth formulations was compared to that of a commercial frother (NF240), while other reagents and conditions were maintained constant.

2. Flotation campaign 1

In the first campaign, the variables to be optimized were collector concentration and air flow rate. Table 1 compiles the results in terms of grade and recovery for Cu and Ni.

The results of the first nine experiments demonstrated that the recovery of both Cu and Ni increased with increasing air-flow rate. When comparing the performance of each frother, an evident pattern was observed. The Cu recoveries were consistently higher with NF240, while CellFroth formulations demonstrated higher grades. When the collector dose was 2 g/t, the reduced collector concentration had an adverse effect on both grade and recovery for NF240, while only recovery values decreased, and grade increased in the presence of the CellFroth formulations. However, at the elevated collector concentration of 20 g/t Cu recovery increased, and the grade slightly decreased for all tested frothers.

The highest air-flow rate only slightly increased Cu recovery, while a more significant increase was observed for the slower floating Ni minerals. To further increase Cu recovery and minimize the recovery of Ni, the chosen default operating conditions for subsequent rougher flotation were 20 g/t of collector and an air-flow rate of 4 l/min as well as implementing pH regulation at pH 11.

Exp No.	Exp Name*	Cu recovery	Cu Grade	Ni Recovery	Ni Grade
1	NF-30-AP-5-3LMin	83.5 %	5.21 %	34.41 %	1.32 %
2	CFA-30-AP-5-3Lmin	81.5 %	6.70 %	30.66 %	1.54 %
3	CFB-30-AP-5-3Lmin	80.67 %	7.24 %	29.41 %	1.65 %
4	NF-30-AP-5-4Lmin	85.3 %	3.75 %	41.75 %	1.12 %
5	CFA-30-AP-5-4Lmin	83.2 %	6.69 %	33.52 %	1.67 %
6	CFB-30-AP5-4Lmin	81.6 %	6.82 %	30.07 %	1.58 %
7	NF-30-AP-5-5Lmin	87.2 %	3.54 %	47.91 %	1.16 %
8	CFA-30-AP-5-5Lmin	83.3 %	6.25 %	35.90 %	1.65 %
9	CFB-30-AP-5-5Lmin	84.2 %	5.70 %	39.11 %	1.62 %
10	NF-30-AP-2-3Lmin	80.0 %	4.79 %	24.62 %	0.89 %
11	CFA-30-AP-2-3Lmin	76.9 %	9.28 %	19.31 %	1.45 %
12	CFB-30-AP-2-3Lmin	75.4 %	8.55 %	17.42 %	1.23 %
13	NF-30-AP-20-4Lmin	89.1 %	3.07 %	56.47 %	1.16 %
14	CFB-30-AP-20-4Lmin	86.2 %	5.41 %	47.23 %	1.81 %

* NF = NasFroth240; CFA = CellFroth A; CFB = CellFroth B; 30 = frother concentration was 30 ppm with all studied frothers; AP-X = Aerophine and its concentration in g/t; XLmin = air flow rate in l/min

Table 1. Flotation performance of studied frothers presented as grade and recovery for Cu and Ni

3. Flotation campaign 2

The second campaign comprised of multi-stage laboratory experiments. The goal was to imitate different industrial flotation stages in laboratory conditions to gain deeper insight into the operational behavior of CellFroth formulations.

Table 2 shows the results of each singular experiment in terms of Cu recovery and grade in the roughing stage along with the final stage and overall Cu recoveries as well as final Cu grade of the cleaning stage (after 10 minutes of cleaning).

Average result values of stages with same conditions (e.g., NF240 in roughing at 10 g/t of collector) were used when compiling *Figures 1 and 2*, when applicable. They are indicated by the error bars, that represent the standard error of the corresponding response with the corresponding conditions. This approach was chosen to facilitate the readability of these figures.

When studying the results of the single frother experiments, robustness in Cu recovery in the roughing stage was observed in the presence of CellFroth formulations, even when collector concentration was reduced. While CellFroth formulations maintained steady Cu recovery at the cost of Cu grade, the performance of NF240 had an opposite behavior, where Cu recovery diminished, and Cu grade increased. The authors have connected such robust flotation performance to the self-stabilizing froth properties provided by CellFroth formulations.

When inspecting the mixed frother results, it is seen that the final grade obtained, when using NF (roughing) + CF A or B (cleaning), was significantly higher compared to only using CFA or CFB in both flotation stages. Simultaneously, extremely high

AP 20 g/t - single frothers			Stage	Overall	
Frother	Cu Rec in RGH	Cu Grade in RGH	Cu rec in CLN	Cu Rec in CLN	Cu Grade in CLN
NF240 + NF240	86.03 %	11.75 %	98.62 %	84.84 %	15.41 %
CFA + CFA	83.48 %	10.05 %	99.73 %	83.26 %	12.34 %
CFB + CFB	84.52 %	7.22 %	99.71 %	83.40 %	10.66 %
NF240 + NF240 (rep)	83.53 %	9.14 %	96.59 %	80.68 %	14.79 %
AP 10 g/t - single frothers			Stage	Overall	
Frother	Cu Rec in RGH	Cu Grade in RGH	Cu Rec in CLN	Cu Rec in CLN	Cu Grade in CLN
NF240 + NF240	84.09 %	13.12 %	98.34 %	82.69 %	18.37 %
CFA + CFA	85.13 %	7.90 %	99.63 %	84.82 %	10.46 %
CFB + CFB	87.28 %	6.01 %	99.59 %	86.92 %	8.14 %
AP 10 g/t - mixed frothers		Stage	Overall		
Frother	Cu Rec in RGH	Cu Grade in RGH	Cu Rec in CLN	Cu Rec in CLN	Cu Grade in CLN
NF240 + NF240 (rep)	82.26 %	13.50 %	98.05 %	80.66 %	20.53 %
NF240 + CFA	83.07 %	14.62 %	99.41 %	82.57 %	16.89 %
NF240 + CFB	83.09 %	14.64 %	99.47 %	82.65 %	17.96 %
CFA + NF240	83.22 %	7.87 %	99.16 %	82.52 %	11.34 %
CFB + NF240	84.92 %	7.42 %	99.45 %	84.46 %	10.32 %
NF240 + CFB (rep)	82.52 %	13.95 %	99.38 %	82.01 %	17.19 %

Table 2. Cu results of flotation campaign 2

stage recoveries for Cu were maintained in the cleaning stage, which resulted in a froth product of higher overall Cu recovery and slightly lower grade when comparing to only NF240 in both stages. While the differences in overall Cu recovery were relatively small, there was a constant tendency in all cleaning stage Cu recoveries for NF240 and CellFroth formulations, where comparatively higher stage recoveries were obtained with the latter.

While the cleaning stage froth products were highly comparable in terms of grade and recovery, there was also a significant disparity in terms of flotation kinetics when comparing NF + NF conditions to those of NF + CF formulations (*Figure 1*). Upon closer inspection, the froth product obtained with CFA in 2 minutes resembled the froth product obtained with NF240 in 4 minutes (solid comparison line). While the kinetics for CFB were not as fast as those obtained with CFA, the froth product obtained at 2 minutes had a notably higher recovery than NF240. A similar observation can be made for Cu recovery with NF240 at 10 minutes, where CF formulations achieved comparable recoveries with only 4 minutes of flotation time (dashed comparison line). These findings highlight that the faster kinetics observed for CF formulations in earlier studies persist even in conditions, where NF240 was used in the roughing stage and CF formulations only in the cleaning stage.

Another key observation is that the cleaning stage selectivity towards Cu was significantly improved in NF + CF experiments due to the more favorable composition of the cleaner feed. This is reflected as a significantly lower overall Ni recovery in the cleaner product (*Figure 2a-c*). In experiments where CellFroth formulations were used in the rougher, the quality of the cleaner feed was worse (*Table 2*). Thus, the resulting froth products obtained with the CF + NF experiments resembled those of using CellFroth formulations in both roughing and cleaning. While the use of NF240 in the cleaning stage had a positive impact on the final Cu grade, the decreased selectivity observed already in the roughing stage resulted in significant Ni recovery into the cleaner product (*Figure 2c*).

Considering the observations described above, it is evident that the cleaning stage performance is highly dependent on its feed. This behavior is especially true when aiming to maximize the benefits of the CellFroth formulations. Indeed, previous findings by the authors indicated that the underlying cause for the robustness of CellFroth formulations was its capability of recovering mineral par-

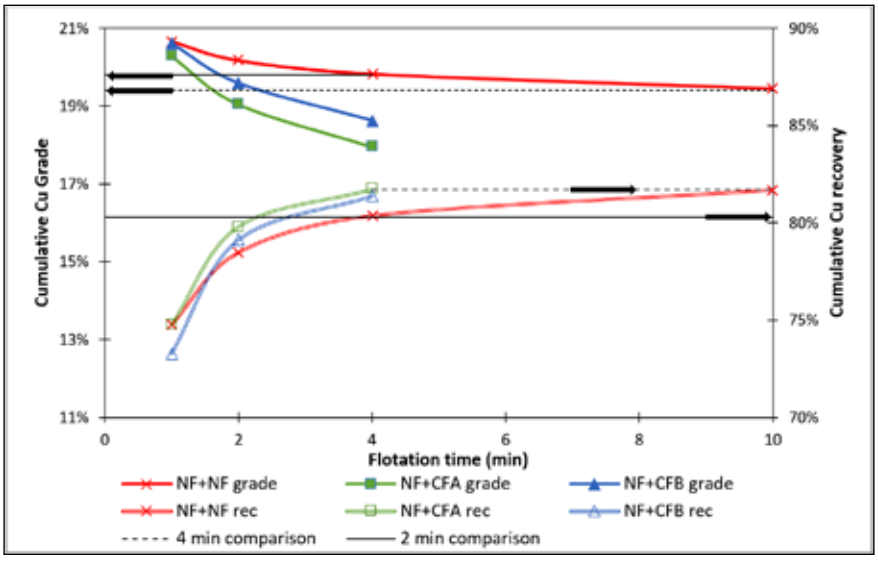


Figure 1. Cu grade-recovery cleaner performance with mixed frother systems. The legend describes used frothers as follows: "roughing stage"+"cleaning stage".

Figure 2a

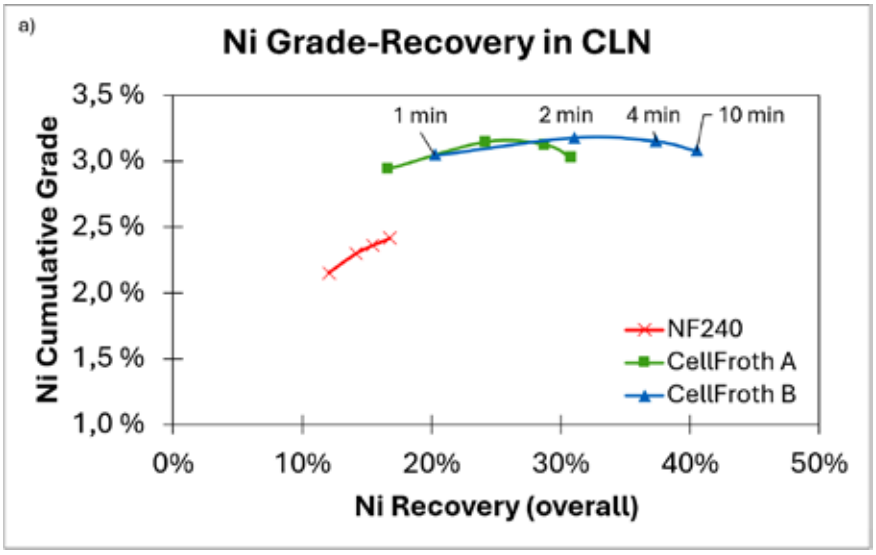


Figure 2b

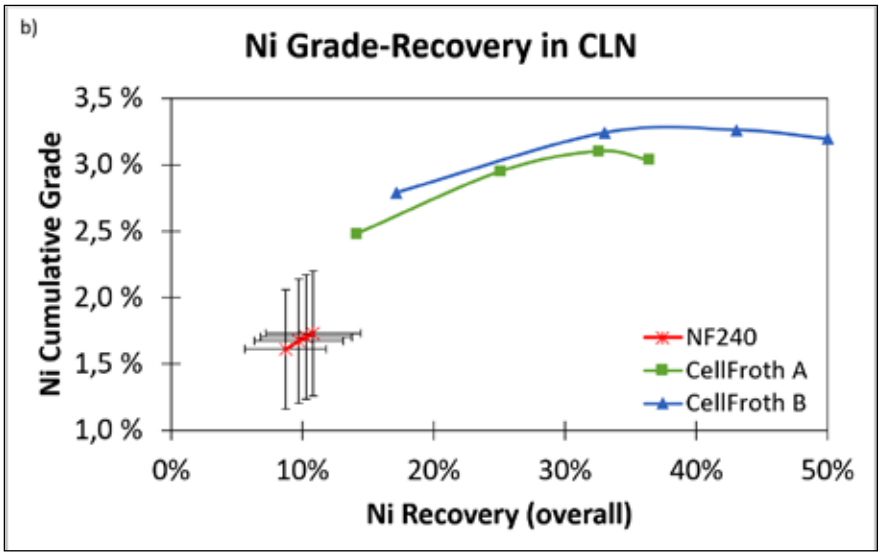
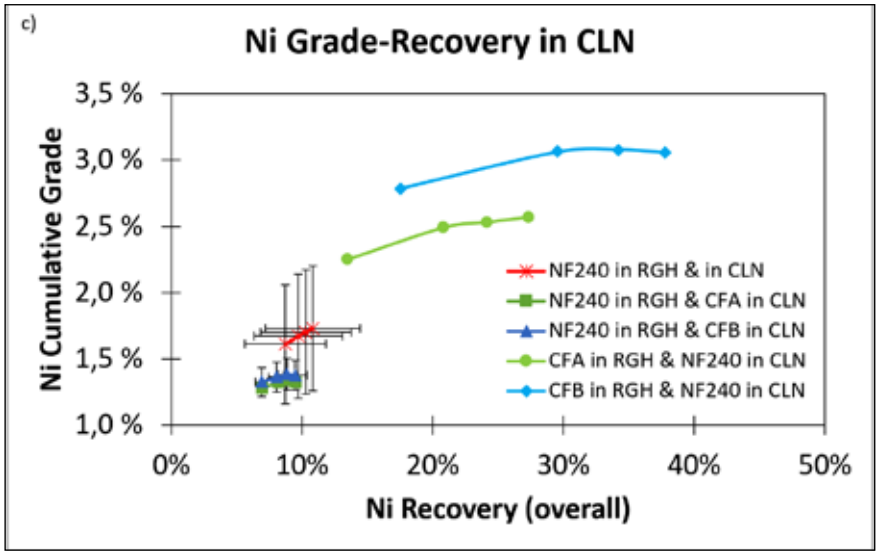


Figure 2. Flotation selectivity visualized by Ni grade-recovery in the cleaning stage: a) AP 20 g/t single frothers, b) AP 10 g/t single frothers c) AP 10 g/t mixed frothers. The time stamps found in 2 a) represent flotation time.

Figure 2c



ticles of reduced hydrophobicity through mechanisms of true flotation. However, these earlier studies were conducted with material, where only one target mineral was present, and in the present study the feed material contained two minerals of interest, both of which are responsive to the used collector (AP3418 A). Such changes in the feed resulted in a rougher product with significant amounts of Cu and Ni when using CellFroth formulations, resembling a bulk flotation type of operation. Naturally, the presence of Ni in a Cu concentrate is unwanted for differential operations and process optimization work may be required to address this issue.

Based on the results presented so far, the benefits of the CellFroth formulations can be best leveraged when the feed quality is better. This tendency can be highlighted by two key observations: 1) The lower feed head grade present in the experiments of section 2 resulted in a comparable flotation performance for both CellFroth formulations and NF240, where the use of CellFroth

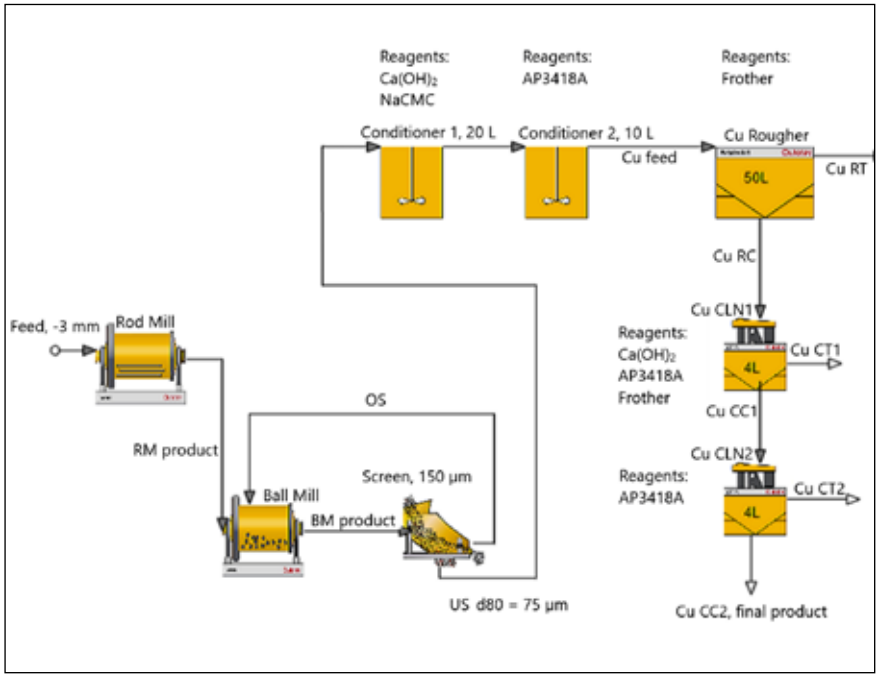


Figure 3. The flowsheet and locations of chemical additions in the miniplant campaign

demonstrated benefits in terms of Cu grade and robustness of operations; 2) in section 3, using NF240 in roughing stage for better cleaner feed quality, and applying CellFroth formulations in the cleaning stage resulted in froth products of higher recoveries and good Cu grade.

4. Flotation campaign 3

The final campaign conducted was a continuous miniplant operation with an approximate feed flow rate of 30 kg/h. The flow sheet is presented in *Figure 3*. The aim of this campaign was to corroborate the laboratory scale performance observed for CellFroth formulations in sections 2 and 3.

The results at each flotation stage are presented in *Table 3* as flotation performance in terms of Cu and Ni grade and recovery. When comparing the performance of CellFroth to that of NF240, it is evident that in all experiments with CellFroth, there are improvements in performance.

CellFroth seemed to maintain a similar behavior in the roughing stage as was observed in section 3, i.e., both Cu and Ni recoveries were significantly higher compared to the performance of NF240 in the roughing stage, but the stage recovery of CFA+CFA was significantly lower compared to the benchmark experiments of NF+NF.

In the roughing stage of the continuous flotation, faster kinetics observed with CellFroth formulations were reflected as higher Cu recovery and mass pull, while also resulting in a higher solids content in the rougher product. Therefore, the premises for the first cleaner were distinctly different depending on the frother used in roughing. The same phenomenon occurred in all flotation stages where CFA was applied. However, CFA seemed to be able to efficiently process such increased quantities of minerals due to its faster kinetics observed in earlier studies. Indeed, the authors hypothesized that CellFroth formulations would be able to treat more material in smaller flotation cells (Nuorivaara and Serna-Guerrero, 2020). Based on the results in Table 3, this behavior is also applicable for continuous flotation, and it seems to occur also when CFA is first added only in the cleaning stage.

Interestingly, the roughing stage results for NF+NF and the first NF+CF experiments were practically identical (*Table 3*). Considering that the findings of section 3 imply that the performance of CellFroth formulations is dependent on feed quality, the Cu grade-recovery and selectivity results

will be compared between these two experiments along with the CFA+CFA experiment. These results are illustrated in Figure 4a, and selectivity in terms of Ni grade-recovery in *Figure 4b*. When using only CFA in all flotation stages, the Cu recovery is significantly higher in the roughing stage while the froth quality after the first cleaning stage was better compared to NF240 after two cleaning stages both in terms of grade and recovery. The second cleaning stage further improved the Cu grade at the expense of Cu recovery, as can be expected. However, this improved performance for Cu came at a cost of selectivity towards Ni (*Figure 4b*), which is in line with the laboratory results. While the overall recovery of Ni into the concentrates of cleaner 1 and 2 was in the same range as with the other frother systems, a Ni recovery of almost 30 % in Cu roughing would translate to significant losses of overall Ni recovery if sequential Cu-Ni flotation were applied.

When comparing the performance of the NF+CFA to the baseline results of the only NF240 system (*Figure 4a*), it is evident that the addition of CFA into the first cleaner significantly improved froth quality in terms of Cu grade and recovery. A similar tendency was observed also in the second cleaner. However, the final Cu grade with NF+CFA did not reach the values of the NF+NF system, while Cu recovery was still significantly better. It is noteworthy that in both experiments, where NF was used in the roughing stage, the grade-recovery performance for Ni was practically identical (*Figure 4b*). Therefore, the benefits of using CFA were reproduced in continuous flotation with minimal detrimental effects to selectivity.

A well-known fact in the field is that pushing the grade-recovery performance towards the upper right side of the graph is simultaneously the most difficult feat to accomplish and yielding the best outcomes in terms of plant productivity.

The results presented above reflect the authors' hypotheses from previous studies, i.e. better froth recovery is reflected as improved performance for Cu, and that faster flotation kinetics observed in laboratory scale facilitate similar flotation performance with smaller total volume of flotation cells in a continuously operated process.

This study highlights the need for detailed and deliberate experimental research required to facilitate the scale-up processing of a fundamentally novel frother. Considering that no process specific flow sheet optimization was done in the miniplant campaign,

Cu rougher	CFA + CFA	NF + NF	NF + CFA	NF + CFA repetition
Mass pull	12.10 %	9.96 %	9.10 %	9.23 %
Cu recovery (overall)	**88.94 %**	82.04 %	81.76 %	76.25 %
Cu grade	2.04 %	2.06 %	**2.16 %**	1.63 %
Ni recovery (overall)	27.91 %	13.93 %	13.11 %	**12.22 %**
Ni Grade	0.52 %	0.31 %	0.29 %	**0.28 %**
Cu Cleaner 1	CFA + CFA	NF + NF	NF + CFA	NF + CFA repetition
Mass pull (overall)	1.12 %	1.64 %	1.47 %	1.24 %
Cu recovery (overall)	73.21 %	73.04 %	**77.12 %**	69.69 %
Cu recovery (stage)	82.31 %	89.03 %	94.32 %	91.41 %
Cu grade	**18.21 %**	11.16 %	12.57 %	11.08 %
Ni recovery (overall)	7.95 %	4.74 %	5.02 %	**3.93 %**
Ni Recovery (stage)	28.50 %	34.03 %	38.31 %	32.19 %
Ni Grade	1.61 %	**0.64 %**	0.68 %	0.67 %
Cu Cleaner 2	CFA + CFA	NF + NF	NF + CFA	NF + CFA repetition
Mass pull (overall)	0.79 %	0.98 %	1.23 %	0.87 %
Cu recovery (overall)	64.40 %	69.63 %	**76.31 %**	68.52 %
Cu recovery (stage)	87.97 %	95.34 %	98.95 %	98.31 %
Cu grade	**22.72 %**	17.79 %	14.88 %	15.59 %
Ni recovery (overall)	3.89 %	3.45 %	4.54 %	**3.24 %**
Ni Recovery (stage)	48.91 %	72.71 %	90.47 %	82.38 %
Ni Grade	1.12 %	0.77 %	0.74 %	**0.78 %**

Table 3. Cu and Ni results of the continuous miniplant campaign, presented separately for each frother system (= campaign day)

Figure 4a

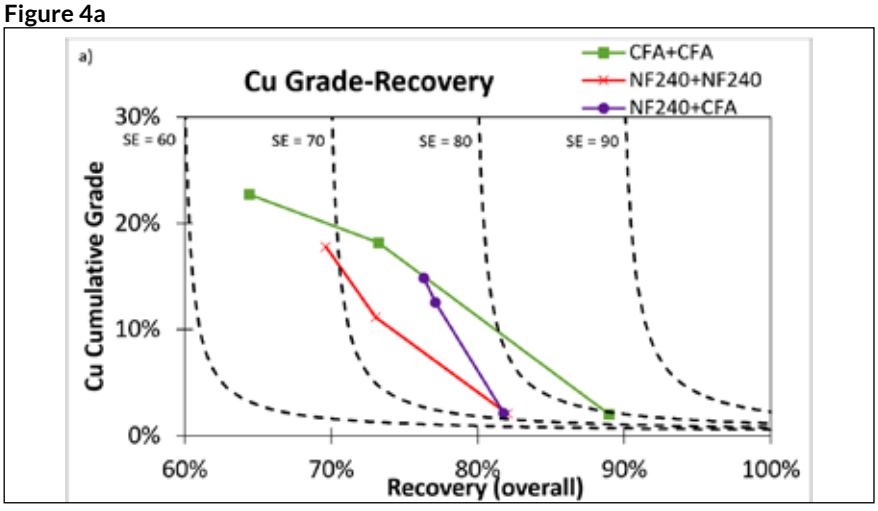


Figure 4b

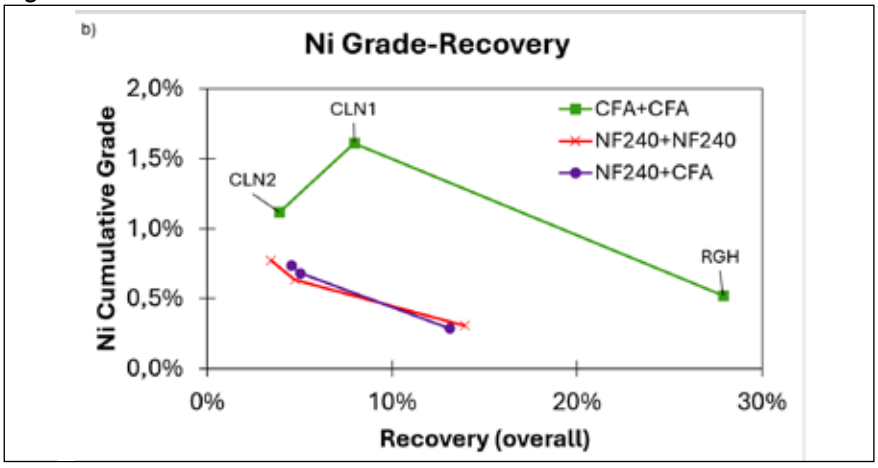


Figure 4. Grade-recovery performance in the miniplant campaign: a) for Cu b) for Ni. The flotation stages follow the same logic as is labeled for CFA+CFA in b).

the results can be considered successful, as CellFroth demonstrated benefits over the commercial frother in various categories. The authors hypothesize that such optimization can lead to even greater performance improvements of the CellFroth formulations.

5. Conclusions

This study describes a sequential multi-campaign flotation study, with a specific focus on the scale-up processing of a novel cellulose-based frother formulation. The results demonstrate similar tendencies throughout all studied conditions from single stage laboratory-scale experiments to the continuous miniplant campaign.

The results presented in this manuscript corroborate that CellFroth formulations are highly versatile frother formulations demonstrating benefits in continuous flotation over current commercial frothers in many aspects, such as:

1. Recovery of valuable minerals in rougher flotation. Especially so, if selectivity for other metal sulfides is not required, e.g., in single mineral cases or bulk rougher flotation.
2. Faster kinetics and more robust flotation performance, which were reflected as a better froth quality in terms of both Cu grade and recovery compared to the commercial frother, with only one cleaning stage compared to two cleaning stages with the commercial frother. However, this remarkable improvement in flotation performance came at a cost to Ni selectivity.
3. When applying CellFroth only in cleaning, the product quality was better for both Cu grade and recovery after the first cleaner and better Cu recovery after the second cleaner compared to the commercial frother. This improvement in performance had no negative reflections in terms of Ni selectivity. It is noteworthy that these benefits seemed to be connected to the feed quality in each flotation stage. Thus, special effort in process design is likely required when applying CellFroth for a new ore. However, conducting laboratory-scale flotation tests when evaluating the performance of a new reagent is a common approach in the field.

The results of this study were achieved with no process-specific flow sheet optimization, and as such they demonstrate that with deliberate optimization and planning, CellFroth formulations can be applied in industrial scale operations to enhance the performance depending on the needs of a specific ore: either throughout the circuit to improve overall grade and recovery with less selectivity; or in cleaning stages to improve flotation performance with smaller impact to selectivity.

Furthermore, CellFroth is a PS-mixture, and the authors theorize that by using different surfactant to polymer ratios at different stages of the flotation circuit it is possible to maximize the demonstrated benefits of the CellFroth formulations.

As a final remark, CellFroth technology is ready for larger scale pilot or even industrial scale trials, while an economically viable production value-chain needs to be defined.

6. Acknowledgements

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REFERENCES

Álvarez, E. *et al.* (2018) *The Oil and Gas value chain: a focus on oil refining*. 46. Instituto Vasco de Competitividad-Fundación Deusto, p. 87.

Eerola, T. (2024) "The origin, evolution and impacts of the mining-sceptical movement in Finland," *The Extractive Industries and Society*, 19, p. 101486. Available at: https://doi.org/10.1016/j.exis.2024.101486.

Michaux, S.P. (2024) *Estimation of the quantity of metals to phase out fossil fuels in a full system replacement, compared to mineral resources*. 416th ed. FI: GTK (Geological Survey of Finland, Bulletin - Special Issue). Available at: https://doi.org/10.30440/bt416 (Accessed: November 22, 2024).

Nagaraj, D.R. and Farinato, R.S. (2016) "Evolution of flotation chemistry and chemicals: A century of innovations and the lingering challenges," *Minerals Engineering*, 96–97, pp. 2–14. Available at: https://doi.org/10.1016/j.mineng.2016.06.019.

Nuorivaara, T. (2021) *Improving sulphide-mineral flotation with sustainable cellulose-based frother formulations*. Ph.D. Dissertation. Aalto University.

Nuorivaara, T. and Serna-Guerrero, R. (2020) "Amphiphilic cellulose and surfactant mixtures as green frothers in mineral flotation. 2. Flotation of chalcopyrite and Cu-containing tailings," *Colloids and Surfaces A: Physicochemical and Engineering Aspects*, 603, p. 125298. Available at: https://doi.org/10.1016/j.colsurfa.2020.125298.

Oulkhir, A. *et al.* (2023) "A critical review on natural surfactants and their potential for sustainable mineral flotation," *Reviews in Environmental Science and Bio/Technology*, 22(1), pp. 105–131. Available at: https://doi.org/10.1007/s11157-022-09639-8.

Pawliszak, P. *et al.* (2024) "Frothers in flotation: A review of performance and function in the context of chemical classification," *Minerals Engineering*, 207, p. 108567. Available at: https://doi.org/10.1016/j.mineng.2023.108567.

The European Green Deal - European Commission (2021). Available at: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en (Accessed: November 22, 2024).

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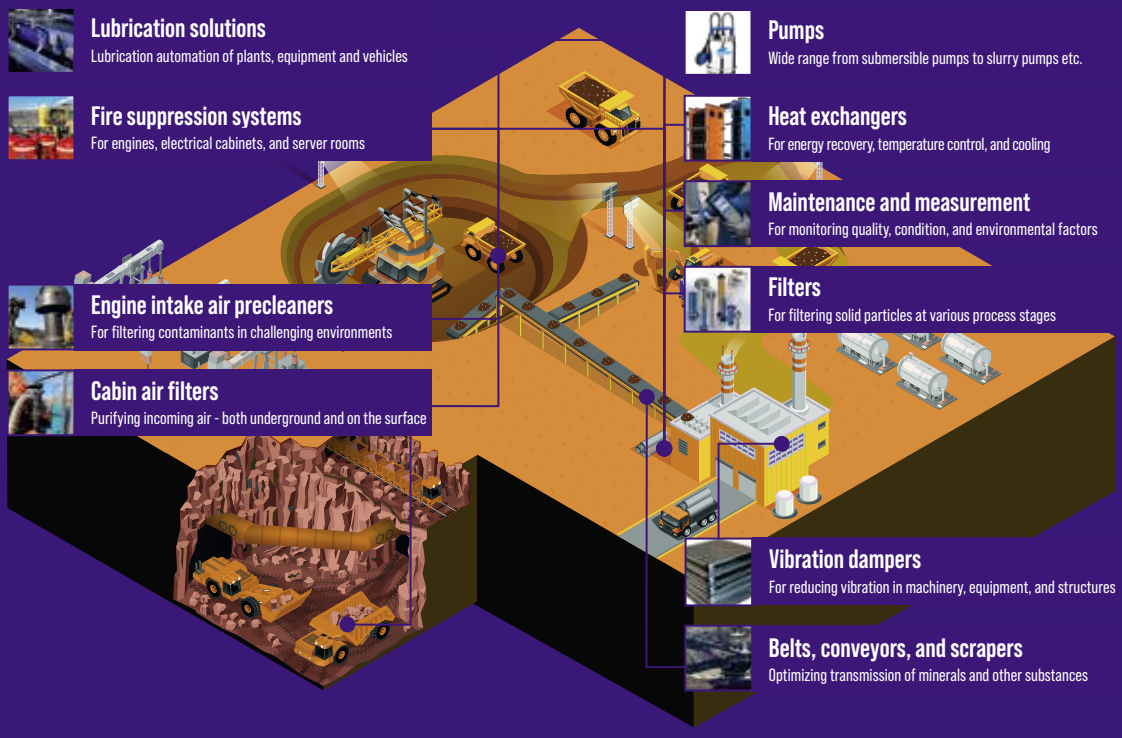

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Tapojärvi sai kansainvälistä tunnustusta työturvallisuustyöstään

▲ Tapojärvi on saanut kunnianosoituksen Eldorado Goldin terveys- ja turvallisuusohjelmassa, joka palkitsee erinomaisia positiivisia toimintatapoja. Tunnustus myönnettiin laajasta kehitystyöstä Skouriesin maanalaisessa kaivoksessa, jossa liikenne- ja jalankulkijaturvallisuutta parannettiin merkittävästi.

▲ Tapojärven tiimi Skouriesissa tunnisti ja raportoi useita riskejä kaivosalueella ja laati vaiheittaisen parannussuunnitelman. Työ toteutettiin vähäliikenteisen pääsiäisajan aikana, ja siihen sisältyi pysäköintialueiden laajentaminen, jalankulku- ja ajoreittien erottaminen sekä uusien liikenteenohjaustoimenpiteiden käyttöönotto.

– Keskeinen parannus oli jalankulkijoiden ja ajoneuvojen erottaminen portaalin sisäänkäynnillä, mikä vähensi onnettomuusriskiä. Esimerkiksi työntekijöitä kuljettava bussi ottaa matkustajat kyytiin ja jättää heidät pois nyt turvallisella, liikenteeltä suljetulla alueella, palkintoperusteissa todetaan.

Toimenpiteet ovat jo edesauttaneet kaivoksen tuotannon kasvua, ja Skouriesin maanalainen kaivostiimi on saavuttanut nyt 969 peräkkäistä päivää ilman poissaoloon johtanutta tapaturmaa (LTI).

– Tämä tunnustus on osoitus Hellas Goldin ja Tapojärven vahvasta yhteistyöstä kaivoksen turvallisuuden edistämisessä. Turvalliset työtavat ovat kaikkien vastuulla, sanoo Janne Harju, Tapojärven tuotantopäällikkö Kreikassa.

Eldorado Goldin mukaan Tapojärven aloite on erinomainen esimerkki siitä, kuinka tuotannon kasvu voidaan saavuttaa tinkimättä turvallisuudesta. Uusi liikennesuunnitelma mahdollistaa sekä turvallisemman että sujuvamman liikenteen kaivosalueella. ▲

TEKSTI: TIINA NOUSIAINEN

Resourcing a sustainable future:

Aalto University educates next generation mining engineers

Dr. Lauri Uotinen was appointed as Assistant Professor of Rock Engineering at Aalto University's Department of Civil Engineering as of the 1st of September 2025. His role strengthens Aalto's profile in rock engineering and mining technology. Both areas are essential for securing raw material supply in Finland and across Europe.

Uotinen's research focuses on the behavior of fractured rock and on the methods to ensure safety in underground spaces. His expertise lies in high-resolution photogrammetry and rock stress inversion methods, combined with detailed studies of fracture mechanics and sampling scale effects. These approaches are directly applicable to stope design, slope stability, groundwater flow modelling, risk assessment in deep mines, and long-term geological storage projects. In his new role, Uotinen plans to make full use of Aalto's unique infrastructure, including the **Underground Research Laboratory of Aalto (URLA)**, state-of-the art rock mechanics testing facilities, and structure-from-motion photogrammetry methods. "My vision is to build a research group where complementary expertise comes together and where solutions are developed across disciplinary boundaries in close dialogue with the mining industry," he says.

He has been closely involved in the Academy of Finland's **Mineral Resources and Material Substitution (MISU)** programme. Within this framework, the **GAGS project (Geophysical and Geochemical Methods for Stope Design)** developed new geophysical and geochemical approaches to support safer and more efficient stope design. One example is the use of **laser-induced breakdown spectroscopy (LIBS)** together with high-resolution photogrammetry to enable semi-automatic rock mass classification. These techniques can be used to identify hazardous zones, reduce the risk of collapses or rockfalls, and provide valuable structural data to support mine design and resource modelling. The international **ORMID project (Online Risk Management in Deep Mines)**, carried out with Canadian partners, pioneered real-time stress monitoring concepts to improve worker safety and production continuity in deep mining environments. Together, these mining research projects demonstrate how Aalto can directly contribute to safer and more productive mining operations.

The European Mining Course 2025 intake visiting Sandvik's test mine in Tampere. Photo: Sandvik

International collaboration and education are also central to Uotinen's agenda. He is actively involved in the **European Mining Course (EMC)**, a joint two-year master's program run by Aalto University, RWTH Aachen University (Germany), and Montanuniversität Leoben (Austria). Students spend one semester at each university and complete a thesis with an industry partner, covering the full life cycle of mineral resources from modeling and mine planning to mineral processing and metallurgy, as well as environmental and safety issues, providing direct connections to the international mining industry. The programme offers companies access to highly trained graduates and fosters a strong international alumni network.

Aalto University is searching mine sites interested in piloting LIBS or photogrammetry-based rock mass classification methods. Each year, several Master's theses are carried out in collaboration with the mining industry, and the EMC students are available for internships between January and March. These collaborations provide companies with early access to innovative methods and the opportunity to engage directly with the next generation of mining engineers. ▲

LAURI UOTINEN
ASSISTANT PROFESSOR OF ROCK ENGINEERING

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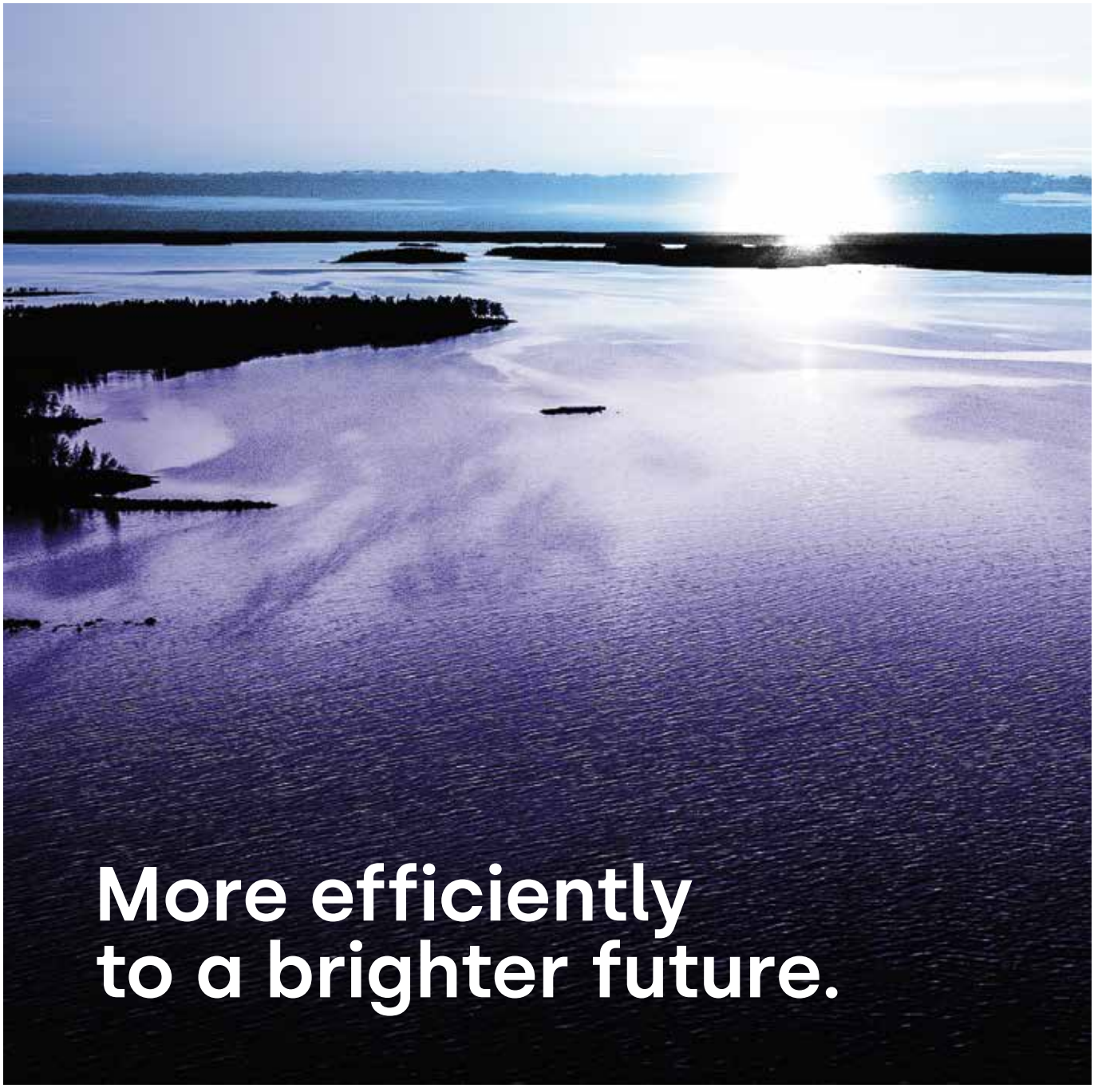

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Mineral separation efficiency improvement through REFLUX™ Flotation Cell

Mining companies have globally been setting goals to increase profitability. The average ore grade has at the same time lowered in various mines. Lower concentrate recovery and/or grade leads to lower profitability. Flotation plays a key role in concentrator's profitability by producing higher grades and higher recovery of the concentrate.

The University of Newcastle, in collaboration with FLS, has developed a novel flotation technology utilising an inverted fluidised bed arranged above a system of inclined channels to enhance the hydrodynamics of flotation. The frothless system allows for stable flotation, enhanced gangue rejection, and faster kinetics – pushing the boundaries of concentrate grade, recovery, and throughput well beyond what is possible with conventional open tank systems.

The REFLUX™ Flotation Cell (RFC) has demonstrated several hydrodynamic advantages over conventional flotation cells. Various batch, pilot, and full-scale tests on RFC have been performed. The test results have shown that this new flotation design has enhanced the flotation performance by significantly improving the flotation kinetics, providing a faster rate of flotation, and reducing the residence time by several orders of magnitude. Additionally, the design of this equipment provides better separation efficiency by shifting the grade-recovery curve in the desired direction, and results in better selectivity. RFC is developed and tested for rougher, scavenger, and cleaner circuits of different commodities such as copper, molybdenum, gold, nickel, potash, limestone, lead-zinc, iron ore, and coal.

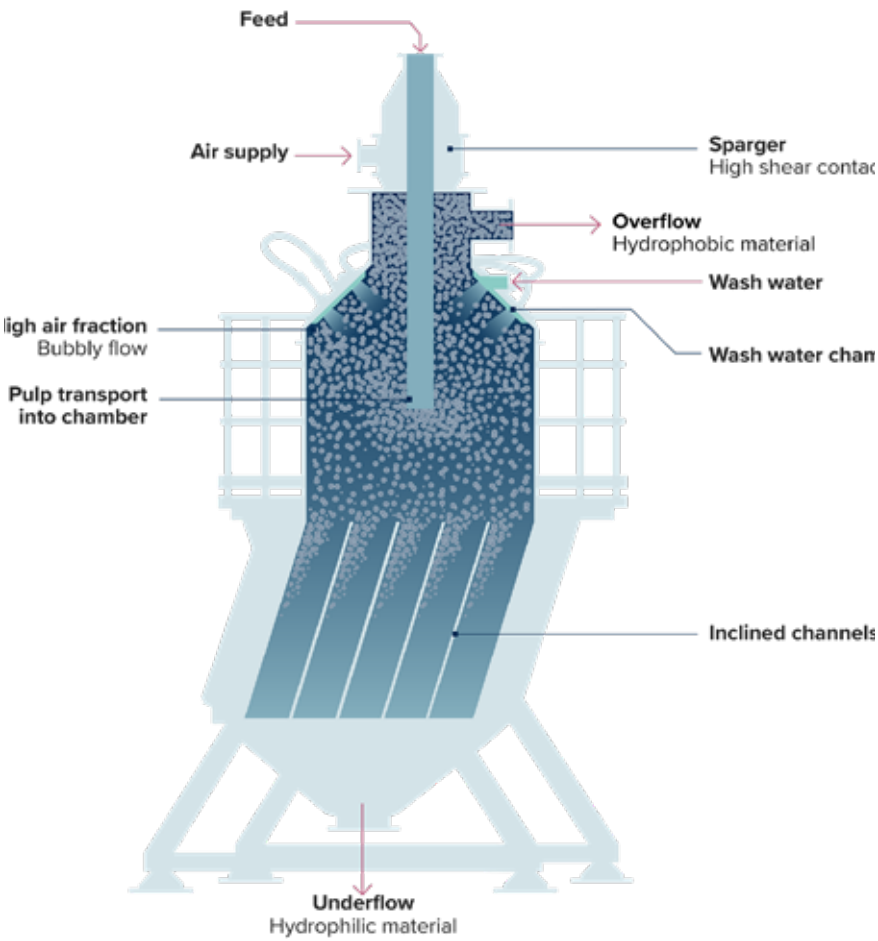

Fig. 1 Schematic of REFLUX™ Flotation Cell (RFC)

A schematic of the RFC is shown in *Figure 1*. The RFC is essentially a staged flotation device where feed is pre-contacted in a high shear rate sparger system, ensuring elevated collision and attachment rates. This contacted bubbly mixture is transported downwards into the main chamber of the RFC, where an air fraction of up to 50% is present. This consequently provides an order of magnitude greater bubble surface area for

further collection of floatable material within the main chamber. The system is frothless, with the bubbly mixture transported to the overflow while being washed with fluidization water, producing high-grade concentrates. The cell operates with a strong positive bias or downward volumetric flow. The presence of inclined channels allows for enhanced bubble-liquid segregation, affording downward velocities well over bubble terminal rise rates, which enables it to process feed fluxes much greater than the typical industrial limit of about 1 cm/s. The machine is not flux curve constrained and can operate at feed and gas fluxes much higher than in conventional systems, approximately at 5-7 cm/s.

Implications on circuit design using RFC technology

An extensive volume of test work has been conducted utilizing the RFC technology.

Case study: Recovery of metal lost in tailings from rougher flotation in copper/gold applications or where fines are lost.

Addition of four RFC2000s to an existing bank of 5x130m^3 conventional flotation cells (*Figure 2*).

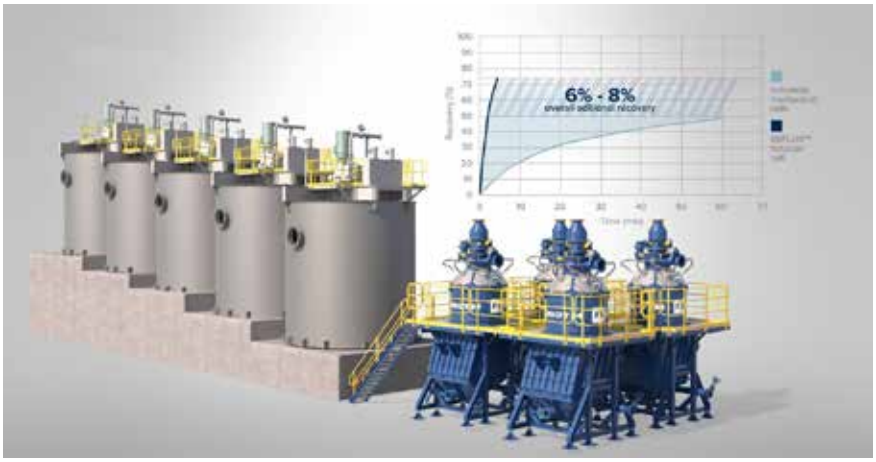

Fig. 2 Case example

Results:

- increase overall recovery by 6-8% compared to doubling the existing flotation capacity, which recovers only an additional 3-5%.
- installation footprint reduced by up to 80%.
- 65% saving in air supply requirement.
- 80% saving in power, with power needed only for slurry transfer pumping.
- 40% saving in capital cost.

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TEXT: SWADHIN SAURABH AND KIMMO KONTOLA

Zero Mine:

Finnish Innovation Turns E-Waste into Critical Metals for the Green Transition

Europe's green transition is rapidly increasing demand for critical metals essential for electric vehicles, batteries, and renewable energy solutions. At the same time, shortage of metals has become a global challenge.

Opening new mines in Europe is a slow process, with permitting alone often taking more than a decade. This has created an urgent need for alternative solutions alongside traditional mining. One solution is the recycling of waste electrical and electronic equipment (WEEE), whose importance in securing raw material supply is growing quickly.

It is estimated that European WEEE contains metals worth up to €80 billion annually. Yet less than a quarter of that value is currently recycled.

Finnish Technology Offers Low-Carbon Metal Recovery

Finnish company Zero Mine Solutions Oy applies hydrometallurgical technology to recover critical raw materials from WEEE efficiently and with a smaller carbon footprint than traditional smelting. The method is based on patented leaching processes that separate and refine metals for industrial use.

"Hydrometallurgical processes require precise design and strict process safety management. Tapojärvi's expertise ensures that this new technology, a prime example of urban mining, can be implemented safely and responsibly," says **Juha Koskinen**, Tapojärvi's R&D Manager.

Initially, the new technology enables the recovery of gold, silver, copper, and palladium. The next step is to target rare earth elements such as neodymium, dysprosium, and terbium. On average, one tonne of discarded circuit boards can yield around 190 kg of copper, 40 kg of aluminum, 1 kg of silver, 300 grams of gold, and 200 grams of palladium.

Backed by Three Experienced Partners

Zero Mine is jointly owned by Alva-yhtiöt Oy, Tapojärvi Oy, and Elker Oy, each with a distinct role: Alva as an energy company, Tapojärvi as a mining and industrial services expert, and Elker as Finland's producer responsibility organization for WEEE.

"It is important to understand that Zero Mine is not a competitor to traditional mining. Conventional mines will still be needed, but we complement them by recycling raw materials that have already been in use once," emphasizes Tapojärvi's board member **Mauri Kauppi**.

From Ash Research to a Circular Economy Innovation

Zero Mine's story began in Jyväskylä in the 2010s, when Alva and the University of Jyväskylä studied the metal content of incinerator ash. A method was developed based on carefully defined acid leaching processes that allowed valuable substances to be extracted.

The method was patented internationally in Europe, the United States, and China. Later, the Technology Industries of Finland proposed applying the method to WEEE, particularly for recovering rare earth elements. Research focus shifted from ashes to printed circuit boards.

From these boards, Zero Mine successfully extracted gold, copper, palladium, and numerous rare earth metals, all of which are in increasing demand due to the green transition.

Zero Mine's patented hydrometallurgical process involves shredding circuit boards, ap-

Zero Mine:

- **Industry:** Recovery and recycling of critical metals (urban mining)
- **Business idea:** Patented technology to extract valuable raw materials (e.g., gold, silver, copper, palladium, rare earths, battery metals) from WEEE, with verifiable footprint
- **Core:** Technology patented in 40 countries, with lower energy use and carbon footprint as compared to smelting
- **Goal:** Strengthen Europe's raw material independence and security of supply, while supporting the green transition. First recycling plant planned in Jyväskylä, as a pilot for European rollout
- **Ownership:** Joint venture of Alva, Elker, and Tapojärvi, developing circular economy solutions into global export products
- **Customer benefits:** Provides alternatives to virgin raw materials, reduces environmental load, and supports traceable and ethical value chains

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plying thermal treatment, and finally leaching them in carefully calibrated acid solutions. The method enables the efficient recovery of metals even in small concentrations, with by far lower energy use than smelting.

Pre-Commercial Plant Planned in Jyväskylä

The company is preparing a €40–50 million investment in a pre-commercial recycling facility in Jyväskylä. According to calculations, the plant could process three tonnes of circuit boards per day, amounting to about one thousand tonnes annually.

The project still faces multiple steps: environmental impact assessments, chemical permits, and other regulatory processes are underway. Pilot operations are expected to begin next year, but commercial-scale operations will not be possible until the early 2030s at the earliest.

"Even at a pre-commercial scale the business case is positive, but more importantly, we need to fine-tune the process for full commercial deployment," says **Risto Ryymin**, Acting CEO of Zero Mine.

Globally Scalable Technology

Zero Mine's solution directly supports the objectives of the EU's Critical Raw Materials Act and Circular Economy Strategy, which aim to secure access to critical raw materials and strengthen Europe's self-sufficiency. Geopolitical tensions and supply chain disruptions have only increased the urgency for Europe to develop domestic, low-carbon solutions for critical metal recovery.

The company's technology is patented in over 40 countries, and it is currently seeking investors and strategic partners to support commercialization. Scalability is the critical factor. One facility can handle only a fraction of Europe's WEEE, so real impact requires multiple plants across different countries.

"Our innovation significantly reduces electronic waste streams while securing the availability of critical raw materials. From Finland it is possible to expand this solution across Europe," Ryymin notes.

The planned Jyväskylä facility will serve as the pilot for this European expansion. ▲

TEXT: TIINA NOUSIAINEN

Printed Circuit Boards in E-Waste: A Hidden Treasure of Critical Metals

Globally, waste electrical and electronic equipment (WEEE) is one of the fastest-growing waste streams. According to the Global E-Waste Monitor 2024, volumes are expected to increase from 62 million tonnes in 2022 to 82 million tonnes by 2030.

Printed circuit boards represent about 3,1% of this waste. They are among the richest sources of critical metals, highlighting the enormous resource potential.

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”Ilman tätä reikää teillä ei olisi töitä”

Matkakertomus Kaivos- ja louhinta- sekä Rikastusjaoston syysekskursiosta 9.-11.9.2025 Outokummun historiaa henkivään kaivoskaupunkiin, jonne suosittelemme matkaamaan koko perheen voimin ajan kanssa.

KARELEX2025-ekskursio ponkaistiin käyntiin iloisella jälleennäkemisellä 30 hengen voimin tiistai-iltana rennosti saunalla kuvankauniin Särkiselän vesistön äärellä. Aiemmin iltapäivällä ohjelmassa oli tarjolla FinnCobaltin tarjoama golfkierros Outokummussa. Golfkierroksen tulokset julkistettiin saunalla, ja kierroksen lahjakkuudeksi paljastui ykköstykki Ville Anttila. Huikean menestyksen ansiosta Finncobalt palkitsi Villen pullolla kuohuvaa, joka luonnollisesti nautittiin saunan lauteilla suoraan pullon suusta.

Ekskursion folkewestimäinen järjestelytoimikunta oli unohtanut tilata Särkiselälle lisäaikaa päivän pituuteen. Aurinkoisen kelin pimetessä ja viiletessä osallistujia lämmittivät saunan lisäksi Forcitin taikomat paikallispitsat virvoitusjuomineen laiturilla nautiskellen vanhojen ja uusien ystävien seurassa. Särkiselkä antoi parastaan kauniissa syyssäässä joutsenten laulun säestämänä vuorimiesten molskahdellessa laiturilta tyyneen veteen.

Reissun pääpäivänä eli keskiviikkona vuorimiehet suuntasivat vierailulle GTK Mintecciin. Pääsimme tutustumaan Mintecin uusiin toimisto- ja laboratoriotiloihin Pirjo Seppälän ja muiden GTK-kollegoiden ohjaamina sekä kuulemaan GTK Mintecin tutkimusmahdollisuuksista aina malmista kaivostoimintaan asti. Tilat olivat hienot, nykyaikaiset ja uteliaisuutta herättävät robotteineen ja laitteineen, ja jokainen osallistuja oppi varmasti uutta yksikön toiminnan laajuudesta. Vaikutuksen tekivät muun muassa rikastuslaboratorion laajuus, murskausprosessi ja rikastuspilotointimahdollisuudet. Kiteyttääksemme paikan funktion lyhykäisyydessään lainaamme Pirjoa, jonka mukaan Mintecillä ”tutkitaan kiviä”.

KARELEX2025 osallistujien saunakomitea

GTK Mintecin vierailu ja oppaat Outokummussa

Mintec -vierailun jälkeen siirryimme lounaalle Hotelli Kumpuun. Maukkaan lounaan jälkiverryttely tehtiin tutustumalla Outokummun kaupungin kaivoshistoriaan Arto Hakolan, Eero Rauhamäen ja Klas Swanljungin vetämän Outotourin muodossa. Kierroksella kävelttiin läpi Outokummun geologinen aikajana 3500 miljoonan vuoden ajalta ja tutustuttiin pääpiirteittäin Outokummun kaivoksen historiaan ja alkulähteisiin sekä vuorineuvos Eero Mäkisen kivipuistoon Outokummun vanhalla kaivoksella. Jalkapatikka oli kevyt kolmen tunnin rupeama, jossa ehdimme nähdä kattauksen kaivostyöntekijöiden asuintaloista vanhoihin rautateihin ja malminkuljetuslinjaan sekä kaikkeen muuhun, mitä kaivoskaupungin ympärille on muodostunut aikanaan. Kierroksella pysähdyttiin kunnioittamaan kairareikää, josta kaikki on saanut alkunsa. Artoa lainaten: ”Ilman tätä reikää teillä ei olisi töitä”. Huumorilla varustetuille lukijoille täytyy tarkentaa, että tällä kertaa puhe oli Otto Trüstedtin kairaamasta reiästä, josta suotuisaa malmia löydettiin ja jonka myötä syntyi päätös perustaa kaivos Outokumpuun. Kierroksen aikana selkeni, kuinka tärkeä ja merkittävä Outokummun kaivos ja paikallisten henkilöiden pitkäjänteisyys ovat olleet Suomen kaivosteollisuudelle.

Lapsiperheille alueelta löytyy Lasten kaivos, jossa tulevat kaivostyöntekijät pääsevät mm. ajamaan kiviautoa ja kiipeämään kaivostorniin leikkipuistossa sekä käyttämään kuljettimia. Sydäntämme lämmitti myös tieto,

Arto Hakola geologisella aikajanalla

Vanhan Kaivoksen leikkipuiston kiviauto

että lapsille on tarjolla omat opastetut kierrokset Vanhalla Kaivoksella, jossa etsitään aarteita ja vieraillaan Vuorenhaltijan luona tunnelissa.

Outotourin jälkeen nautittiin karjalanpiirakoita ja levähdettiin ennen Kyykerin Kartanon tyylikästä illallista. Illallisella kuultiin helmeileviä puheenvuoroja järjestävältä taholta, esitelmiä sponsoreilta sekä laulettiin muutamat vuoriteemaiset juomalaulut. Kyykerin Kartanon emäntä Kaija oli loihtinut upeat ruoat itsetehtyine karjalanpiirakoineen. Arton opastamana osa porukasta koki herätyksen konjakin nauttimistaktiikasta vuorimiehen tavoin. Illallisen ja keskusteluiden lomassa aika kului, kun verkostoja laajennettiin yli jaostorajojen. Illan ylimääräisenä ohjelmanumerona pääsimme paikalliseen Metsähoviin vaihtamaan farkut verkkarihousuun karaoken säestämänä.

Viimeisen KARELEX-päivän ohjelman kruunasi vierailu Outokummun Vanhaan kaivosmuseoon. Kierrosta johtivat jälleen upeat paikallisoppaamme sekä Vanhan kaivoksen museo-oppaat, ja lisäksi pääsimme tapaamaan aikanaan kaivoksella työskennel-

Vanhan kaivoksen museotunneli

leitä kunniahenkilöitä. Kaivosmuseokierros aloitettiin 277 metrin pituisesta museotunnelista, joka tarjoaa kansalaisille elämyksen ja jännittävän oppimispaikan historiallisessa ympäristössä. Museotunnelin varrelta löytyy valokuvia, vanhoja kaivoskoneita ja -työkaluja sekä maanalainen ruokala, jossa voi kuvitella soppamummon jakaneen riisivelliä kaivosmiehille 1900-luvulla. Tunnelin kahdeksan C-asteen lämpöinen ilmasto 50 metrin syvyydessä on elämänmakuinen kokemus, jonne pääsevät myös perheen pienemmät uteliaat ihmisalut.

Vanhan kaivoksen alueella tutustuimme myös nostokonelaitteeseen, jolla ovat alun perin nousseet sekä malmi että henkilöstö. Kaivosalueen mäen päälle kivutessa lämpö palasi kehoon ja pääsimme ihailemaan maisemien lisäksi kaivostornia ja murskaamoa sekä tutustumaan jauhimon tiloihin, jotka toimivat nykypäivänä myös juhlatilana.

Outokummun Vanha Rikastamo kruunasi kierroksen, ja pääsimme utelemaan vuonna 1928 aloittaneen rikastamon toiminnasta. Rikastamon rakentaminen mäen päälle on jo aikanaan ollut nerokas ratkaisu, sillä rinnerikastamo on hyödyntänyt korkeuseroja prosessin eri vaiheissa, mikä on vähentänyt pumppaustarvetta. Rinnerikastamon rikastusprosessia kuvaavaan näyttelyyn kannattaa jokaisen vuorimiehen tutustua. Seurueemme totesi, että osa rikastusprosessista ei sinänsä ole tuosta kehittynyt vuosikymmenten aikana, vaan samat metodit ovat vieläkin käytössä. Mitäpä sitä toimivaa vaihtamaan.

Vanhan kaivoksen tilat ja ympäristö tekivät vaikutuksen vuorimiehiin, ja nykyaikaisen mobiilimuseo-oppaan avulla kukin voi käydä itsenäisesti tutustumassa kohteeseen sekä saada tietoa Suomen ja Outokummun kaivoshistoriasta. Outokumpu jätti vuorimiehiin pysyvän jäljen ja vahvisti kaivoshistorian tietämystämme.

Haluamme kiittää matkan onnistumisesta sponsoreita CRS Laboratories, Forcit, FinnCobalt, Endomines, Outokummun kaupunki, sekä Vanha Kaivos. Kiitoksen saavat myös yhdistyksen jäsenet, folkewestimäinen järjestelytoimikunta ja paikalliset oppaat, joita ilman reissu ei varmastikaan olisi ollut yhtä tiedontäyteinen ja ikimuistoinen. Verkostossa on todistettua voimaa, ja järjestävältä taholta (Kaivos- ja louhinta- sekä Rikastusjaosto) jo lupailtiin, että yhteisekskursioperinnettä tullaan jatkamaan, ja rikastamaan jaostojen välistä yhteistoimintaa ja verkostoitumista myös tulevaisuudessa. ▲

Matkakertomus on kooste nuorisojäsenten Eemil Tikkasen & Lassi Pekkasen muisteloista varttuneempien yhdistysjäsenten joukossa, sekä järjestelytoimikunnan muisteloista.
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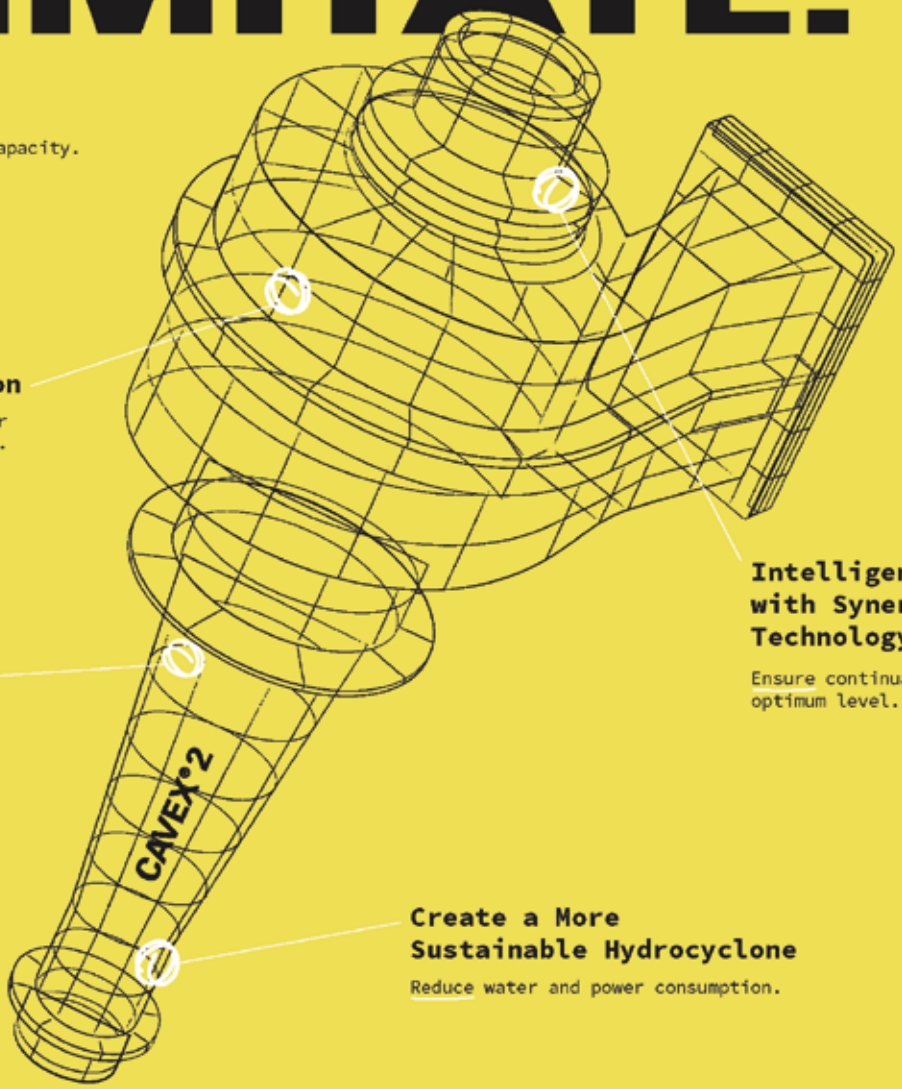

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Mining Finland – Viedään suomalaista kaivososaamista maailmalle yhdessä

Suomi tunnetaan vastuullisesta ja huipputeknologisesta kaivosteollisuudestaan. Mining Finland ry kokoaa alan osaajat yhteen ja vie suomalaisen kaivos- ja mineraalialan ratkaisujen viestin maailmalle.

”Uudessa kansallisessa mineraalistrategiassa Mining Finlandilla on vetovastuu Suomen kaivosteollisuuden arvoketjun viennistä ja kansainvälisistä hankkeista. Tule mukaan kehittämään, verkostoitumaan ja viemään suomalaista osaamista maailmalle – yhdessä.”

Lasse Moilanen, toimitusjohtaja
Mining Finland ry

Haluatko olla mukana rakentamassa Suomen mineraalialan tulevaisuutta ja verkostoitumassa kansainvälisesti?
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Kiitämme pitkäaikaista toimitusjohtajaamme Lasse Moilasta arvokkaasta työstä ja toivotamme menestystä BioSO4:n kasvun rakentamiseen.

JÄSENMAKSUT:

Suuret organisaatiot
Yritykset/organisaatiot, joilla on yli 250 työntekijää ja liikevaihto yli 50 miljoonaa euroa ..... **7 000 €**

Keskisuuret organisaatiot
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Yliopistot ja muut oppilaitokset ..... **5 000 €**

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Pienet organisaatiot
Yritykset/organisaatiot, joilla on 10–50 työntekijää ja liikevaihto 1–10 miljoonaa euroa ..... **2 500 €**

Mikroyritykset
Yritykset/organisaatiot, joilla on alle 10 työntekijää ja liikevaihto alle 1 miljoona euroa
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Seuraaviin tapahtumiin Mining Finlandin yhteisosastoille on vielä muutamia paikkoja jäsenorganisaatioille ja muille osallistujille:

Mining Indaba 9.-12.2.2026, Kapkaupunki

PDAC 1.-4.3. 2026, Toronto

Responsible Mining and Mineral Technologies from Finland seminaari, 3.11.2026, Jyväskylä

Finnmateria 4.-5.11.2026, Jyväskylä

Vastahuuhtelusuodatin tuo fosfaattikaivokselle merkittäviä säästöjä

Yara Siilinjärven fosfaattikaivoksella jauhinvesikiertoon kulkeutuvat epäpuhtaudet tukkivat toistuvasti Floatexien teetervesiputkia, mikä aiheutti huomattavia kustannuksia. HYDAC-vastahuuhtelusuodattimen asentaminen ratkaisi ongelman ja auttoi nostamaan tuotantokapasiteettia.

Yara Siilinjärven fosfaattikaivoksen alkuperäiset automaattiset putkisuodattimet päästivät läpi liian suuria partikkeleita Floatexien teetervesikiertoon. Vesiputkia oli puhdistettava jatkuvasti, mikä aiheutti sekä suoria että välillisiä kustannuksia. Siksi ongelmaan oli löydettävä pysyvä ratkaisu.

”Putkisuodattimista läpi päässeet muoviset ampulangat tukkivat toistuvasti vesiputkien suuttimet, joita jouduttiin puhdistamaan viikoittain. Tilannetta pahensi myös alkuperäisen suodattimen toimintatapa eli suuri virtausnopeus, joka rikkoi muovit pienempiin osiin. Tästä aiheutuivat useiden prosenttien, jopa lähes 10 prosentin viikoittaiset tuotantotappiot. Ongelman ratkaisemiseksi päädyimme hankkimaan alkuperäisen suodattimen tilalle HYDAC-vastahuuhtelusuodattimen”, kertoo Yara Siilinjärven vuorotyönjohtaja **Marko Räsänen.**

Suodattimen hankinnan aikaan Räsänen toimi Yara Siilinjärven kunnossapidon asiantuntijana. Oikeanlaisen suodatintyypin löytämiseksi HYDAC ja Yara Siilinjärvi testasivat HYDAC-suodatinta vuonna 2012. Testauksen perusteella HYDAC RF3 -vastahuuhtelusuodatin todettiin toimivaksi ja tehokkaaksi ratkaisuksi.

Kaivokselle valittiin HYDAC RF3 (DN800) -vastahuuhtelusuodatin, jonka kapasiteetti vastaa kaivoksen tarpeisiin. Suodatin toimitettiin ja asennettiin vuonna 2013.

”Ennen HYDAC-suodattimen asentamista jatkuvat huoltoseisokit ja puhdistamiset aiheuttivat tuotantohäviöitä sekä nostivat henkilöstökustannuksia, energiakustannuksia ja vedenkulutusta. Nyt tasainen ja energiatehokas prosessi säästää aikaa, rahaa ja energiaa sekä vähentää hukkaveden määrää”, summaa Räsänen.

Vastahuuhtelusuodatin säästää energiaa ja vettä

HYDAC RF3-8 (DN800) -suodattimen asentaminen edesauttoi huomattavasti Yara Siilinjärven fosfaattikaivosta kasvattamaan tuotantokapasiteettiaan. Varmatoimisen suodattimen ansiosta kaivoksen tuotantoprosessi on merkittävästi aiempaa vakaampi.

HYDAC RF3 -suodatin mitoitetaan alhaiselle 0,05-0,1 bar lähtöpainehäviölle. Vastahuuhtelu suoritetaan noin 0,5 bar paine-erossa, joten suodattimen toimiessa oikein ei painehäviö pääse kasvamaan sitä suuremmaksi. HYDAC RF3 -suodattimen tuoma energiansäästö kohoaa jopa kymmeniin tuhansiin euroihin vuodessa, koska alkuperäinen suodatin aiheutti prosessiin yli yhden barin painehäviön virtauksen ollessa 5 500 m^3/h. Suodattimen tukkeutuessa energiahukka lisääntyi, sillä pumpun tuottoa oli korotettava, jotta prosessiin saatiin haluttu vesimäärä.

”Olemme tyytyväisiä valintaamme. Laite modifioitiin juuri meidän tarpeisiimme. Yhteistyö HYDACin kanssa on ollut erittäin toimivaa, ja asennus tapahtui sujuvasti tiukasta aikataulusta huolimatta”, Räsänen kertoo.

Vuosien mittaan Floatexien teetervesiprosessia on optimoitu yhteistyössä HYDACin asiantuntijoiden kanssa. Yara Siilinjärven kaivoksella on lisäksi käytössä useita pienempiä HYDAC-suodattimia.

”HYDAC toimittaa laitteita laajalle toimialueelle ja heillä on tietotaitoa, jonka ansiosta heiltä saa aina apua ja parannusehdotuksia niin Euroopasta kuin paikallisestikin. Pidämme arvossa myös HYDACin tarjoamaa toimintatakuuta”, sanoo Räsänen.

TEKSTI: MERI MAUKONEN

Lue lisää osoitteessa:
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Kohti vuoden 2026 suurinta kaivostapahtumaa – FinnMateria kasvaa ja kokoaa alan yhteen

Lämmin kiitos Lapin Liitolle FEM 2025:n järjestämisestä. Kun FEM käynnistyy marraskuussa, on hyvä suunnata katseet jo seuraavaan koko alan huipputapahtumaan: FinnMateria 2026. Jyväskylässä järjestettävä FinnMateria on kasvanut kansallisesta tapahtumasta yhdeksi Pohjois-Euroopan merkittävimmistä kaivos- ja mineraalialan kohtaamispaikoista – ja kasvu jatkuu.

Suomen mineraalistrategian yhtenä tavoitteena on rakentaa FinnMateriasta yksi Euroopan johtavista tapahtumista, joka kokoaa yhteen koko arvoketjun. Tämä ei ole enää vain visio, vaan etenee vauhdilla. FinnMaterian vahvuutena on se, että tapahtuma suunnitellaan yhdessä alan huippuorganisaatioiden kanssa, mikä varmistaa ohjelman ajankohtaisuuden ja sisällön laadun.

Vuonna 2026 Mining Finlandilla on FinnMateriassa 32 jäsenorganisaation yhteisosasto keskeisellä paikalla, ja suurin osa 166 jäsenestämme on mukana omilla osastoillaan, tapahtumavieraina tai avaamassamme seminaarissa *Responsible Mining and Mineral Processing Technologies from Nordic*. Seminaari nostaa esiin pohjoismaista osaamista vastuullisuudessa ja jalostusteknologiassa.

Yhteisosasto tarjoaa erityisesti kasvuyrityksille näkyvyyttä ja mahdollisuuden kansainväliseen esiinmarssiin ilman yksin rakentamisen taakkaa. FinnMateria on myös ainutlaatuinen verkostoitumispaikka – siellä kasvuyritykset ja alasta kiinnostuneet voivat kohdata alan globaalit huippuosaajat, kansainväliset sijoittajat ja tulevaisuuden kumppanit. Tällaiset kontaktit voivat avata ovia uusille markkinoille ja vauhdittaa koko alan kansainvälistymistä.

Jyväskylän Paviljonki ansaitsee kiitoksen tapahtumapaikkana. Se on muokkaantunut FinnMaterian kasvaessa, ja paviljongin organisaatio on yhdessä Jyväskylän kaupungin ja kotimaisten huippuosaajien kanssa rakentanut tapahtuman vastaamaan globaalin kaivosteollisuuden toiveisiin. Kiertotalouden tuominen osaksi vuoden 2026 messujen aihealuetta on erinomainen esimerkki siitä, miten oivaltava organisaatio mukauttaa tapahtumaa alan kansainvälisiin tarpeisiin. Näin FinnMateria kattaa koko kaivosteollisuuden arvoketjun entistä laajemmin ja ajankohtaisemmin.

Mining Finland panostaa kansainväliseen näkyvyyteen yhdessä Team Finlandin ja jäsentemme kanssa. PDAC, Mining Indaba, ZIMEC ja Exponor ovat esimerkkejä tapahtumista, joissa Suomi-osastot ovat nousseet Euroopan suurimpiin. Näissä verkostoidutaan, opitaan markkinoista ja avataan vientimahdollisuuksia – aivan kuten myös FinnMateriassa.

FinnMateria 2026 on tilaisuus, jota ei kannata ohittaa. Se kokoaa yhteen toimijat kaivoksista tutkimukseen, koneista prosesseihin ja palveluista kestävyyteen. Toivotan lämpimästi tervetulleiksi niin vanhat kumppanit kuin uudet tulijat – nähdään Jyväskylässä rakentamassa tulevaisuutta yhdessä! Jos haluat mukaan Mining Finlandin messuosastolle tai seminaariin, ota rohkeasti yhteyttä – paikkoja varataan parhaillaan. ▲

MAKE in Finland rakentaa älykkäämpää valmistavaa teollisuutta yli 50 yrityksen voimin

Valmistavan teollisuuden toimijoita yhdistävä MAKE in Finland on kasvanut reilussa vuodessa lähes 60 yrityksen ja 400 asiantuntijan yhteisöksi. MAKEssa rakennetaan älykkäämpää ja vahvempaa valmistavan teollisuuden tulevaisuutta vahvan yhteistyön, luottamuksen ja avoimuuden kautta.

MAKE-ekosysteemiin haluttiin alusta alkaen koota koko arvoketjun toimijat valmistajista palveluntarjoajiin. Ekosysteemin tavoite on vahvistaa kilpailukykyä, vauhdittaa kestävää kasvua ja synnyttää uudenlaista yhteistyötä, joka ylittää perinteiset rajat.

"MAKE ei ole projekti tai ohjelma. Se on elävä yhteisö, joka rakentuu luottamukselle ja avoimuudelle. Haluamme varmistaa, että valmistavalla teollisuudella on parhaat mahdolliset edellytykset yhteistyöhön, sillä yhteistyö on todellinen kilpailuetumme", sanoo MAKE in Finlandin ekosysteemijohtaja **Clémentine Arpiainen** DIMECC Oy:stä.

Lähtöisin teollisuudesta

MAKE sai alkunsa syksyllä 2023, kun suomalaisen teknologia- ja valmistavan teollisuuden johtajat halusivat luoda uudenlaisen, teollisuuslähtöisen yhteisön viemään koko alan tulevaisuutta eteenpäin. Teknologiateollisuus tuki ajatusta. Toteuttajaksi valittiin kokenut ekosysteemien rakentaja DIMECC Oy. Virallisesti MAKE in Finland perustettiin kesäkuussa 2024, jolloin 16 perustajakumppania sopi yhteisestä missiosta ja toimintamalleista.

MAKE edistää valmistavan teollisuuden menestystä verkostoitumisen ja tiedonjaon, yhteiskehittämisen ja innovaatioiden, osaamisen kehittämisen sekä strategisen vaikuttamisen kautta.

Konkreettisia toimia

MAKEssa tiedonjakamista ja yhteistyötä vauhdittavat neljä asiantuntijaverkostoa (Expert Networks), joissa tunnistetaan uusia yhteiskehitystarpeita ja luodaan ratkaisuja, joihin yksittäinen yritys ei yksin pystyisi. Suomenkielisten verkostojen teemat kattavat koneistuksen, valmistuksen ja materiaalit. Englanninkielisten verkostojen teemoina ovat Design, Assembly, Quality and Logistics; Sustainability, Occupational Safety and Health, and Data Driven Manufacturing.

Vain yhden vuoden aikana ekosysteemissä on järjestetty jo yli 50 yhteistyötapahtumaa - webinaareista ja koulutuksista tehdasvierailuihin ja verkostotapaamisiin. Näissä on syntynyt uusia kontakteja, osaamista ja konkreettisia kehitysprojekteja. MAKE in Finland on lyhyessä ajassa vakiinnuttanut asemansa vahvana valmistavan teollisuuden yhteisönä.

Rohkeaa johtajuutta tarvitaan

MAKE panostaa myös strategiseen vaikuttamiseen. Tavoitteena on vahvistaa suomalaista valmistavaa teollisuutta jatkuvan muutoksen keskellä, ja siihen tarvitaan rohkeaa johtajuutta. Yksi esimerkki tästä on *Rohkeaa johtajuutta – Kasvua ja kilpailukykyä suomalaiselle teollisuudelle* -seminaari, jonka MAKE järjestää marraskuussa Teknologia 25 -messujen yhteydessä Helsingin Messukeskuksessa.

Seminaarissa kuullaan hallitusjäsenten ja johtajien näkemyksiä siitä, millaisia toimia tarvitaan, jotta suomalainen teollisuus pysyy kansainvälisen kilpailun kärjessä. Keskustelijoina on osaajia eri kokoisista yrityksistä, arvoketjun eri osista ja eri sukupolvista.

– Maailma on murroksessa, ja nyt jos koskaan tarvitsemme rohkeita päätöksiä. Jotta pystymme olemaan teknologisesti ja muillakin tavoin huipulla, ajattelumuutoksen pitää lähteä hallituksista. Jotta tuotantomme pystyisi uudistumaan, sitä ohjaavan hallituksen pitää olla rohkea, Clémentine Arpiainen painottaa.

Teollisuuden tulevaisuus rakennetaan yhdessä

MAKEn vahvuus perustuu siihen, että kaikki toimijat – pienistä pk-yrityksistä suuriin globaaleihin konserneihin – pääsevät hyötymään yhteisestä tiedosta, osaamisesta ja kehittämisestä. MAKE on matalan kustannuksen, mutta korkean vaikuttavuuden malli, joka tekee Suomesta valmistavan teollisuuden uudistumisen edelläkävijän. ▲

TEKSTI: KAISA KAUKOVIRTA, DIMECC

KUVA: DIMECC

MAKE in Finlandin työturvallisuuden asiantuntijaverkosto tutustui Sandvikin testikaivokseen Tampereella.

PEKKA SUOMELA
TOIMINNANJOHTAJA
KAIVOSTEOLLISUUS R.Y.

Suomalaisen kaivostoiminnan etujen ajaminen EU:ssa

Malminetsintä ja kaivostoiminta EU:ssa on edunvalvonnan kannalta monikerroksinen asiavyyhti, koska EU:n päätökset vaikuttavat suoraan lupaprosesseihin, rahoitukseen, ympäristösääntelyyn ja markkinoihin.

Erityisesti ympäristölainsäädännön saralla on entistä selvemmin nähtävissä kehitys, jossa EU:n ja kansallisen lainsäädännön muutokset kulkevat samanaikaisesti – ja välillä toisistaan tietämättä. Kauppapolitiikka ja energiakysymykset ovat keskeisiä kaikelle prosessiteollisuudelle ja suorastaan erittäin merkityksellisiä.

EU-lainsäädäntöön vaikuttamisessa aikainen kukko nokkii parhaiten. Kaikkien on syytä olla hereillä jo ennen direktiivitehtailua. Erilaiset puiteohjelmat tai strategiavalmistelut tuppaavat muokkautua lainsäädäntöhankkeiksi varsin usein, vaikkakin tällä hetkellä komissio hieman vetää henkeä. Geopolitiikalla on merkitystä.

Jäsenvaltio Suomen näkökulmasta keskeisiä toimijoita ovat ministeriöt ja Brysselin lähetystö. Nämä valmistelevat ja muokkaavat Suomen kantoja neuvoston päätöksentekoprosessiin. Aina ei siis tarvitse lennellä Belgiaan, vaan rupattelu ministeriön tai eduskunnan suuntaan voi olla tehokkaampaa.

EU:n toimielimistä komissio on valmistelija ja samalla hyvin keskeinen viisas toimija. Neuvosto eli Council on voimakkain ja usein se paaluttaa linjaukset. Parlamentti on kasvattanut rooliaan, ja siellä kaiken kehittäminen ja paremmin tekeminen pulpahtavat pintaan joka asiassa. Tämän vuoksi europarlamentaarikot ovat rooleissa, joista meidän on oltava perillä ja kiinnostuneita – myös kaivosasioissa.

Kaivosalan vaikuttamisessa meille tärkein kumppani on Eurominesin jäseniä ovat Agnico Eagle Finland, Metso-konserni, Finnish Minerals Group ja Kaivosteollisuus ry. Boliden on vahvasti läsnä ja samoin Anglo American. Teemme paljon yhteistyötä Sveminin kanssa, sillä Suomen ja Ruotsin intressit ovat hyvin pitkälle samankaltaiset. Brysselistä löytyy myös Outokummun, SSAB:n, EK:n ja Teknologiateollisuuden sekä Kemianteollisuuden kollegoja, joiden kanssa voi käydä haasteita läpi.

Eurominesin, joka on omimmillaan energia-, vastuullisuus- ja ympäristöteemoissa. Euromines eli European Association of Mining Industries, Metal Ores & Industrial Minerals toimii kaivosalan äänenä EU:n toimielimissä (komissio, parlamentti, neuvosto). Euromines antaa lausuntoja ja ehdotuksia EU:n lainsäädäntöön liittyen esimerkiksi ympäristövaatimuksiin, kriittisiin raaka-aineisiin, kiertotalouteen, lupaprosesseihin ja energiaverotukseen. Viime vuosina edunvalvonta on keskittynyt raaka-aineomavaraisuuden edistämiseen sekä viestintään EU:n kuplassa. Eurooppalainen kaivosperhe on hyvin moninainen, ja Eurominesin tärkeä rooli on koota yhteistä näkemystä.

Suomessa kaivokset toimivat tiukkojen ympäristönormien puitteissa, mikä voidaan kääntää kilpailueduksi EU:n vihreässä siirtymässä. Koko mineraalitalouden arvoketju on Suomessa hyvin hallinnassa ja aktiivinen – siksi se toimii esimerkkinä koko EU:lle.

GTK, Business Finland ja maakunnalliset toimijat ovat omien erityisalojensa asiantuntijoita ja tuntevat hyvin myös EU:n moninaiset rahoituskanavat.

Suomalaisen kaivostoiminnan etuja ajetaan EU:ssa parhaiten yhdistämällä kansallinen vaikuttaminen, aktiivinen rooli Eurominesissa, pohjoismainen yhteistyö sekä Suomen vahvuuksien (vastuullisuus, akkumineraalit, kiertotalous) korostaminen. ▲

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FT Harri Leppänen Metallinjalostajien toimitusjohtajaksi

Filosofian tohtori **Harri Leppänen** on valittu Metallinjalostajat ry:n toimitusjohtajaksi. Hän aloittaa tehtävässään syyskuun aikana. Saku Vuori palaa virkavapaansa päättyessä Geologian tutkimuskeskuksen tutkimus- ja innovaatiotoiminnasta vastaavaksi johtajaksi.

”Kotimaisella metallinjalostuksella on keskeinen rooli koko yhteiskunnassa. Sen vaikutus ulottuu aina arjen infrastruktuurista vihreän siirtymän mahdollistaviin ratkaisuihin. Ala tuottaa vastuullisesti jalostettuja materiaaleja ja synnyttää Suomelle tärkeitä vientituloja. Tässä tehtävässä pääsen tukemaan alan kilpailukykyä ja uudistumista keskellä suuria globaaleja muutoksia, ja juuri siksi tämä tehtävä tuntuu poikkeuksellisen merkitykselliseltä”, Harri Leppänen toteaa.

Metallinjalostajat ry:n toimitusjohtajana Harri Leppänen vastaa toimialan elinkeinopoliittisesta edunvalvonnasta. Suomalaisen metallien jalostuksen kilpailukyvyn ja investointien edistäminen on tärkeää paitsi talouden myös huoltovarmuuden näkökulmasta.

”Olemme erittäin tyytyväisiä voidessamme toivottaa Harrin tervetulleeksi Metallinjalostajat ry:n uudeksi toimitusjohtajaksi. Hänen laaja-alainen ja pitkäaikainen kokemuksensa terästeollisuuden eri osa-alueilta sekä aiemmissa tehtävissä osoittamansa vahva vaikuttajuus luovat erinomaiset edellytykset menestyä tässä vaativassa roolissa. Uskomme, että Harrin asiantuntemus ja strateginen näkemys tukevat vahvasti Metallinjalostajien tulevaa kehitystä ja toiminnan pitkäjänteistä tavoitteiden saavuttamista”, toteaa valintaprosessia johtanut Metallinjalostajat ry:n hallituksen puheenjohtaja **Martti Sassi**.

Metallinjalostajat ry on Teknologiateollisuus ry:n toimialayhdistys, ja metallinjalostus on yksi teknologiateollisuuden päätoimialoista. Teknologiateollisuuden toimitusjohtaja **Minna Helle** toivottaa Harri Leppäsen lämpimästi tervetulleeksi joukkoon.

”Metallinjalostus on keskeinen tekijä teollisuuden raaka-aineiden saatavuuden varmistamisessa ja kotimaisten arvoketjujen kestävän kehityksen edistämisessä. Alan panostukset kiertotalouteen ja vähäpäästöisiin tuotantomenetelmiin ovat avainasemassa, kun Suomi tavoittelee hiilineutraaliutta vuoteen 2035 mennessä. Näiden toimien kautta metallinjalostus vahvistaa kokonaisten toimitusketjujen vastuullisuutta. On ilo toivottaa tehtävään Harrin kaltainen kokenut ja sitoutunut johtaja, jolla on vahva ymmärrys alan pitkäjänteisestä roolista”, Minna Helle toteaa. ▲

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▼
KOLUMNI

PERTTI VOUTILAINEN

Muuttuuko ihminen?

Otsikossa etsitään meille kaikille tutun virolaisen oopperalaulajan Georg Otsin sanoin vastausta kysymykseen siitä, mihin ihminen oikein on kehityksessään matkalla. Ots esitti myös lisäkysymyksen mahdollisen muutoksen suunnasta. Hän ei julkisesti halunnut ottaa kantaa asiaan, koska eli kommunistisen neuvostoyhteiskunnan rajoitusten alaisena. Näkyvä kritiikki olisi saattanut katkaista kansan suosikiksi nousseen taiteilijan uran. Oli parempi kätkeä harmitus iloisten rallien alle. Virolaiset kyllä näkivät totuuden. Saarenmaan valssissa kuvatut neuvostosotilaiden kiiltävät napit olivat todellisuudessa irvailua eivätkä ihailua.

Uutiset maailmalta kertovat kauhistuttavia tietoja ihmisen pahuudesta. Diktaattorit tekevät kansanmurhaa monessa paikassa. Sellaiseen syyllistyy myös mies, joka johtaa holokaustin julman tappamisen uhriksi joutunutta kansaa. Eipä ole tapahtuneesta mitään opittu. Tavaksi on jopa tullut avoimesti kertoa tappamisen tavoitteista. Hitlerin kannattajat vielä yrittivät salata tekojaan.

Edellä kerrotun perusteella on selvää, ettei ihminen ole ainakaan paremmaksi muuttumassa. Mutta muuttuuko huonommaksikaan? Siihen saadaan vastauksia vasta pitemmällä ajalla. Huonolta näyttää.

Olen saattanut itseni hankalaan tilanteeseen. Edellisessä kolumnissani yritin vakuuttaa, etteivät asiat välttämättä ole niin huonosti kuin miltä ne näyttävät. Nyt joudun asettamaan tuon arvion kyseenalaiseksi. Mutta periksi en anna. Jos ei ihminen koko maapalloa ydinpommilla tuhoa, jää vieläkin mahdollisuus järjen voittoon. Jossakin sen siemen vielä elää.

Hyvääkin kerrottavaa on paljon. Penkkiurheilijalle kesä oli mahtava. Televisio tarjosi päivittäin suoria lähetyksiä suurista urheilutapahtumista. Ja kun illan päätteeksi saimme usein nähdä Bond-elokuvan, oli päivä täydellinen. Minuun tekivät suuren vaikutuksen nuorten kilpailut. Nähtiin eri puolilta maailmaa tulleita nuoria, jotka kilpailivat rehdisti ja käyttäytyivät hienosti. Lipsahti kerran television kaukosäädintä ohjaava sormeni väärälle nappulalle. Tämä kanava näytti kuvaa valtavan isosta joukosta nuoria, joista osa pomppi hullun apinan lailla esiintymislavalla hassuissa asuissa rämpyttäen kitaraa ja karjahdellen. Selostaja kertoi, että menossa oli tapahtuma, jota musiikkifestivaaliksi kutsuttiin. Oli monelta soittajalta jäänyt parta ajamatta ja tukka leikkaamatta. Monella näytti myös olevan reikä housun polvessa. Eino Leino runoili viisaasti kun hän kyseli : ”Kylttyyri, kylttyyri, mikä se on se kylttyyri, siinäpä pulma on jyyri”. Parasta on vain todeta, että meitä riittää moneen lähtöön. Kiireesti palasin urheilukanavalle sivistyksen pariin. Insinöörit ovat onneksi kehittäneet kaukosäätimen tällaisia tilanteita varten.

Arvaan sohaisseeni ampiaispesään, mutta uskon useimpien haluavan muutosta maailman menoon. Uskallan toivoa, että ihmisen muutoksen suunta olisi urheilevan nuorison käyttäytymisen suuntaan. Uskoani vahvisti nähdä kilpailijoiden iloisin mielin halaavan niin voittajia kuin häviäjiäkin jokaisen kamppailun jälkeen. Etniset ja uskomukselliset rajat olivat poissa. Ihon värillä ei näyttänyt olevan merkitystä. Tässä meille avautuu maailma, jossa kaikki ei vielä olekaan menetetty. Tervetuloa ihmisen muutos!

Eivät kaikki muutokset aina osu naulan kantaan. Ikuisuudelta tuntuneen kiistelyn jälkeen meillä on nyt innostuttu entisöimään vaelluskalojen kutuvesiä. Ihmisen mieli on vihreän keskustelun tuoksinassa muuttunut niin, että kalat voittivat kilpailun pienten koskien vesistä. Voimalaitoksia räjäytellään, jotta kalat pääsevät uimaan muinaisille elinpaikoilleen. Kovasti ilahduin, kun tämän lehdestä luin. Ilo jäi kuitenkin lyhyeksi, kun seuraavana päivänä kerrottiin, että ilmaston lämpeneminen nostaa pintavesien lämpötilaa niin paljon, etteivät lohikalat pysty niissä elämään, vaan kuolevat pois. Teetpä siis niin tai näin, aina menee väärin päin. Sellainen on muutosten maailma. ▲

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Ravintolatyöntekijöiden vaatimus:
Eläinkokeista on luovuttava. Tekevät niin huonoa ruokaa.

TUOMO TIAINEN

Kitkahitsauksen kimpussa, osa 5: Pyörivän työkalun kitkahitsaus

Kuten edellisessä, kitkahitsaussarjan neljännessä pakinassa todettiin, alkoi maailmalta kuulua 1990-luvun alkuvuosina viestejä uuden tyyppisestä kitkahitsausmenetelmästä. Menetelmää kutsuttiin alusta lähtien englanninkielisessä terminologiassa nimellä Friction Stir Welding, joka on sittemmin myös vakiintunut käyttöön lyhenteenä FSW. Suomen kielessä tämä nimi kääntyy sananmukaisesti lähinnä kitkasekoitushitsaukseksi. Sen lisäksi suomen kielessä puhuttiin aluksi tappikitkahitsauksesta, mutta nykyisin menetelmää kutsutaan meillä yleisimmin pyörivän työkalun kitkahitsaukseksi.

Alun perin alumiinilevyjen päittäisliitosten hitsaamiseen kehitetty menetelmä on periaatteeltaan yksinkertainen, kuten yleensä kaikki nerokas. Lieriömäisen hitsaustyökalun pään keskiakselilla on samanakselinen, mutta ohuempi, niin ikään lieriömäinen tappi. Sen pituus on aavistuksen verran hitsattavaa ainepaksuutta pienempi.

Liitettävät levyt puristetaan halutusta saumakohdasta päittäin kiinni toisiinsa ja kiinnitetään tukevasti alustaansa. Halutulla nopeudella pyörivä työkalu tuodaan hitsattavan sauman päähän niin, että sen paksumman osan alapinta asettuu hitsattavien levyjen yläpinnan tasoon. Tapin keskiakseli on hitsattavan sauman kohdalla, ja sen alapää on hiukan levyjen kiinnitysalustan pinnan yläpuolella.

Pyörivä työkalu painetaan levyjen saumakohtaan ja sitä puristetaan voimalla hitsattavien levyjen saumakohtaa vasten. Työkalun ja hitsattavan materiaalin välinen kitka kuumentaa hitsattavan materiaalin, kunnes se plastisoituu. Puristuksen jatkuessa plastisoitunut materiaali alkaa virrata työkalun etupuolelta eli puristuskohdasta sen takapuolelle, jossa plastisoitunut materiaali muodostaa liitoksen levyjen välille perinteisen kitkahitsauksen tapaan kiinteässä tilassa.

Työkalu liikkuu pitkin hitsattavaa saumaa nopeudella, jonka määrittävät sen pyörimisnopeus, puristusvoima ja hitsattavan materiaalin kuumenemis- eli plastisoitumisnopeus. Työkalun paksumman osan alapinta toimii kitkaa lisäävänä laippana, joka estää materiaalin virtaamisen pystysuunnassa ylöspäin, ja kiinnitysalusta rajoittaa virtauksen alaspäin. Tuloksena hitsaussauma muodostuu koko hitsattavien levyjen ainepaksuuden kattavaksi. Sauma muodostuu myös kiinnitysalustaa vasten olevalle pinnalle tapin pään ja alustan välisessä tilassa tapahtuvan plastisoitumisen ja materiaalivirtauksen ansiosta.

Alumiini on luonteva materiaali kitkahitsattavaksi sen matalan sulamis- ja plastisoitumislämpötilan vuoksi. Pyörivän työkalun kitkahitsauksessa työkalun kokemat lämpö- ja mekaaniset rasitukset jäävät tällöin alhaisemmiksi, ja hitsausta voidaan suorittaa työkaluteräksistä valmistetuilla työkaluilla. Kiinnostuksemme kohteeksi nousikin mahdollisuus käyttää menetelmää korkeamman sulamislämpötilan vuoksi astetta vaikeamman kuparin hitsaukseen.

Tarvittava infrastruktuurikin oli pääosin olemassa. Laitoksen työpajassa oli riittävän tukeva pystykarainen jyrsinkone, johon oli helppo toteuttaa tarvittava kiinnitysalusta sekä kiinnittimet. Työkalun hitsausliike voitiin toteuttaa joko manuaalisena tai koneellisena. Työkaluja voitiin valmistaa erilaisista työkalu- ja erikoismateriaaleista joko bulkki- tai eri tavoin pinnoitettuina versioina.

Ei kun kokeilemaan. Haimme ensi koesarjoissa oikeita työkalugeometrioita ja hitsausparametreja ohuiden, luokkaa 2 mm olevien levynpaksuuksien hitsaukseen. Näillä ainepaksuuksilla myös työkalurasitukset pysyivät pienempinä, ja työkaluteräksiset työkalut kestivät kohtuullisesti. Tässä vaiheessa saimme aikaan hyviä, virheettömiä liitoksia melko joutuisasti.

Ainepaksuuden kasvaessa ongelmat tulivat vastaan varsin nopeasti. Suuremmilla ainepaksuuksilla työkaluun kohdistuvat mekaaniset ja lämpörasitukset ylittivät työkaluterästen kestokyvyn. Erilaisista kokeilluista pinnoitteista ei myöskään ollut merkittävää apua.

Työkaluteräksiin verrattuna selvästi korkeampiin lämpötiloihin tarkoitetut korkean lämpötilan superseokset mahdollistivat työkalumateriaaleina pykälää suurempien ainepaksuuksien hitsaamisen. Virheettömiä liitoksia saatiin aikaan aina kuuden millimetrin ainepaksuuksiin saakka. Alustavia kokeita tehtiin myös keraamisilla työkaluilla, mutta ne päättyivät melko pian tapin katkeamiseen parannetusta työkalugeometriasta huolimatta.

Havaintonamme näistä lähes kolmekymmentä vuotta sitten tehdyistä hyvin kotikutoisista kokeista oli se, että kupariin voitiin tehdä onnistuneita FSW-liitoksia ohuemmilla ainepaksuuksilla olemassa olevia tekniikoita ja työkalumateriaaleja käyttäen. Sittemmin kehitys on edennyt vauhdilla, ja alumiinin FSW-hitsaus on saavuttanut merkittävän aseman laivateollisuudessa mm. kevyiden yläkansirakenteiden valmistamisessa levy-profiiliyhdistelmistä.

Kuparin kohdalla on myös päästy niin pitkälle, että useita vuosia kestäneiden tutkimusten ja testausten jälkeen FSW on valittu ydinjätteiden loppusijoituksessa käytettävien, ainepaksuudeltaan luokkaa 50 mm ja yli olevien massiivisten kuparikapselien lopullisen sulkemisen menetelmäksi. FSW-hitsausta onkin luonnehdittu viime vuosikymmenten merkittävimmäksi uutuudeksi hitsaustekniikan alalla. ▲

Ensimmäinen pääsihteeripalstani on tässä - aloitin tehtävässä syyskuun alussa saatuani hallitukselta mandaatin ja Tediltä ja Arilta hyvät eväät. Kiitos niistä - hyvillä pohjilla on aina hyvä lähteä uusiin seikkailuihin. Onhan tämä niin kuin kotiin tulisi, poissa ollessani brändinsä uudistaneeseen yhdistykseen, jossa perinteet ovat yhä tärkeitä, vaikka uudet polvet illallispöytien vierestä marssivatkin.

Vaikea ehkä uskoa, mutta nämä sanat ovat ensimmäiset koskaan Materia-lehteen kirjoittamani. Suurin syy on tietenkin se, ettei kukaan ole koskaan aiemmin pyytänyt - oiva aasinsilta pääaiheeseen.

Vuorimiesyhdistys pyörii pitkälti vapaaehtoisvoimin, ja vapaaehtoiset helposti seulotaan kunkin omasta kuplasta tai kauimmillaan kaverien kavereista. Päätin käyttää tämän palstatilan rohkaistakseni teitä kaikkia hakeutumaan yhdistyksen tehtäviin. Eniten resursseja kaipaa Materia, jossa lehden tekemisestä kiinnostuneita kaivataan lehden toimitukseen jäseniksi. Myös toisen päätoimittajan vastuullinen tehtävä on vapaana.

Innostus lehden tekoon ja kiinnostuneisuus alan asioihin on hyvä alku. Kokeneet opettavat kaiken muun. Hakeminen onnistuu laittamalla sähköpostia, viestimällä, soittamalla tai vaikka nykäisemällä hihasta lehden tekijöitä.

Jaostojen toimintaan sopii myös hakeutua. Sinne mahtuu myös jo useamman vuoden jäsenenä ollut - diversiteettiä kaivataan paitsi vanhojen asioiden muisteluun, myös vaikkapa teekkari-infoihin kertomaan omasta urastaan. Yhteystietoja yhdistykseen ja Materiaan on lehden sivulla 5 ja 80 sekä nettisivuilla www.vuorimiesyhdistys.fi.

Nyt on teitä kaikkia pyydetty - mukaan vaan!

Mukana taas,
LIISA
PÄÄSIHTEERI

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