

Conference Information

17th MiningForum · 06. & 07.06.2024 · Estrel Berlin

For a
sustainable
Future.



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Opening of MiningForum 2024 – For a Sustainable Future

Jens-Peter Lux, Managing Director, DMT GROUP

Dear ladies and gentlemen, dear participants, dear guests and friends,

It is my pleasure to welcome you to MiningForum 2024. I'd also like to welcome you here to the Estrel hotel in Berlin on behalf of the TÜV NORD GROUP, the DMT GROUP and our partners the Federation of German Industries (BDI) and the Federal Ministry for Economic Affairs and Climate Action (BMWK), patron of the MiningForum. It's great to see so many of you here today.

Once more, this year's MiningForum offers a unique platform to discuss new trends and the future of the raw materials sector, and its role in society. It is an honour and a privilege to welcome so many representatives, passionate politicians, scientists and business people who are increasingly working to create a sustainable future for our industry together. Your knowledge is shaping the cornerstone of this conference.

The circumstances in which we are meeting this year could hardly be more challenging and complex. The world is quickly changing into a multipolar and ever-evolving system. The challenges we must all face are enormous: Climate change, the energy transition, environmental pollution, real and artificial scarcity of resources, fragile supply chains, and military conflicts, some triggered by raw material imperialism. Additionally, the achievement of the UN's Sustainable Development Goals is crucial. We all know the current situation and we all know that the raw materials sector itself is affected. The sector has a key role in mastering this situation.

We don't want to simply manage these challenges. We don't just want to maintain the status quo. We want to do our part to achieve improvements. Any successful transformation aims to eliminate inefficiencies and weaknesses in the current system. We need to implement sustainable, future-proof solutions.

The transformation process requires courage, openness to change and a willingness to give up old habits in favour of new and better approaches. Our aim is always to create a better, more sustainable and future-proof situation. One that meets the demands of a changing world.

This requires joint efforts by society as a whole. Therefore, I am even more delighted that so many representatives from politicians, business and science, as well as members of civil society, are gathered here today.

Partnerships and collaborations allow us to master the challenges that lie ahead, together. I would therefore like to extend a special welcome to Mr. Wolfgang Niedermark, Member of the Executive Board of the BDI, and Mrs. Hildegard Bentele, Member of the European Parliament. They will be speaking to you shortly and are representing our sponsors and partners today.

Ladies and gentlemen,

The raw materials sector has always been known for its ability to respond to new challenges with innovation. I look forward to the next two days, and the future in general, with great confidence and enthusiasm. Shaping and changing, but not forgetting where we come from. That is what the raw materials sector is about.

We have the opportunity to drive positive and sustainable change. If we do it properly, we can improve the status quo for ourselves as a sector, but also for society. And we can set standards that have an impact far beyond the mining industry.

Our sector is a key player in this transformation. We supply the raw materials that are essentials to maintaining our way of living and the foundations of life on our planet. Technological progress and economic prosperity have always been dependant on the supply of raw materials. Even if specific needs change, our industry is always at the beginning of the supply chain. Whether it involves everyday items or high tech.

We talk so much about critical raw materials for a good reason. Without them, a sustainable and digital transformation is simply impossible. At the same time, we cannot be sure that we'll still have a constant supply of these raw materials. They are so critical because of their importance for the European industry and the risk of supply shortages.

We need raw materials to achieve climate targets and to accelerate the energy transition. We also need them for digital connectivity and to ensure the high-tech industry remains competitive. From microchips to wind turbines, raw materials are the foundation of the digital and sustainable transformation. In the same way that mining made industrialisation possible, it is the prerequisite today for connecting our prosperity with environmental and climate protection as well as social responsibility.

Dear guests,

Critical raw materials are essential for Europe's security, development, autonomy and resilience. Their demand is growing rapidly and steadily. If we do not take action, Europe could be at risk of supply shortages and unwanted dependencies. With the European Critical Raw Materials Act (CRM – May 23, 2024) that just came into force and is being implemented, we are countering this risk and will have significantly more mining in Europe again by 2030.

We are increasing our capacities for the extraction, processing, refining and recycling of raw materials (10% of CRM requirements from Europe, 40% of processing in Europe, 25% of consumed minerals being returned to recycling life cycles, with a maximum of 65% from one source). All while complying with the highest environmental and social standards. To achieve this, approval procedures for strategic projects will be shortened and access to funds will be facilitated. For example, via a European Commodities Fund, which we believe is necessary. And through national commodities funds, which have already been initiated in Germany, France and Italy. Global partnerships are also being developed to diversify our supply sources.

This opens up tremendous opportunities for positive development in the mining sector in Europe and beyond. But, if we want to seize these opportunities, we need to develop methods that allow us to extract and process the raw materials for a lasting transformation as sustainably as possible. Enormous challenges lie ahead. Particularly when with regard to climate protection, environmental impact, social responsibility and economic efficiency, we as an industry are often not yet as good in as we could be.

Ladies and gentlemen,

It is a fact that there have been tensions in the past over mining projects involving environmental and/or social aspects. These have damaged the reputation of the entire industry. This is precisely why it is important to take responsibility and leverage the enormous potential that will come with a structural and holistic change towards greater sustainability in the sector. And yes, we do want to take that responsibility.

Sustainability has arrived in the raw materials sector. Its importance is rapidly growing and will become essential for the social licence to operate sooner rather than later. We need this transformation towards greater sustainability in order to gain societal acceptance as an industry and be able to operate profitably in the future.

Given the growing demand for raw materials and the tremendous importance of raw materials, the mining sector can create a new reputation for itself. As an enabler of the energy transition, digitalisation and multifaceted transformation routes.

To do this, however, we have to show that we are not 'only' meeting the increased market demands. We must also show that we work and act responsibly.

We must work together to find solutions that enable us to make the raw materials sector more sustainable. This means promoting responsible mining practices, protecting the environment, respecting the rights of local communities, educating civil society about necessities and dependencies, and sharing the value we create in a fair way.

This requires innovation and cooperation. While raw materials are often difficult or impossible to substitute and therefore have no alternative, we are able to continuously improve our own processes, from exploration to reclamation. State-of-the-art technologies and processes, transparent actions and a solution-oriented dialogue on an equal footing with all stakeholders. That is how we can further improve the efficiency and sustainability of the mining sector.

The MiningForum offers a unique opportunity to discuss these issues, share our experiences and find solutions, together. I invite you to actively participate in the discussions, share your knowledge and gain new perspectives.

Ladies and gentlemen, let me be very clear.

Mining is not on the decline. It is one of the key industries for the coming decades. It is up to politicians and society to recognise it as such, and we must ourselves lay the foundations for it. Together, we can make the raw materials sector an engine for sustainable development. One that not only meets our current needs, but also addresses those of future generations. I look forward to working with you on this important mission.

Together, we will find the best ways to master the challenges and seize the opportunities that these turbulent times are creating for our sector.

The motto of this year's forum is 'For a Sustainable Future'. With the growing importance of the sector for sustainable transformation, sustainability also becomes more important for the sector. So, let's drive a sustainable future for mining.

The advances, insights and innovations presented at this year's MiningForum allow us to look to the future with confidence. They show that our industry can combine entrepreneurial value creation with added value for society.

Thank you for being here today. I wish us all an inspiring and productive MiningForum 2024.

Let's get started! Glückauf!



Jens-Peter Lux,
Managing Director, DMT GROUP

Agenda

06.06.2024, 09.00h (Room A-B)

Welcome Presenter: Sven Ulbrich, TÜV NORD AG

Jens-Peter Lux, Management Board, DMT GROUP

Opening Remarks

Wolfgang Niedermark, Executive Board, The Federation of German Industries (BDI)

Key Note

Hildegard Bentele, Member of the European Parliament

06.06.2024, 09.50h (Room A-B)

Pitch Session: Global Perspectives on Raw Materials - demands, advances, challenges

Presenter: Diana Sündermann, TÜV NORD AG

- Julia Braune, CEO, GTAI Germany Trade and Invest
- Dr. Dirk Stenkamp, CEO, TÜV NORD AG

- Dr. Babette Winter, Regional Director, South Harz Potash Ltd
- Dr. Andreas Klossek, COO, EIT RawMaterials

10.45h, Coffee Break & Networking (Foyer/Exhibitor)

06.06.2024, 11.30h (parallel Sessions & Panels)

Room A Major & Challenging Projects

Presenter: Dr. Michael Paul, Wismut GmbH

- Dr. Thomas Lautsch, Bundesgesellschaft für Endlagerung
- Martin Ebeling, K+S Minerals and Agriculture GmbH
- Jonathan Vanherberghen, Rio Tinto
- Prof. Thomas Baumgartl, Federation University Australia

- BGE 2.0 - the prospects of BGE in its second five-year period of existence
- The Transformation project Werra 2060
- European raw materials policy
- Pathways and challenges to successful mine closure

Room B Investments in Mining

Presenter: Detlef Gürtler, Germany Trade & Invest (GTAI)

- Dr. Sven-Uwe Schulz, Deutsche Rohstoffagentur (DERA) in der BGR
- Edda Wolf, Germany Trade & Invest (GTAI)
- Dr. Jan Klasen, KfW Bank
- Tetiana Dzhumurat, European Bank for Reconstruction & Development (EBRD)
- Stefan Müller, Deutsche Gesellschaft für Wertpapieranalyse (DGWA)

- Current price & supply risk on global raw material markets
- Exciting alternatives for raw materials: Argentina, Zimbabwe, Uzbekistan
- Financing of raw materials projects: The German government's raw materials fund
- Financing of raw materials projects: EBRD financing instruments

Room C Panel Discussion Natural Resources

Presenter: Diana Sündermann, TÜV NORD AG

- Susanne Szech-Koundouros, Federal Ministry for Economic Affairs and Climate Action (BMWK)
- Anne Lauenroth, The Federation of German Industries (BDI)
- Prof. Dr. Elisabeth Clausen, RWTH Aachen University

Ambassadors' Meeting: Natural Resources for the German Industry – between Dependencies and Diversification

Room D Panel Discussion ESG and Responsible Mineral Supply Chain

Presenter: Daria Goncharova, DMT

- Ivor Kadragic, CDP
- Dr. Mary Mildred Stith, Pula Group
- Tanja Winter, Aurubis
- Galina Donnik, Sirius

- The Role of Climate Data in Ensuring Sustainable Investments
- ESG as a key principle of funds allocation
- ESG perspective of copper products manufacturer and end-customers
- Improving ESG data disclosure in metals and mining companies

13.00h, Lunch & Networking (Foyer/Exhibitor)

06.06.2024, 14.30h (parallel Sessions & Panels)

Room A Innovation in Shaft Construction Presenter: Dr. Jürgen Franz, DMT

- Dirk Fraas, TransnetBW
- Thomas Jenßen, THYSSEN SCHACHTBAU
- Dzianis Iholka, REDPATH DEILMANN GmbH

- Michael Weinhold, Herrenknecht AG

- Through the ages: shaft construction for the energy turnaround
- BIM implementation in shaft construction using the example of the Heilbronn shafts
- Accelerating return of investment: Revolutionizing Potash and Polyhalite Mines Development through Rapid Shaft Sinking Technologies
- Shaft excavation and lining with the Boxhole Backreaming Technology in complex geological conditions

Room B AI in automation technology Presenter: Prof. Dr. Günther Apel, TSU e. V.

- Michael Kieviert, LAPWING GmbH
- Dr. Gereon Weiß, Fraunhofer-Institut
- Julius Kahmann, Baxtair Arcure S.A
- Maximilian Rolf, sensmore

- AI in industrial automation - potentials, risks, safety
- Safety assurance and resilience of cognitive systems
- When AI saves live
- Automating heavy vehicles in mining with AI using 4D imaging radar

Room C Panel Discussion Sustainability Presenter: Knut Hirsch, DMT

- Dr. Michael Seeger, MX Mining Capital Advisors GmbH
- Luisa Daxeder, DMT GmbH & Co. KG
- Albrecht von Kempis, VonKempisResources GmbH
- Dr. Frank Leschhorn, Munich Mining International

- Sustainable Mining Projects – Business Case and Financing
- TÜV NORD – CERA 4in1 Sustainability Certification System
- Establishing Sustainable Magnesium Production in Europe
- Environmental Issues of Nickel Production

Room D Panel Discussion Contextualising Digital Transformation in Mining Presenter: Michalis Katapotis, DMT

- Caitlin Corrigan, Institute for Ethics in Artificial Intelligence (IEAI) Technical University of Munich
- Julia Haske, Technische Hochschule Georg Agricola
- Georg Meißner, TU Bergakademie Freiberg
- Anja Straumann, GIZ

- Ethical Considerations for the Use of AI in the Mining Industry
- Mining education in digital times: Hurdles and opportunities from different perspectives
- One Step Ahead in Advancing Digital Education
- The potential of digitalization for powering resilience in mining communities: employment, local content and shared digital infrastructure

15.45h, Coffee Break & Networking (Foyer/Exhibitor)



06.06.2024, 16.15h (parallel Sessions & Panels)

<p>Room A Post-Mining issues & challenges</p> <ul style="list-style-type: none"> ■ Dr. Khanindra Pathak, Indian Institute of Technology Kharagpur ■ Marcin Pawlik, Technische Hochschule Georg Agricola ■ Frederic Poulard, Ineris 	<p>Presenter: Ralf Bufler, CDM Smith SE</p> <ul style="list-style-type: none"> ■ Surface and Ground water management plan for a hilltop manganese mines: integrated socially responsible mining ■ Social Participation and Acceptance in Post-Mining Transition Processes ■ Prevention of local sinkhole hazards in a post-mining context - French approach
<p>Room B Future Mining</p> <ul style="list-style-type: none"> ■ Max Friedemann, TU Bergakademie Freiberg ■ Mariaelena Murphy, Montanuniversität Leoben ■ Tobias Kornblum, Bundesgesellschaft für Endlagerung 	<p>Presenter: Prof. Dr. Helmut Mischo, Bergakademie Freiberg</p> <ul style="list-style-type: none"> ■ Process Optimization of an Underground In-Situ Bioleaching Test Laboratory for Low-Sulfidic Ores ■ Balancing Responsible Extraction of Resources and Related Social Impacts ■ Challenges of vertical string shaft Konrad 2
<p>Room C (Post) Mining Projects</p> <ul style="list-style-type: none"> ■ Matthias Bock, Plejades ■ Thomas Schicht, K-UTEC AG Salt Technologies ■ Tobias Steinert, BsS Bergsicherung Sachsen GmbH 	<p>Presenter: Toni Schmidt, TS BAU GmbH</p> <ul style="list-style-type: none"> ■ Post-use options for mining g ■ In-situ method for the non-invasive determination of the pore fraction in dumps at risk of subsidence flow ■ Schneeberg weather project - radon reduction in the urban area
<p>Room D Panel Discussion Green Steel technology</p> <ul style="list-style-type: none"> ■ Andreas Hees, DMT ■ Andreas Koller, Gerald Arbogast, SPC Steel Partner Consulting GmbH ■ Philipp Wagner, Wagner Consulting Service ■ Tsanislav Kolev, NLMK Europe ■ Erik van Doezum, ING 	<p>Presenter: Andreas Hees, DMT</p> <ul style="list-style-type: none"> ■ Processing and Pelletizing ■ Future of Ironmaking Technologies ■ Green Energy ■ Decarbonisation in Steel Making Process
<p>17.30h, End of the 1st conference day</p>	
<p>19.00h, Miner´s evening (Room A-B) Musical accompaniment with the "MEDLZ"</p>	<p>Welcome: Michael Kellner, Parliamentary State Secretary, Federal Ministry for Economic Affairs and Climate Action / Jens-Peter Lux, DMT GROUP / Michael Weberink, bsn e. V.</p>



07.06.2024, 9.00h (parallel Sessions & Panels)

Room A Sustainability Presenter: Dr. Martin Wedig, FAB e. V.

- Marietta Sander, Hannah Rotthoff, EE Energy Engineers GmbH
- Bob Tri Winarno, Ministry of Energy and Mineral Resources
- Dr. Herwig Marbler, Deutsche Rohstoffagentur (DERA) in der BGR
- Sanjey Bhoowanpursadh, DMT Kai Batla

- Sustainable securing of raw materials for the energy transition
- An initial assessment to define and classify critical minerals in Indonesia
- High-Tech-Metals as by-products in primary deposits in South America
- Confronting the Financing Challenges in the African Critical Minerals Revolution

Room B Challenges of digitalisation in mining Presenter: Michael Weberink, bsn e. V.

- Sebastian Westphal, Bundesgesellschaft für Endlagerung mbH
- Stefan Ebert
- Sandra Nowosad, TU Clausthal
- Dr. Claus Bachmann, J&C Bachmann

- Collaboration the construction of the radioactive waste disposal to a new level
- Digitalization of Mining Operations – A Roadmap to Data-Driven Decisions
- Global mining overview, mining methods and technology for autonomous mines
- Efficient geological modeling using IBERIA and ANCORELOG

Room C International Mining Projects Presenter: Florian Beier, DMT

- Prof. Archil Magalashvili, Ilia University
- Gvanca Delibashvili, Georgian Coal LTD

- Georgian mining sector - potential, challenges & changes
- Shaft construction project Georgia

Room D Panel Discussion Industry Standards Presenter: Dr. Michael Haschke, DMT

- Maria Nyberg, European Commission DG GROW
- Dr. Michael Haschke, DMT
- Dario Liguti, UNECE
- Cécilie Legallic OECD
- Prof. Dr. Peter Goerke-Mallet, Technische Hochschule Georg Agricola
- Julia Listringhaus, DIN Deutsches Institut für Normung e. V.

- Critical Raw Materials Act – sustainability provisions
- Sustainable Raw Materials
- Harmonizing global efforts: UNFC and UNRMS in sustainable raw materials
- Due diligence expectations as per the OECD Minerals Guidance: alignment practice

10.30 h, Coffee Break & Networking (Foyer/Exhibition)



07.06.2024, 11.00h (parallel Sessions & Panels)

Room A Mining Projects Presenter: Ulrich Wessel, DMT Gesellschaft für Bildung mbH

- Ulf Barnekow, Wismut GmbH
 - Dr. Lingampally Sai Vinay, MINISTRY OF COAL
 - Dr. Chukwuemeka Onaa, VDMA
 - Dr. Amir Kianfar, Institute for Advanced Mining Technologies der RWTH Aachen
- Completion of the Helmsdorf Tailings Remediation Project (Zwickau/Saxony)
 - Mine Closure: Repurposing of closed and abandoned mines and diversification of local economy
 - Role of Organized Private-sector Groups in Shaping Future Mining - the VDMA example
 - Advancements in Mine Communication Systems: the Efficacy and Applications of 5G and LoRa Technologies in Modern Mining Operations

Room B Exploration Presenter: Olaf Alisch, Verband Bergbau, Geologie und Umwelt e. V.

- Rüdiger Giese, Helmholtz-Zentrum Potsdam Deutsches GeoForschungsZentrum GFZ
 - Sebastian Lüning, K-UTEC AG Salt Technologies
 - Andreas Knobloch, Beak Consultants GmbH
 - Egbert Jolie, fluxtec UG
- The application of underground seismic methods for the characterization of clay rocks
 - A new geophysical method to better image the steep flanks of salt diapirs
 - EIS: Exploration Information System – Linking of mineral systems and mineral prospectivity mapping
 - High-resolution gas emission mapping for exploration and monitoring of georesources

Room C Hackathon Presenter: Dr. Karsten Zimmermann, DMT

- Dr. Karsten Zimmermann, DMT
 - Prof. Elisabeth Clausen, RWTH Aachen
 - Stephan Oehme, VDMA
 - Winner-Team
- Winners Award - Hack Mining 2024 - Germany's original raw materials techathon**

Room D Panel Discussion Geothermal Energy Presenter: Prof. Dr. Bodo Lehmann, DMT

- Gregor Dilger, Bundesverband Geothermie
 - Ingo Forstner, Bundesverband Erdgas, Erdöl und Geoenergie e. V.
 - Dr. Johannes Birner, Senatsverwaltung für Mobilität, Verkehr, Klimaschutz und Umwelt Berlin
 - Daniel Acksel, Geosysteme/Prof. Dr. Ingo Sass, Deutsches GeoforschungsZentrum
 - Andre Zucker, Anger's Söhne
- How can deep geothermal energy support the heating transition in Germany?
 - Doing the right things right: tools for a smooth rollout of deep geothermal
 - Exploration measures in Berlin for deep geothermal energy
 - Heat transition in Berlin/Brandenburg with deep geothermal energy
 - Innovative exploration for raw materials and geothermal exploration in urban areas

12.30 h, Lunch & Networking (Foyer/Exhibition)



07.06.2024, 14.00h (parallel Sessions & Panels)

Room A Ground Control

- Prof. Dr. Jörg Benndorf, Technische Universität Bergakademie Freiberg
- Maria-Barbara Schaller, GGB mbH
- Jan Anderssohn, Tre Altamira

Presenter: Dr. Ralf Fritschen, DMT

- Prediction and Monitoring Methods of Ground Movements above Underground Gas Storage in the Context of Environmental Impact Management
- Long-term monitoring of backfilled salt mines - new wireless rock pressure measuring system
- Mining related ground and structural movement measurements from space

Room B Mining Projects

- Silvio Engelmann, Dr. Dominic Demand, CDM Smith SE
- Michael Cofalik, THYSSEN SCHACHTBAU
- Maximilian Beyer, Sympatec GmbH

Presenter: Dr. Sebastian Westermann, Technische Hochschule Georg Agricola

- Analyzing heavy rainfall hazard of a mining heap: stability, surface runoff and erosion
- Conversion of the Concordia dewatering system into a backup site during ongoing pumping operations
- Optimisation of milling process by real-time particle size analysis

15.30 h, End of the conference



Abstracts

Major & Challenging Projects

Thomas Lautsch, Bundesgesellschaft für Endlagerung

BGE 2.0 – the prospects of BGE in its second five-year period of existence

With the construction of the nuclear facility around the Konrad storage shaft, the implementation of the Asse retrieval plan, the start of the licensing procedure for the Morsleben decommissioning plan, the submission of the proposal for the exploration of siting regions for the final repository for high-level radioactive waste and the backfilling of the Gorleben mine, the BGE is in the second year of a very intensive phase of the implementation of the National Program for the Disposal of Radioactive Waste.

Martin Ebeling, K+S Minerals and Agriculture GmbH

The Transformation project Werra 2060

With the Werra 2060 project, K+S is shaping the transformation of the Werra plant, which is currently responsible for around 45 percent of European production of basic materials containing potassium and magnesium. By 2028, production at the Wintershall plant will be converted to dry processing of crude salt and the Unterbreizbach plant will be developed into a refining site. At the same time, secondary mining, which has already been tested in Unterbreizbach, will be introduced at the Hattorf-Wintershall mine so that solid residues can be returned underground. These changes will enable K+S to halve CO₂ emissions and the amount of saline production water at the Werra plant. In addition, the growth of the Wintershall tailings pile will be reduced by 90 percent. At the same time, the company is strengthening its specialty portfolio with green potash products. The Werra 2060 project will involve investments of around 600 million euros in the coming years. K+S also expects significant funding from the federal and state governments.

The Werra Verbund plant with its sites in Hattorf and Wintershall in Hesse and Unterbreizbach and Merkers in Thuringia is the largest site of K+S Minerals and Agriculture GmbH. In addition to fertilizers, the Werra potash plant also produces preliminary products for a wide range of technical and industrial applications as well as for the pharmaceutical, food and animal feed industries.

It employs almost 4700 people, including 300 trainees. This makes it an important employer and training company in the triangle of towns between Bad Hersfeld, Bad Salzungen and Eisenach. It is also an important client for local small and medium-sized businesses and makes a significant contribution to value creation in the region. This makes it a central building block for the economic and demographic development of the East Hesse/West Thuringia region.

Jonathan Vanherberghen, Rio Tinto

European raw materials policy*

Prof. Thomas Baumgartl, Federation University Australia

Pathways and challenges to successful mine closure*

*No abstract available at the editorial deadline

Investments in Mining

Edda Wolf, Germany Trade & Invest (GTAI)

Exciting alternatives for raw materials: Argentina, Zimbabwe, Uzbekistan

From antimony to lithium to ytterbium: More than 90 percent of all metallic raw materials used in Germany have to be imported – many from politically problematic supplier countries. The resulting dependencies represent a major risk for German industry. And this in a situation in which the demand for some critical raw materials will increase dramatically due to digital and green transformation.

Because of the growing importance of safe and sustainable raw material procurement for German companies, Germany Trade & Invest has examined established and emerging supplier countries for critical raw materials: www.gtai.de/de/trade/specials/kritische-rohstoffe. In addition to well-known mining heavyweights such as Australia, China, India, Canada and the USA, smaller supplier countries such as Argentina, Zimbabwe and Uzbekistan are worth taking a closer look at.

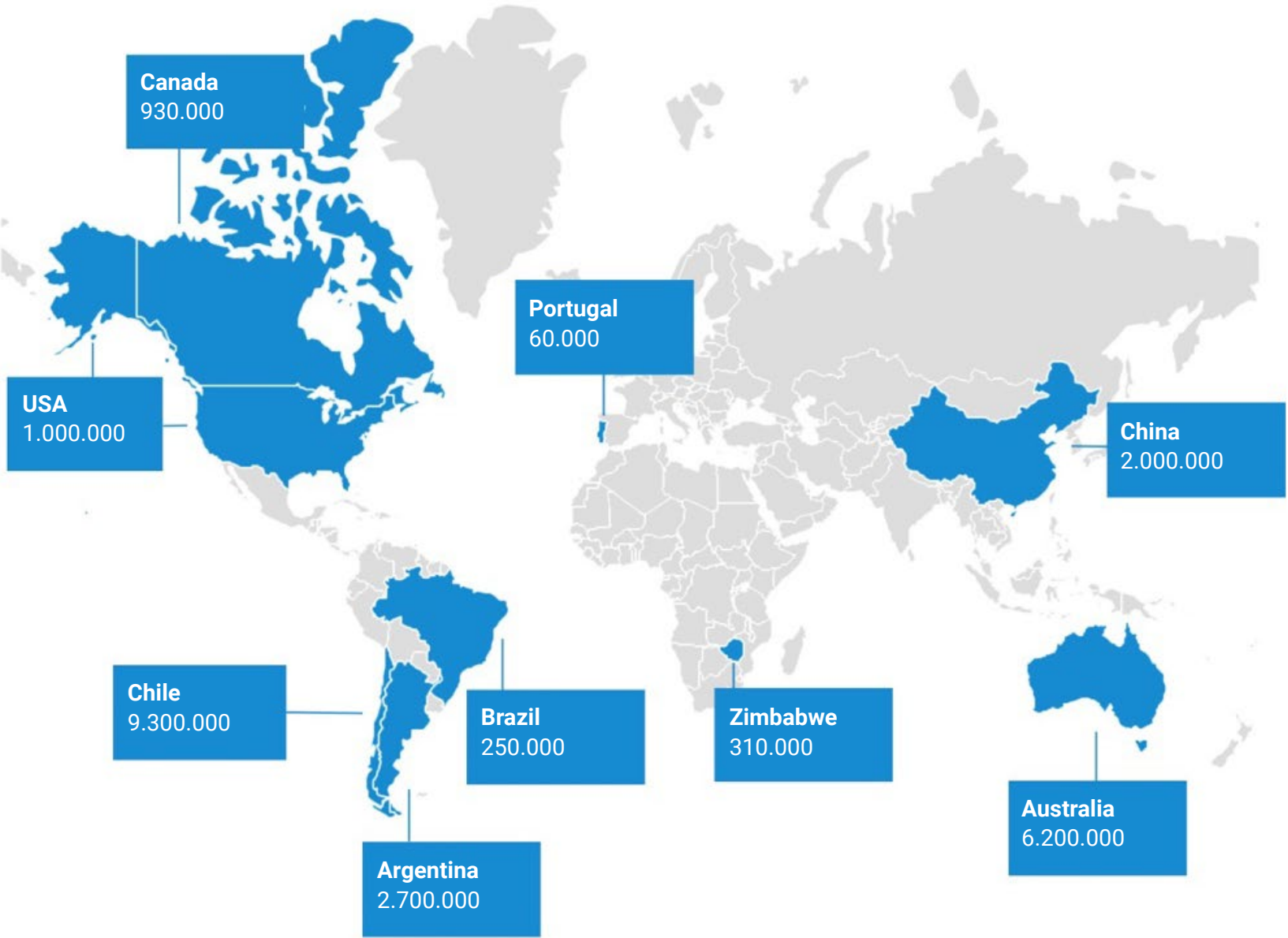
Argentina offers the world's third largest lithium reserves. Behind Chile and Australia the country is clearly developing into the third laughingstock. Argentina is still ranked fourth in the world in terms of production, but is working on moving up to third place in the future. It is greatly expanding lithium mining: in 2023, production rose by almost a third to 9,600 tons. There are currently over 70 lithium projects. Of these, almost 40 are in the advanced exploration phase, such as Deutsche E-Metalle AG's Carachi Blanco project. Argentina also has the ninth largest molybdenum reserves and is the tenth largest silver producer in the world. Another German company is active on site: the engineering firm K-UTECH AG Salt Technologies from Saxony-Anhalt.

Zimbabwe's government wants to benefit from the global energy transition and is aiming for high growth rates in the mining and export of platinum and lithium. With 1.2 million tons, the African country has the world's third largest reserves of metals of the platinum group (iridium, osmium, palladium, platinum, rhodium, ruthenium). In 2022, Zimbabwe accounted for almost 8 percent of global platinum metal mining. Three platinum projects are currently in development: Darwendale in Mashonaland Central, Karo in the Midlands Province and Mupanis south of Selous. Zimbabwe is also the largest lithium producer in Africa. Six active projects and four in the development phase ensure growth. Investors can reduce reputational risks for sourcing by going the necessary extra mile in the absence of government regulations.

Uzbekistan is just beginning to develop its raw material potential. Thanks to ambitious reforms, mining is experiencing a strong upswing. Since 2022, the usage rights to mineral raw material deposits are being auctioned in online auctions. By 2030, gold production is expected to increase by 50 percent and silver production by as much as 200 percent. Priority is also given to the mining of uranium and iron ores, along with metals such as lead, zinc and molybdenum. The government wants to explore and industrially develop the deposits of lithium, graphite, aluminum and tungsten with the help of private investors. Uzbekistan is pushing for high domestic value creation in its raw materials policy. Only a small part of the raw ores is to be exported. On April 5, 2024, the EU and Uzbekistan signed a memorandum of understanding and established a strategic partnership for critical raw materials. German companies should now take advantage of the opportunity to get involved in new projects.

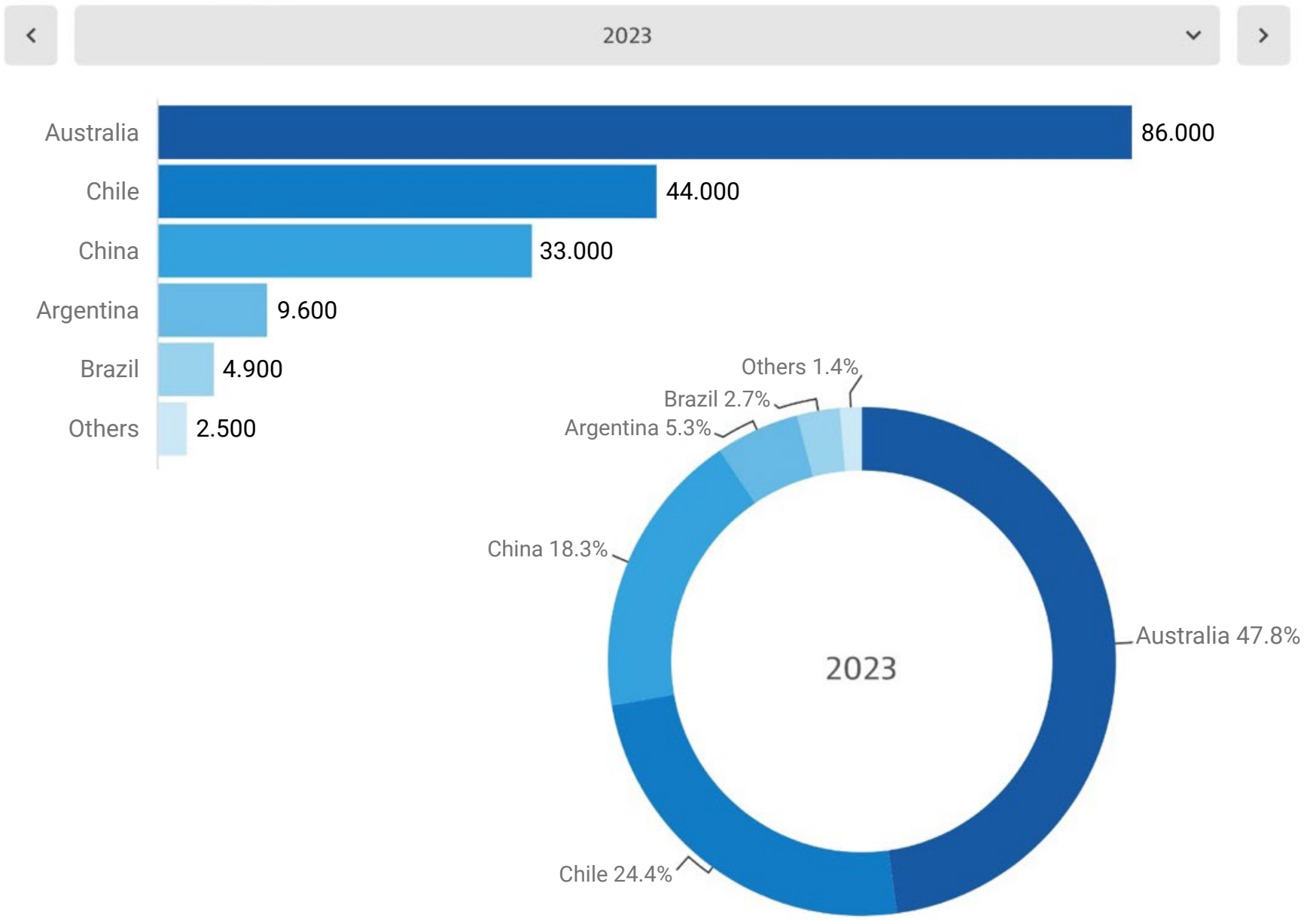
In this lecture, the raw material deposits and current projects in all three countries will be presented and business opportunities for German companies will be highlighted.

Localisation of global lithium reserves*
in tons



*Raw material reserves are proven quantities of raw materials that are currently economically recoverable
Source information: U.S. Geological Survey, Mineral Commodity Summaries, January 2023

The world's most important lithium producers
Production volumes in tonnes and share of global production



Note: without the USA, because the data is classified as secret
Source information: U.S. Geological Survey 2024

Dr. Sven-Uwe Schulz, Deutsche Rohstoffagentur (DERA) in der BGR

Current price & supply risk on global raw material markets*

Dr. Jan Klasen, KfW Bank

Financing of raw materials projects: The German government's raw materials fund*

Tetiana Dzhumurat, European Bank for Reconstruction & Development (EBRD)

Financing of raw materials projects: EBRD financing instruments*

Stefan Müller, Deutsche Gesellschaft für Wertpapieranalyse (DGWA)*

Panel Discussion ESG and Responsible Mineral Supply Chain

Ivor Kadragic, CDP

The Role of Climate Data in Ensuring Sustainable Investments*

Dr. Mary Mildred Stith, Pula Group

ESG as a key principle of funds allocation*

Tanja Winter, Aurubis

ESG perspective of copper products manufacturer and end-customers*

Galina Donnik, Sirius

Improving ESG data disclosure in metals and mining companies*

*No abstract available at the editorial deadline

Innovation in Shaft Construction

Dirk Fraas, TransnetBW

Through the ages: shaft construction for the energy turnaround

The increased use of renewable energies requires new ways of thinking – in many respects! In Germany's north, for example, wind energy can be effectively converted into usable electricity on the coasts of the North and Baltic Seas. However, in order to be able to distribute the generated energy to consumers nationwide, a modified electricity infrastructure is required. In this context, a 700 km long extra-high voltage direct current line is being built in Germany from north to south, which can make a significant contribution to the expansion of renewable energies.

In such a densely populated country, however, creative solutions have to be found for laying these cables, which are about 15 cm thick. This is also the case in the Heilbronn area, where, in addition to existing motorways and rivers, large industrial plants and settlement areas have to be crossed. Since active salt mining has been carried out in this area for over 100 years, there are extensive underground route systems here, which are now being used to lay the cables. Over a length of about 16 km, the cables will be routed under existing settlements, rivers and infrastructure structures through the existing mine. For this, however, two new shafts have to be planned, approved and sunk. The special features and challenges of this planning and approval of the shafts within the framework of a planning approval procedure for a large-scale cable route are discussed and presented in detail in this lecture/publication

In particular, the challenges of shaft construction in the case of the penetration of water horizons and the planning of a permanently watertight lining system to ensure the safe continued operation of the existing salt mine are highlighted and presented in pictures and text.

The different requirements for the unusual use of the shaft compared to the classic mining-specific tasks also pose special challenges for the planning and require a new, comprehensive approach.



Thomas Jenßen, THYSSEN SCHACHTBAU

BIM implementation in shaft construction using the example of the Heilbronn shafts

The presentation deals with some of the challenges that arise when a new working method is to be introduced.

These challenges can be simplified and summarised in three subject areas. These are people, technology and work processes. It is important to address all of these areas when introducing a new working method.

On the subject of technology, it must be noted that the programmes typical of the industry are not suitable for meeting the typical requirements of digital delivery items. We are therefore using other programmes for the current project. The motto is to only change what absolutely needs to be changed. This results in complex dependencies and a large number of interfaces that need to be identified, tested and optimised before a new working method can be described.

We understand work processes to be describable and repeatable work steps in daily project business. Technical and organisational issues must be taken into account as well as the project needs of all colleagues involved and the company's internal standardisation. If you join an existing organisation as a newcomer, you will recognise patterns and have the necessary distance to describe them.

However, it takes a lot of time to get a complete impression. We also have a consortium in the project consisting of Redpath Deilmann and Thyssen Schachtbau. So we are not only getting to know our own organisation, but also RD and the consortium to a certain extent. Here, too, the main aim is not to disrupt existing and functioning work processes while still realising the added value of the BIM method. A delicate balancing act! People as a subject area is of course the biggest challenge. It's not just about further training in BIM and the training of new software.

It's also not just about the distribution of tasks within the organisation. It's about creating understanding and enthusiasm. And about maintaining these. Within the consortium, the companies have decided to use the BIM method to a limited extent. The client's requirements are substantial but getting more relevant towards the end of the project. This offers the opportunity to introduce BIM as the project progresses. Picking the low-hanging fruit without overstressing the budget. In this way, the team develops the understanding and skills to fulfil the requirements of Südwest Salz and TransnetBW. The lecture will take up and explain some examples from all three subject areas.

Dzianis Iholka, REDPATH DEILMANN GmbH

Accelerating return of investment: Revolutionizing Potash and Polyhalite Mines Development Through Rapid Shaft Sinking Technologies

This paper investigates the transformative role of mechanized sinking technologies, notably Shaft Boring Roadheaders (SBR), in expediting shaft construction for potash mining projects. By leveraging cutting-edge innovations in mine and shaft construction, such as SBR and other advanced methodologies, the study elucidates the technical intricacies and operational efficiencies that enable rapid shaft sinking. Through detailed analysis of case studies and comparative assessments of traditional versus mechanized sinking approaches, the paper demonstrates how these technologies optimize excavation processes, enhance safety standards, and minimize project timelines. Emphasizing the technical superiority and cost-effectiveness of mechanized sinking, the research underscores its instrumental contribution to accelerating project delivery and maximizing return on investment (ROI) in the context of greenfield potash mine development.

Michael Weinhold, Herrenknecht AG

Shaft excavation and lining with the Boxhole Backreaming Technology in complex geological conditions*

*No abstract available at the editorial deadline

AI in automation technology

Michael Kieviet, LAPWING GmbH

The use of artificial intelligence in safety-relevant industrial automation applications

This presentation represents the current debate in functional safety in industrial automation on the use of AI-based safety systems.

The normative requirements and the developmental challenges of AI in current application scenarios are compared in practice. This includes both the special features of the AI development process and the resulting requirements for proof of conformity in accordance with existing functional safety standards.

Julius Kahmann, Baxtair Arcure S.A

When AI saves lives

The Blaxtair Origin system can distinguish people from objects based on their shape and thus warn of people in adjustable areas.

In the application case described, a water pipe had to be installed in an area that was closed to people. The edge of the Cottbusser Ostsee is partially at risk of collapsing, so people are not allowed to stay there. However, as there are only signs indicating the ban, it cannot be ruled out that people are not in the area. Nevertheless, earth had to be moved in this area. This could therefore only be done with a remote-controlled machine. AI-based person recognition was used here to ensure that the immediate vicinity of the machine was as secure as possible.

As soon as the person detection system recognized a person based on their shape and determined that the person was too close to the machine, a visual and acoustic warning was sent to the machine operator. A stop of the machine was also initiated. It should be noted that a new risk assessment may need to be created for this machine.



One challenge was the transmission of the camera image, as this had to be as latency-free as possible and with as little loss of quality as possible over a distance of more than 100m. This was not possible without a great deal of effort, so the decision was made to use a W-Lan transmission for approx. 50m. In future applications with a longer range, a local 5G network can be created that enables fast transmission.

Regardless of the application, it is important not to overburden the driver of construction machinery, but also not to disempower them. Person detection is an assistance system. The entire responsibility remains with the driver.

It is equally important to recognize reliably. A “suitable” database and a fast response time are crucial for this. The database should be context-related and rich in variants.

Maximilian Rolf, sensmore

Automating heavy vehicles in mining with AI using 4D imaging radar

sensmore innovates in mining automation, integrating 4D imaging radar and AI for safer, eco-friendly operations. Supported by the Pro FIT program and funded by the European Union Regional Development Fund, sensmore is building the world’s first foundational AI for 4D radar in off-highway automation. Unique AI powered products that are able to build-up an unprecedented understanding of the harsh environments where heavy machinery operate. sensmore will present customer insights from the deployment of the first AI-powered product, a radar-driven Driver Assist for Collision & Traffic Warning.

Dr. Gereon Weiß, Fraunhofer-Institut

Safety assurance and resilience of cognitive systems*

*No abstract available at the editorial deadline

Panel Discussion Sustainability

Michael Seeger, MX Mining Capital Advisors GmbH

Sustainable Mining Projects – Business Case and Financing

There is an ever-growing need for critical minerals to support the transition to a green economy. The mining industry is tasked with producing these minerals and metals. However, the contemporary mining industry faces significant environmental and social challenges, driven by traditional mining practices that yield substantial waste and carbon emissions, negatively impacting communities.

This presentation outlines a robust business case for sustainable mining practices, emphasizing innovative technical solutions and financing methods for these pressing challenges.

The conventional mining business model, based on mining of reserves, mineral processing, and customer delivery, is under increasing scrutiny due to its environmental footprint. The presentation highlights the urgent need for a shift towards sustainability, addressing intensive carbon emissions, the generation of significant waste, and water consumption.

Mining engineer Dr Seeger proposes a framework for the development of a sustainable mining business case that integrates advanced mineral processing technologies, renewable energy sources, and hybrid mining equipment into the conventional mining process. This framework not only minimizes environmental impact but also enhances efficiency in mineral recovery and reduces waste production.

A key component of the proposed model is financing sustainable mining projects. Various financing options are discussed, including equity finance, project finance, development finance, streaming, equipment finance and green bonds.

The presentation explores case studies where these innovative business cases and financing methods are being successfully applied, such as in projects entailing sustainable copper mining and processing, metal recovery and building material from slag dumps, and the use of hybrid / electric mining equipment on mines to reduce carbon emissions.

In summary, Dr Michael Seeger advocates for a transformative approach to mining, where sustainability is not only a necessity but a viable business strategy that can be funded. The adoption of renewable energies, cutting-edge mining and processing technologies, and responsible, innovative financing mechanisms forms the cornerstone of this new era in mining, aiming for a reduced environmental footprint and a sustainable future for the mining industry.

Albrecht von Kempis, VonKempisResources GmbH
Establishing Sustainable Magnesium Production in Europe

MFE Magnesium For Europe GmbH (“MFE”) was founded in 2021 to establish a clean, green and competitive Magnesium (“Mg”) production in Kupres, Bosnia- Herzegovina (“BH”), Europe, with an initial production capacity of 15.000 mt Mg p.a. starting in 2026. MFE’s project is motivated by two catalysts: 1 Progress in Mg-manufacturing technology; 2 An advantageous location where MFE has control over and access to a high-quality dolomite deposit of up to 100 Mio. mt proven and indicated reserve of raw material, ownership of a suitable production site close to the deposit, good infrastructure, and access to an abundance of low-cost green energy.

Dr. Frank Leschhorn, Munich Mining International
Environmental Issues of Nickel Production

Nickel plays a key role in stainless steel production (65%) and in lithium-ion batteries (17%) for electric vehicles with an increasing share. Nickel production increased from 1.4 Mt (2010) to 3.37 Mt (2023). The five main producers of primary nickel in 2023 were Indonesia (1.72 Mt), Philippines (0.37 Mt), Russia (0.22 Mt), New Caledonia (0.19 Mt) and Australia (0.16 Mt). While Indonesia and the Philippines accounted for about 60% of the primary global output, the production of refined nickel is dominated by Indonesia (about 40%) and China (about 30%).

The environmental issues of nickel production are reflected by these facts. Most of the globally mined nickel-ores are laterites (about 80%) which are found in tropical areas with their sensitive circumstances. The impact of nickel mining is extremely serious compared to the influence of sulfide ore production. Nickel refining is energy-intensive, especially the pyrometallurgical production of ferro-nickel products such as NPI and matte. The hydrometallurgical refining of nickel ore is less energy-intensive but the handling of the HPAL tailings is causing problems in areas of heavy tropical rains, aggravated by earthquake events.

The presentation addresses these issues including the carbon footprint of nickel production from different ores, in different countries with their specific energy supplies and the possibilities of carbon sequestration.

Luisa Daxeder, DMT GmbH & Co. KG
TÜV NORD – CERA 4in1 Sustainability Certification System*

*No abstract available at the editorial deadline

Panel Discussion Contextualising Digital Transformation in Mining

**Caitlin Corrigan, Institute for Ethics in Artificial Intelligence (IEAI),
Technical University of Munich**
Ethical Considerations for the Use of AI in the Mining Industry

In the effort to rapidly transform the way we use energy, valuable minerals are coming increasingly into high demand. However, their extraction often comes with high societal and environmental costs. Artificial intelligence (AI) enabled applications provide one avenue by which to potentially speed up extraction process. But, how do we ensure AI is used in an ethical way that benefits communities, societal development, and environmental sustainability in the mining industry? This short presentation will give an overview of current and potential uses of AI in the mining sector and present some ethical considerations for the responsible use of AI in the industry.

Georg Meißner, TU Bergakademie Freiberg
One Step Ahead in Advancing Digital Education

The international online course “European Critical Raw Materials for the Green and Digital Transition” addresses a gap in digital educational resources that help to understand the various facets of critical raw materials and their significance in everyday life. This is achieved through a close collaboration of industrial and academic entities affiliated with the Horizon Europe project AGEMERA (EU grant agreement ID: 101058178), where up-to-date information from the practical field is integrated into educational content in the form of a micro-credential. The course serves as an early example of the incorporation of micro-credentials into the educational system of the TU Bergakademie Freiberg. It was launched in March 2024 on the Opal online platform (also known as “Bildungsplattform Sachsen”), aimed towards students from TU Bergakademie Freiberg, Tallinn University of Technology, University of Oulu, University of Lapland, and University of Zambia.

Initially designed for aspiring scientists and engineers, the course is accessible for free to anyone. This resulted in 74 registered participants from over 25 nations during the first term of the course. Based on feedback from participants, the course complements the curricula of mostly graduate and postgraduate students enhancing the understanding of geological and engineering information, while addressing geopolitical, economic and marketing topics, as well as social and environmental aspects. Furthermore, the course deals with the United Nations Sustainable Development Goals, the United Nations Framework Classification for Resources, and the United Nations Resource Management System.

The participants found the topics related to the technology used in AGEMERA to be especially interesting and new. Based on the contents presented throughout 14 different sessions, participants are able to achieve a certificate of attendance. To receive the certificate of attendance, participants must successfully complete an automated online quiz and submit feedback to the course coordinators via an online questionnaire. As the live sessions were recorded and stored on a video platform, it is possible for participants to obtain the certificate of attendance at any given time. The certificate of attendance is a prerequisite for being authorised to take a 90-minute graded, written online examination. Upon successful completion of the written examination, achieving a score of at least 40% of the total possible points, in addition to enrolment at TU Bergakademie Freiberg, participants are eligible to receive three credits through the European Credit Transfer and Accumulation System.

Julia Haske, Technische Hochschule Georg Agricola
Mining education in digital times: Hurdles and opportunities from different perspectives*

Anja Straumann, GIZ
**The potential of digitalization for powering resilience in mining communities:
employment, local content and shared digital infrastructure***

*No abstract available at the editorial deadline

Post-Mining issues & challenges

Dr. Khanindra Pathak

Surface and Ground water management plan for a hilltop manganese mines: integrated socially responsible mining

Threats to biodiversity are unavoidable in surface mining operations in forest regions, particularly in case of hilltop mining. They affect water resources and leave footprints with adverse long-term ecological consequences in terms of soil erosion, land stability, degradation of water quality in the river basin and threats to aquatic ecosystems.

Thus, environmentally friendly mining requires effective watershed management.

This paper presents an effective watershed management approach integrating Remote Sensing and Geographic Information Systems (RS-GIS) technique to hydrological conditions for soil moisture conservation and surface and ground water management in surface mining areas.

A case study conducted at the Jhillingburu mine in the Saranda forest, Jharkhand state, India examined the hydrological factors such as topography, slope, flow direction, flow accumulation, stream network, drainage density, etc. and revealed the land use land cover (LULC) pattern and associated land use issues of the study area. The study reveals that to protect the Karo River, one of the main water sources of the Saranda forest, needs implementation of an effective watershed management strategy addressing soil erosion, water conservation, and ecological preservation.

RS-GIS based terrain analysis techniques provides necessary recommendations for establishment of green belt corridors, multi-purpose rainwater harvesting, check dam construction and development of ecotourism site and balancing economic development with environmental conservation efforts. The methodology employed in this study can be readily extended to any mining-affected forest region for sustainable conservation planning.

Marcin Pawlik, Research Center of Post-Mining – Technische Hochschule Georg Agricola The use of remote sensing data for Geomonitoring of post-mining processes

The use of remote sensing data for monitoring mining environments is becoming increasingly popular. Multisensor geomonitoring allows for the collection of environmental data in mining areas. The collected data can be used for spatiotemporal change analyses with remote sensing indicators. Integrating data from various sources enables more accurate visualization and a deeper understanding of environmental processes.

The study presents an innovative and interdisciplinary approach to post-mining processes at the site of the closed Prosper-Haniel mine in Bottrop, which is located in the northwestern part of the Ruhr area in Germany. The main mining activities in the research region started in the 1990s and lasted until 2018 (Böse et al., 2018; Busch et al., 2012; RAG Stiftung).

This approach was developed within the project „Digital Twin - Integrated Geomonitoring“, funded by the RAG Foundation. The aim of this study is to understand the phenomena and processes occurring after the cessation of mining activities using multispectral imaging from Landsat 4,5,7,8 and 9 space missions for the period 1984-2022. As the mining activity influences all the Earth's spheres, first of all the lithosphere and indirectly the biosphere, atmosphere, hydrosphere, therefore about 160 images were selected, on the basis of which remote sensing indices were calculated, which can be classified in three groups: vegetation indices (NDVI, GNDVI), soil indices (SAVI, MSAVI) and water indices (NDWIGao, MNDWI). The investigations carried out demonstrate the possibility of long-term spatial and temporal observation of the selected test areas at Weihnachtssee and Pflingstsee.

The analysis results show that only some of the mentioned indicators—NDVI, GNDVI, ND-WIGao, and MNDWI—correctly represent the mining-related correlations with vegetation health and soil water content, as well as the formation of mining subsidence lakes in the years 2000-2014. These results are important for future mining projects because only by selecting the appropriate remote sensing indicators can changes on the surface be identified early and quickly.

Frederic Poulard, Ineris

Prevention of local sinkhole hazards in a post-mining context - French approach

For almost 25 years, Ineris has been supporting the French government, alongside the Public Groupment GEODERIS, in its management of hazards and risks associated with post-mining operations, and in particular ground movements such as local collapses and sinkholes. The article focus on these experience and the method developped for managing thiese specif hazards.

Future Mining

Tobias Kornblum, Bundesgesellschaft für Endlagerung

Challenges of vertical string shaft Konrad

The Konrad mine is the first final repository for low- and intermediate-level radioactive waste in Germany approved under nuclear law. The approval process started in 1982 and the approval finally became legally binding in 2007. Due to the requirements of the approval situation and the requirement to build according to the current state of science and technology, there are special challenges that need to be met.

The lecture provides a rough overview of the large number of approval-related requirements as well as the additional provisions of the planning approval decision that must be adhered to. After a brief overview of the entire system on Konrad 2, the operating facilities, ie the winding tower, shaft cellar with chess hall and shaft hall extension as well as the shaft conveyor system, are presented in the area of the shaft.

This particularly includes the representation of the interfaces between the individual trades, for example fire protection, radiation protection or statics and dynamics.

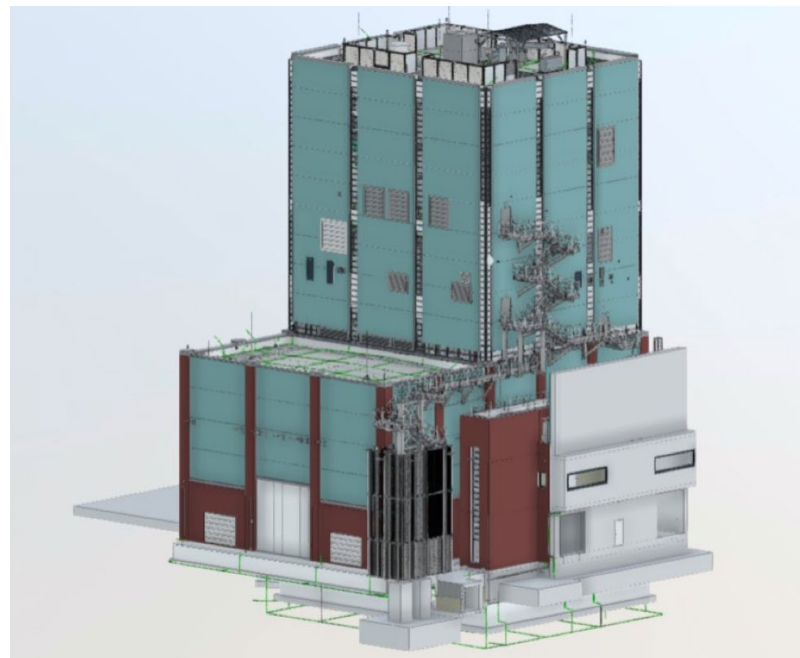
Furthermore, the area of statics and dynamics is discussed in more detail.

The connections between the individual building parts and the components to be fastened are shown using an example. Furthermore, changes to the legal situation and the resulting planning adjustments are presented.

In the further course of the lecture, the existing challenges underground will be explained. These include, among other things, ensuring the second accessible exit while simultaneously upgrading the shaft and the filling locations.

For example, the filling location on the 850m level was expanded from a cross section of 10m² to 134m² and provided with a slotted outer shell (shotcrete with expansion anchors).

After the convergence has subsided, a reinforced inner shell made of in-situ concrete is installed. Once the expansion has been completed, the shaft frame and all technical equipment will be installed. Shaft chairs, etc. must also be installed on the 1st and 3rd levels. After the shaft tube has been renovated, the guide devices (consoles and guide rails), media lines and the shaft conveyor systems (HSFA, MSFA) are installed. The entire material supply for the work in the Konrad 2 shaft and the areas close to the shaft must be carried out centrally via the Konrad 1 shaft.



Blas Urioste, KSL Kupferschiefer Lausitz GmbH
Modernising the KSL Project*

Mariaelena Murphy, Montanuniversität Leoben
Balancing Responsible Extraction of Resources and Related Social Impacts*

*No abstract available at the editorial deadline

(Post) Mining Projects

Matthias Bock, Plejades
Post-use options for mining

Geotechnical & mine surveying aspects and economic boundary conditions.

Possible options for the subsequent utilisation of mining facilities are determined largely by geotechnical and mine surveying aspects and economic boundary conditions.

Furthermore, legal, and social aspects can lead to areas of tension.

A fundamental problem of all reutilisation options is the widespread negative connotation of the terms “mining” and “mining legacies”. These terms are associated in particular with risks for people and nature, high remediation costs, environmental pollution, and undesirable legacies.

Reuse offers the possibility of mitigating many of these negative aspects or redirecting the impact. The site-specific options must always be analysed in detail from a technical point of view in order to be able to calculate, minimise or, in some cases, exclude project risks.

In addition to the basic definitions and explanations of delimitation issues, the presentation provides information on potential subsequent use options as well as the technical aspects for assessing project risks and important boundary conditions. Guiding principles for the development of post-utilisation will be presented.

Case studies are used to present subsequent uses for various mining sites.

The implementation of the subsequent use of former mining sites for a visitor mine, for environment and nature conservation, for energy generation and for landfilling is illustrated. Important assessment aspects are described in practice.

Thomas Schicht, K-UTEC AG Salt Technologies
In-situ method for the non-invasive determination of the pore fraction n in dumps at risk of subsidence flow

Since the closure of many former open-cast lignite mines in Lower Lusatia (eastern Germany), the rise in groundwater has led to an increase in stability problems in the area of the former spoil tips. These artificially created bodies are only slightly consolidated due to the transport and tipping technologies used in some cases. After they were flooded for landscape reorganisation purposes, the groundwater level in the surrounding area rose sharply. This leads to saturation of the filled, non-naturally grown soils, which can result in spontaneous soil flow or ground collapse.

The question of success control always arises, when compacting loose materials for subsoil improvement, renaturalisation measures and landscape ground improvement to prevent hazards such as soil liquefaction, mass movements, landslides, etc. The success of compaction measures can be specifically defined using geotechnical parameters. These parameters can usually only be obtained at great expense and then only selectively, e.g. by means of directed push soundings or undisturbed sampling in accordance with Category I.

Due to the size of the areas at risk, however, it is essential to identify the proportion of pores n over a large area and not just at specific points. Furthermore, there is a great need for an area-wide verification of the compaction success after necessary soil compaction by vibro-compaction or blast compaction.

The aim of the proceeded R&D project was to develop a method for the non-invasive and large-scale determination of the pore fraction n of unconsolidated rock in natural or anthropogenically influenced depositions.

The method is intended in particular to minimise deficits in the verification of compaction in heterogeneous mining dumps at risk of subsidence. The spatial image of the proportion of pores n in the dump will enable more effective monitoring of success and thus the planning of further compaction and faster utilisation.

By bundling the different competences of the research partners TU Darmstadt, TU Berlin, K-UTEC AG Salt Technologies and BIUG, an innovative technology was developed within the framework of the R&D. This development makes it technologically possible to determine one of the most important geotechnical parameters - the pore fraction n - over a wide area with the aid of spectrally induced polarisation.

Additionally, geoelectrical and seismic investigations were carried out on two internal dumps at risk of subsidence. The timing of the SIP measurements and the other geophysical measurements was planned and carried out in such a way that they took place before and after the blasting compaction measures.

In addition to these field tests, the project partners carried out laboratory tests on different scales. For example, the project partners at TU Berlin took disturbed samples from both test areas and obtained samples of the Darmstadt model sand for their comparative laboratory tests. This experimental work was the basis for the development of a petrophysical transformation model to obtain porosity n from SIP measurements. Meanwhile, the project partners in Darmstadt worked on setting up the large-scale test on a pilot plant scale, in which SIP and seismic investigations were carried out.

With the modelling approach for fully saturated tipping sand at hand, it was possible to demonstrate compaction success in areas of reduced porosity distribution after the compaction measures on two SIP field test sites. However, the modelling approach is valid for fully saturated loose sediments only. The modelling approach for partial saturation still needs to be extended in order to achieve full validity considering the upper most layers.

Tobias Steinert, BsS Bergsicherung Sachsen GmbH weather project

The “Schneeberg Weather Project I” consortium (Bergsicherung Schneeberg GbmH & Co KG and BsS Bergsicherung Sachsen GmbH [BsS]) has been working on the implementation of Phase I of the Schneeberg weather project since October 2021. The aim of the project is to reduce the sometimes serious radon contamination in the buildings of the mining town by constructing drainage structures and building a weathering network in the mine field under Schneeberg. The project is financed in equal parts by the Free State of Saxony and the project management organization of the Free State of Saxony for the remediation of the Wismut contaminated sites.

Within the consortium, the work was divided up so that Bergsicherung Schneeberg was responsible for the excavation and permanent securing of shaft 76 with the connected horizontal mine workings at the level of the upper Fürstenstolln and the establishment of the control capability of the deep Fürstenstolln up to the shaft Weißer Hirsch.

BsS Bergsicherung Sachsen is responsible for the excavation of Shaft 25, the conversion / equipping of Shaft Magazin and the excavation and permanent development of the roadways around Shaft 25.

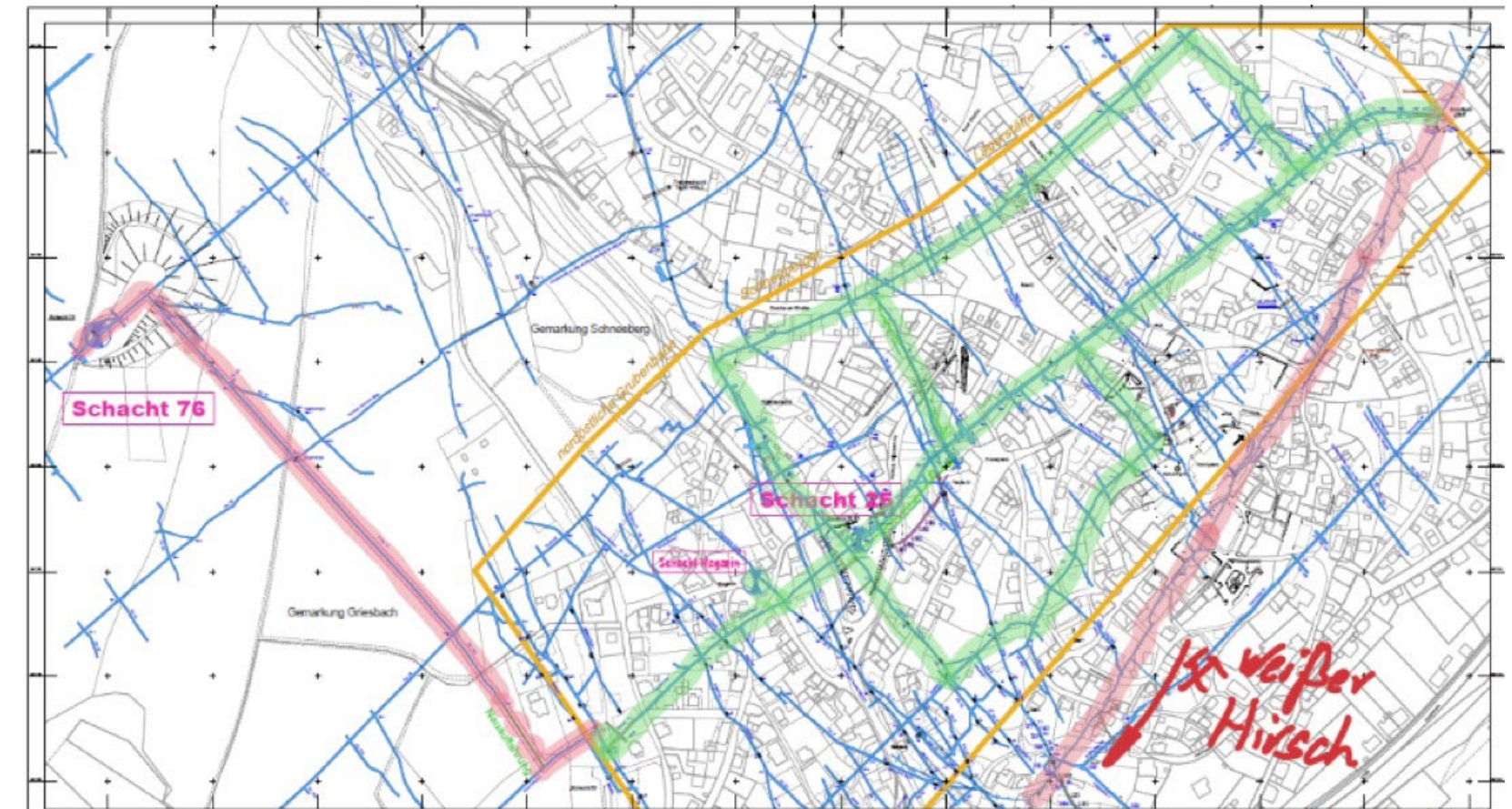


Bild 1: Planned processing area – Phase I, Wetterprojekt Schneeberg

1 Aufwältigung Schacht 25

The shaft is located in the town center, approx. 300m south-east of Schneeberg’s market square. The sinking work was started together with shaft 76 and other shafts in 1947. The 178 m deep shaft went into operation in 1948. After it was determined that the Schneeberg deposit did not contain any significant deposits of pitchblende, operation of the shaft was discontinued in 1952. Shaft 25 was finally sealed in 1980 by installing a concrete seal between 25 m and 18 m below the surface. Above the seal, the shaft tube was backfilled with waste rock and stone sand up to the surface.

Once the excavation pit and shaft head had been constructed and the hoisting system installed, the backfill column was removed and the concrete seal removed by blasting. The shaft was lined with a single-layer reinforced shotcrete shell except for crosscut 6 (level of the upper Fürstenstolln 42.5m below ground level) and in less stable areas additionally with steel frames and provided with a - partly temporary - driving center.

The shaft gates and flaps are currently being installed in the filling location. It is planned to excavate shaft 25 a further approx. 45 m to the filling point of the Markus Semmler Stolln, to secure it if necessary and to install a permanent transportation center.

Shaft 25 will serve as the central access, hoisting and supply shaft for Phase I of the ventilation project. It will be sealed and backfilled above the so-called 6 Lachter section once Phase I has been completed.



2 Querschlag 6 und Streckennetz

In shaft field 25, a total length of approx. 3600 m of horizontal ventilation ducts are to be excavated and permanently secured. In accordance with the existing old documents and the mining situation encountered, approx. 1100 m³ of broken masses are to be moved and sections of the route are to be permanently secured in accordance with the planning with approx. 300 steel door frames, or in sections with anchored structural steel mats and shotcrete (approx. 300 m²).

The excavation material should preferably be placed in mine workings that are not required for the project objectives. Excess material will be removed to the surface and disposed of properly. For horizontal conveying, approx. 2,000 m of 600 mm track will be installed and locomotive operation set up in areas requiring a lot of work and transportation. The other horizontal conveying work is carried out with battery-powered wheeled vehicles.

Panel Discussion Green Steel technology

Andreas Hees, DMT
Processing and Pelletizing*

Andreas Koller, Gerald Arbogast, SPC Steel Partner Consulting GmbH
Future of Ironmaking Technologies*

Philipp Wagner, Wagner Consulting Service
Green Energy*

Tsanislav Kolev, NLMK Europe
Decarbonisation in Steel Making Process*

Erik van Doezum, ING*

*No abstract available at the editorial deadline

Sustainability

Marietta Sander, Hannah Rotthoff, DMT Energy Engineers

Sustainable securing of raw materials for the energy transition in the federal state of North Rhine-Westphalia (NRW) - Presentation of the project and selected outputs on behalf of NRW.Energy4Climate

Raw materials have always been of crucial importance for human life. A sustainable and secure supply of raw materials is a precondition for functioning economic value chains, new industries and economic sectors. Secure access to raw materials is crucial for the performance of the economy in the federal state of North Rhine-Westphalia (NRW) and the energy transition.

We note a strong dependence on foreign resources and suppliers when obtaining certain raw materials for the energy transition. Within the project scope a focus is placed on rare earth elements, metal ores and battery raw materials.

As an energy- and industry-intensive state, NRW is particularly dependent on many sustainable solutions. For this reason, the NRW entity Energy4Climate appointed DMT ENERGY ENERGIES to find solutions for a secure and sustainable raw material supply to facilitate the energy turnaround in NRW. In our presentation we provide an insight in project outputs which relate to the energy strategy and policy goals of NRW in relation to the energy transition. An overview is shown on raw material demands, availability, markets as well as value and supply chains. Furthermore, risks and opportunities through circular economy solutions are provided with a view on NRW's extensive mining expertise.

The presentation gives an insight into project outputs which include technology and raw materials factsheets, workshop outputs and market insights. Project results are communicated with stakeholders, partners, the client and the public.

Dr. Herwig Marbler, Deutsche Rohstoffagentur (DERA) in der BGR
High-Tech-Metals as by-products in primary deposits in South America

Primary deposits often contain important by-products of critical raw materials, which are often not extracted, because additional economical processing technologies as well as financial investments are required. This means that many valuable products end up in tailings or stockpiles, in ideal circumstances for a later use. In several projects with Latin American partners, we are developing economical and sustainable processing methods and technologies for the extraction of, for example, cobalt from nickel deposits, tantalum and REE from tin deposits and gallium and germanium from zinc-copper deposits.

Sanjey Bhoowanpursadh, DMT Kai Batla
Confronting the Financing Challenges in the African Critical Minerals Revolution

As Europe reaches out to Africa in securing its supply of critical raw materials that will support its energy transition and digital transformation aspirations, new mining projects on the continent will be faced with a number of challenges, amongst which financing will probably be the most significant. In the past, access to finance has proved to be one of the greatest challenges, but venturing into new age minerals will pose their own unique set of obstacles, ranging from policy decisions and regulatory complexities to risk perceptions around infrastructure, social requirements, new markets and skills capacity.

The presentation explores how these challenges could be confronted and resolved through risk management processes that will attract and sustain investments in the critical minerals space in Africa.

Extracting and processing critical minerals is a capital intensive venture due to the large tonnages of material to be moved, specialised technology and equipment, and infrastructure requirements. African countries that are well endowed with mineral wealth, but which have fragile economies, may have limited access to capital markets, and are therefore reliant upon foreign shareholders and financial institutions to provide the necessary funding. However, many critical mineral projects are located in jurisdictions with high levels of uncertainty, and hence limited political and economic predictability. Once the industry landscape is overlain with the project's technical complexities, the multiplicity effect increases the risks perceived by financial institutions, thus making access to funding very onerous, and in some cases prohibitively expensive.

Infrastructure is another challenge that needs to be overcome. Generally mining sites are located in remote areas with poor access to reliable power, water, and road, rail and port facilities. The lack of efficient transportation increases logistical costs and the likelihood of potential project delays, which can deter potential investors. Access and reliability to clean, affordable power is another impediment where quality and security of supply cannot be guaranteed.

As a result, mining companies often have to invest in their own power generation sources and rely upon expensive backup solutions, thereby increasing capital requirements. Similarly, water management, social impacts and sustainable environmental practices increase the costs and risks associated with mining projects, thus compounding financing risks and adversely affecting the economics and credit quality of the mining transaction.

To overcome the swathe of financing challenges, and to improve access to funding, projects in Africa need to rely on a diverse range of financing sources including debt, equity, mezzanine funding, collaborative public-private partnerships, and non-conventional or alternative sources of finance, so that reliance on a single source is reduced, and project risk is spread across multiple funders.

Funding diversification should also be accompanied by rigorous due diligence processes, which are essential to assess project viability, identify potential risks, and develop risk mitigation strategies to minimise residual risks. Adopting robust risk management practices and developing contingency plans can help protect investors' interests, and also provide greater certainty and predictability to funding institutions.

On a national level, creating a conducive investment climate through predictable legislation, transparent regulations, investor-friendly policies, and political stability can attract foreign direct investment which can supplement domestic financing sources in the longer term, and stimulate economic growth in the mining industry.

Bob Tri Winarno, Ministry of Energy and Mineral Resources
An initial assessment to define and classify critical minerals in Indonesia*

*No abstract available at the editorial deadline

Challenges of digitalisation in mining

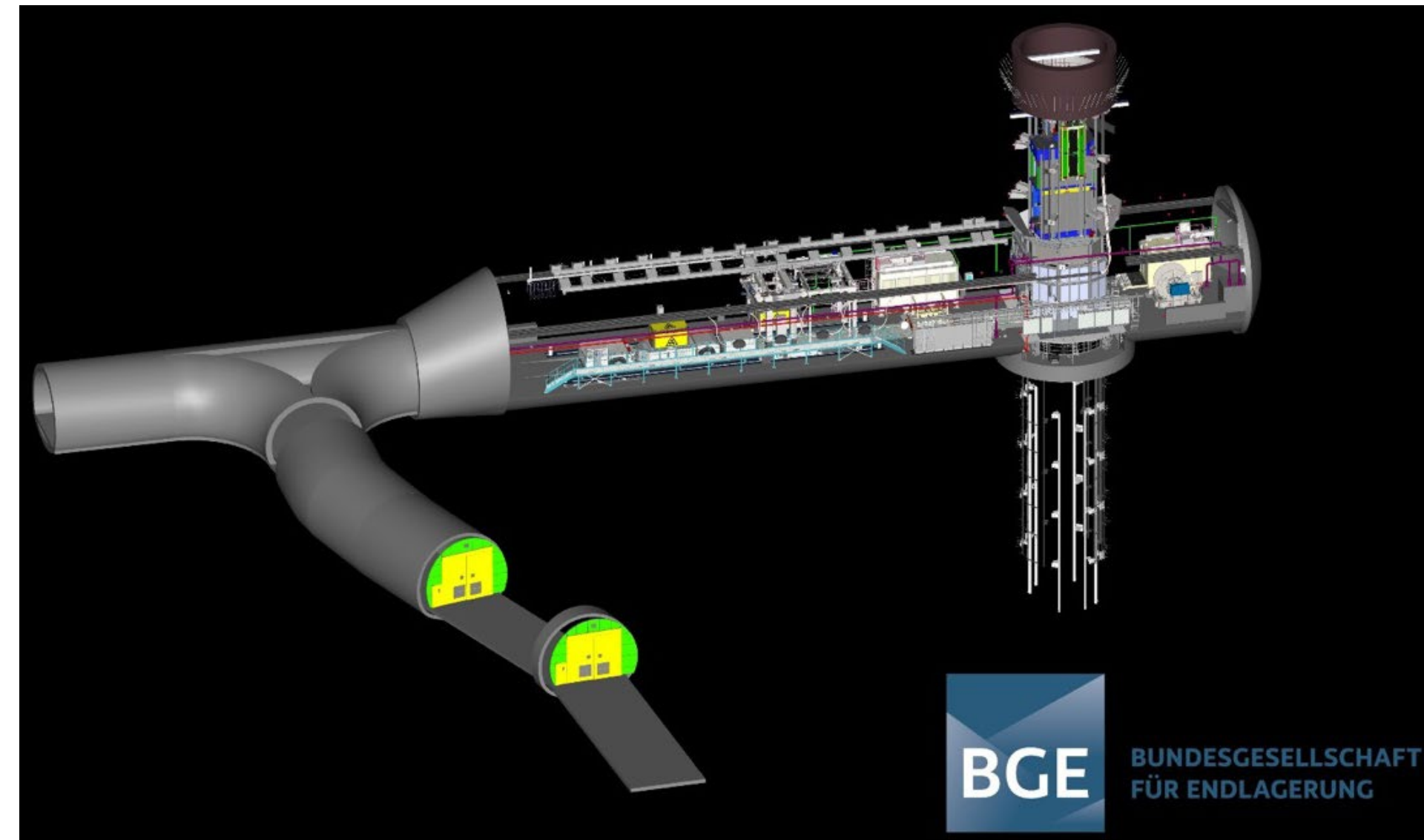
Sebastian Westphal, Bundesgesellschaft für Endlagerung mbH

Collaboration the construction of the radioactive waste disposal on a new level

By introducing the BIM method (Building Information Modeling), a new level of collaboration has been in the planning and construction of the final repository for radioactive waste in Germany, the Konrad shaft near Salzgitter. The BIM method enables the efficient coordination of various specialist trades, their accelerated communication exchange through issue management and offers optimized collision checking through the integration of geo-referenced 3D models. This leads to more precise planning and execution of construction projects. A key technology here is 4D simulation, which makes it possible to simulate and optimize the construction process over time, making planning, construction and building processes more transparent and efficient.

Component storage and assembly areas are taken into account in order to be able to determine the forecast timing of the construction sites more specifically in a schedule. The additional application of virtual reality (VR) and augmented reality (AR) technology supports the coordination and communication process. VR makes it possible to visualize and drive complex models in a virtual environment, while AR integrates digital information into the real world, the underground construction sites.

Further use cases of BIM in repository construction include virtually supported operational occupational safety instruction (VUBASU), which uses realistic simulations to enable employees to be trained for regular and emergency procedures in a safe environment. Virtual commissioning, which allows efficient review and optimization of operational processes before actual commissioning through the integration of BIM models with control systems, shows the significant potential of BIM to minimize risks and increase efficiency in complex construction projects in high-security areas such as repository construction.



Stefan Ebert

Digitalization of Mining Operations – A Roadmap to Data-Driven Decisions

Digitalization in the mining environment involves two complex problems. One is the interplay and interaction of the individual processes in the mining or operating process and the other is the development and selection of an adequate database or IT infrastructure.

The overarching objective of digitalization initiatives is usually very clearly formulated and is aimed at the transparent presentation of processes and improved decisions based on data and data analyses. However, there are two major difficulties in the implementation of projects, which means that many projects largely fizzle out:

Firstly, this is the anchoring of the topic purely in IT or e-technology, so that very provider-driven IT technologies or sensor solutions are introduced as an island, but a holistic structure for the use of the collected operating data is missing.

On the other hand, it is critical that problems and requirements from operations are often only specified at the start of the project and do not achieve the necessary depth due to a purely generic approach. An IT infrastructure is then built on the basis of this specification, but without regular feedback and verification of the correct mapping of the business problem with the specialist departments. Unfortunately, with this approach, the tool created through high resource expenditure rarely matches the requirements of the business to be able to make value-adding decisions based on data.

Consequently, it is essential for the successful implementation of digitalization projects in mining that relevant business parameters (KPIs) are worked out and correlations defined through specialist expertise, especially through the extensive involvement of future users of the data and the specialist departments generating the data, in order to prepare a clearly defined framework and a specific problem as a requirement for the IT infrastructure in advance.

In addition, it is essential to understand and design the integration itself as a structured and step-by-step, sometimes iterative, process. During the technical implementation of the IT environment, an ongoing exchange between IT and specialist personnel familiar with mining business processes must be ensured so that ambiguities and interpretations are clarified and correctly integrated directly in an agile manner during the project.

This step-by-step approach makes it possible to break down the complexities of mining and IT to a processable level and thus create a sustainable, analyzable and therefore value-adding data landscape.



Sandra Nowosad, TU Clausthal

Global mining overview, mining methods and technology for autonomous mines

The World Bank projects that over 3 billion tons of minerals and metals will be required to facilitate the transition to renewable energy sources and enhance energy storage capabilities. This demand underscores the urgent need to expand mining operations and open new mines. However, the conceptualization, design, and operation of future mines come with a host of challenges, including greater operational depths, higher rock temperatures, increased environmental constraints, greater interoperability, the integration of advanced technological systems, and automation, as well as a declining workforce.

Future mines prioritize safety and aim for zero-harm and zero-entry environments, with automation playing a crucial role. In recent years, several mines and machinery manufacturers globally have spearheaded efforts by conducting trials, initiating pilot implementations, and advancing technologies to meet these goals.

This presentation offers a comprehensive overview of current technological trends in the mining industry, with a focus on automation. It assesses the current state of technology, examines the constraints of its implementation, discusses the industry's technology readiness level, and identifies global challenges to technological integration. Additionally, it introduces a series of global overview dashboards that provide insights into mining information and highlight trends in mine automation worldwide.

Dr. Claus Bachmann, J&C Bachmann

Efficient geological modeling using IBERIA and ANCORELOG

Ore grade control is often based on geochemical sampling of boreholes cores or detritus. Limitations of this method include a single assay result representing a certain length of the borehole column, bias generated by sampling of the material and the delay in the delivery of results which can take days or even weeks, so that many decisions in the field have to be taken without fully understanding of the real element contents of the ore body. Presently this limited approach is still the standard even though elemental analysis is such a fundamental component of mining grade control and resource block models.

The drawback of these conventional methods can be overcome using newly developed tools.

The XRF based logging tool IBERIA has been developed specifically for providing real time elemental analysis through wireline logging. This tool produces a geochemical log along the column of the boreholes, allowing the generation of nearly continuous data for different elements based on X-ray fluorescence. Results can be delivered as soon as logging is complete. In this way, the IBERIA probe delivers valuable information in a faster, more detailed and more representative manner than the methods currently used.

However, core sampling cannot be replaced by IBERIA; core samples are still required for resource estimation according to international standards. Therefore DMT in conjunction with J&C Bachmann has developed the core scanner ANCORELOG which can be equipped not only with an XRF scanner but also with various optical sensors to provide a wide range of information about the cores. Handling of the cores is automated; the scan can be done directly in the core crates.

This paper presents the results of a series of tests demonstrating the accuracy, precision and features of the IBERIA tool as well as the ANCORELOG scanner. Results obtained on different base metal deposits will be presented.

International Mining Projects

Prof. Archil Magalashvili, Ilia University**Georgian mining sector - potential, challenges & changes*****Gvanca Delibashvili, Georgian Coal LTD****Shaft construction project Georgia***

*No abstract available at the editorial deadline

Panel Discussion Industry Standards

In spite of numerous international standards, guidelines and regulations for sustainable raw materials emerging over the last decade across the globe, some commodity-specific, some country-specific, there is still uncertainty for industry stakeholders on which standard(s) to use that deliver the necessary global acceptance and regulatory compliancy. This uncertainty is growing as the ever increasing demand for more mineral raw materials to accomplish the renewable energy transition adds extra strain on supply chains of sustainable raw materials. The global nature of raw material supply chains dictates a global approach for any plausible standard or guidelines for sustainable raw materials.

Due to the abundant and complex nature of the standard landscape for sustainable raw materials across the globe, there is a common understanding that both ESG criteria and standards are to be globally harmonized for more acceptance and transparency. This panel session is discussing essential criteria for harmonization and highlights some important activities in the field of standardization of sustainable raw materials.

Dario Liguti, UNECE**Harmonizing global efforts: UNFC and UNRMS in sustainable raw materials**

Harmonizing global efforts is paramount in striving to achieve the global goals. UNFC and UNRMS are pivotal in standardizing sustainable practices. UNFC is mandated under the EU Critical Raw Materials Act to guide the production, processing, and traceability of raw materials, ensuring they meet stringent criteria of sustainability. By fostering integrated resource management, UNFC and UNRMS not only support the circular economy but also strengthen international partnerships towards achieving the SDGs.

Maria Nyberg, European Commission DG GROW**Critical Raw Materials Act – sustainability provisions*****Dr. Michael Haschke, DMT****Sustainable Raw Materials*****Cécilie Legallic OECD****Due diligence expectations as per the OECD Minerals Guidance: alignment practice*****Prof. Dr. Peter Goerke-Mallet, Technische Hochschule Georg Agricola****Julia Listringhaus, DIN Deutsches Institut für Normung e. V.**

*No abstract available at the editorial deadline

Mining Projects

Ulf Barnekow, Wismut GmbH**Completion of the remediation of the Helmsdorf tailings pond**

The long-term storage of the Helmsdorf industrial tailings plant (IAA) was one of the most technically, ecologically and financially demanding remediation tasks. With its completion on December 31, 2023, approximately €300 million were spent on the renovation of the largest IAA in the Free State of Saxony. In the former processing plant 101 in Crossen, uranium ore was processed using soda-alkaline leaching from 1949 to 1989, producing around 87,000 t of uranium. Tailings were brought to the Crossen mining dump until 1989. From 1958 to 1989 the tailings were deposited into the IAA Helmsdorf. By 1989 the IAA had grown to an area of 208 ha surrounded by barrier structures and natural terrain in the south over a length of around 6.5 km. The tailings were flushed in from the dam tops, initially from the main dam and later also from the northwest and west dams. Approximately 50 million m³ of tailings with a thickness of up to 55 m were stored (Fig. 1). Next to the IAA Helmsdorf is the IAA Dänkriz 1 (22 ha; 4.5 million m³), which was also remediated by Wismut.

In 1990, Wismut began implementing first safety measures such as fencing and temporary cover on exposed tailings beaches and setting up environmental monitoring. Years of extensive investigations followed, which resulted in the selection of the preferred option for remediation, i.e. dry in-situ storage with partial technical drainage. This included the following renovation steps: removal of open water, water collection and treatment before discharge, intermediate coverage of the pool area, contouring of the dams and former pool area, final coverage with greened cover layers and subsequently constructed drainage systems linked to natural streams nearby as well as access pathways. Extensive monitoring was implemented to ensure the safety of the system and its impact on people and the environment.

In 1994/95 the first water treatment plant in Helmsdorf with a capacity of 250 m³/h was built. Until the WTP went into operation, no contaminated water could be released from the tailings pond into the receiving streams, resulting in the surface area of open water in the tailings pond increasing to 132 ha. The immobilized materials from the water treatment have since been stored in approved areas.

From 1993 to 2011, an intermediate cover was applied to the tailings surfaces. Covering liquid and unconsolidated fine sludge was, geotechnically, the most demanding challenge. The low-load-bearing tailings areas that fell free when the open water was removed were covered with geo-fleece and geo-grid and approximately 5-m-deep vertical drains were inserted. The intermediate cover was then applied in layers using material from the Crossen tailings pile and later using a 0/56 sand-gravel mixture, gradually progressing.

The slope of the main dam, which is up to 57 m high, was re-contoured from 2003 to 2008 through a combination of backfill and flattening of the upper embankment inwards to ensure long-term earthquake-proof stability. Some 800,000 m³ of tailings were relocated. Later, slopes of the northwest and west dams, which were built from tailings, were flattened in the same way. The contouring of the basin surface created a long-term stable surface that drains precipitation along natural gradients. Stockpile material and approx. 800,000 m³ of tailings from the Crossen mine dump as well as remediation materials from the former Crossen processing plant were used for that. Over 5.5 million m³ were relocated, including 3.25 million m³ from 1997 to 2016 by pipe conveyor.

The final cover layer serves to reduce water infiltration as well the exhalation radon. It also prevents unauthorised access to the tailings and forms the basis for final landscaping and greening. For this purpose, 3.7 million m³ of Rotliegend material was mined on site and installed in layers with a total thickness of 1.5 m.

Together with the compacted intermediate cover II made of Rotliegend material below, a minimum coverage of contaminated areas of approx. 2.0 m is guaranteed. Paths and channels were created on the surface to drain away precipitation. The surface was and is still being greened in accordance with the landscape conservation plan (Fig. 2).

From 2011 onwards, an avifaunistic replacement body of water for the IAA Dänkritz 2 rehabilitation project was built and developed in the remaining mining fields.

In 2023, the newly built Helmsdorf water treatment plant was put into operation for the aftercare phase. In the coming years, the old WBA Helmsdorf will be demolished and the remaining areas in the area around the IAA will be renovated. The IAA Helmsdorf has been in aftercare since January 1st, 2024. The long-term tasks include water management, care and maintenance as well as environmental monitoring.



Dr. Lingampally Sai Vinay, MINISTRY OF COAL

Mine Closure: Repurposing of closed and abandoned mines and diversification of local economy

Achieving net-zero emissions is a critical cross-sector climate-action goal, yet a complex undertaking with many significant but surmountable obstacles. Globally, there is huge pressure to shift primary energy from fossil fuel energy to clean energy. In the process of shifting fossil fuel to clean energy, it is also of utmost importance to identify some of the most important challenges and solutions for a feasible pathway to net zero. Mainly mine closure issues, which may affect the complete land air and water quality.

Globally, existing mine closure legislation lacks provisions to adequately address the socio-economic and cultural aspects, highlighting the need for an improved policy paradigm. The current policy focuses on technical aspects like dismantling building structures, removing tailing materials, and decommissioning mining machinery.

However, there is insufficient attention to transitioning the community from mining-dependent livelihoods to a post-mining economy. The adoption of global best practices is crucial to facilitating successful mine closure. This paper highlights the necessity of mine closure and issues related to it.

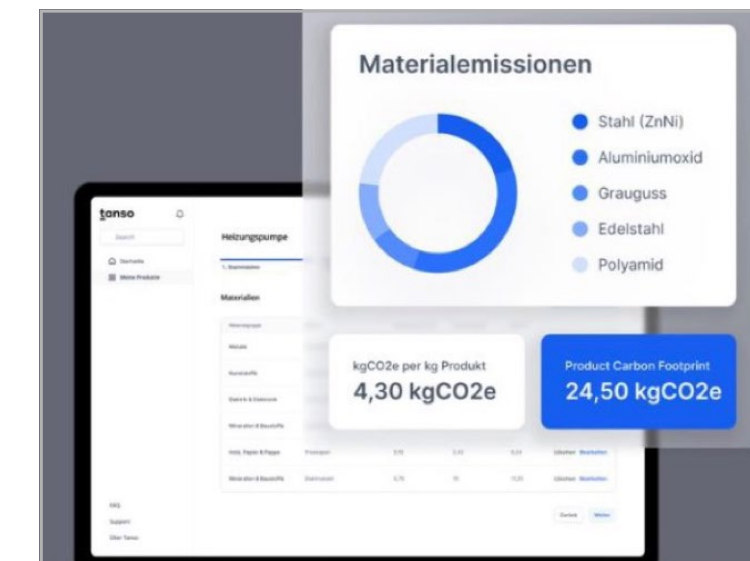
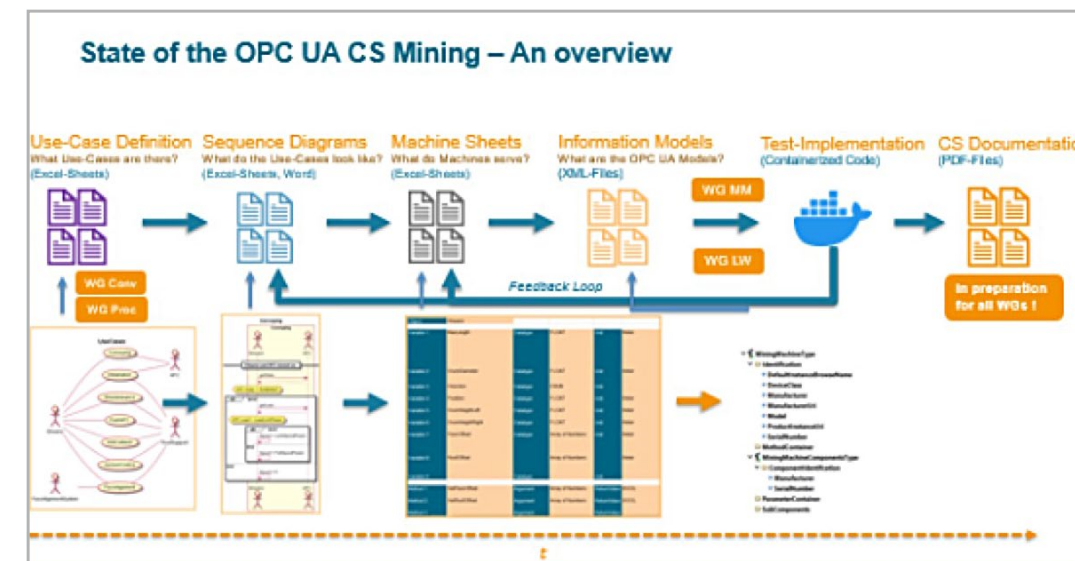
Dr. Chukwuemeka Onaa, VDMA

Role of Organized Private-sector Groups in Shaping Future Mining - the VDMA example

Focusing on the exemplary contributions of the Machinery and Equipment Manufacturers Association (VDMA), the organized private sector plays critical roles in shaping the future of mining. As a prominent and Europe’s largest industry association representing over 3,600 companies that produce critical industrial goods and collectively form the backbone of German industry, the VDMA is an enabler in driving innovation, promoting sustainable practices, and enhancing safety standards within the industry.

Through collaborative efforts, strategic engagements, knowledge sharing, and advocacy, the VDMA and similar private sector organizations contribute to advancing technology adoption tilted towards a sustainable future. In addition to research and development, such efforts include initiating, sponsoring, and partnering with industry stakeholders in executing knowledge-driven projects, such as hackathons, technical working groups, and smart-mining conferences, with a view to future-proofing the mining industry.

At the heart of VDMA’s role in shaping future mining is promoting Digitization in mining – built on the OPC UA platform, and in Product Carbon Footprint (PCF) calculation. Within the OPC UA Mining framework, the VDMA joint working group galvanized OEMs, software companies, operators, and universities to complete 19 Companion Specifications (CS) in pursuit of common language for mining. The CS report, Release 1.0, was published at the end of 2022 with current CS execution focusing on conveying and processing. Ongoing discussions with the Global Mining Guideline Group (GMG) and ErdiTestlab aims at scaling collaborations to international level. Since manufacturing contributes nearly 32% of CO₂ emissions in Germany, the VDMA’s PCF in Mechanical and Plant engineering working group has developed the PCF STARTER – a pragmatic solution that allow members to freely calculate their Product Carbon Footprint (PCF) in a time-and-cost efficient manner.



**Dr. Amir Kianfar, Elisabeth Clausen,
Institute for Advanced Mining Technologies der RWTH Aachen
Advancements in Mine Communication Systems: the Efficacy and Applications
of 5G and LoRa Technologies in Modern Mining Operations**

In the transition towards digitalization and automation of mining processes, high volumes of data are generated, including sensor data, voice communications, videofeeds and vehicle telemetry. This generated data is preprocessed on-site and subsequently transferred not only to headquarters for detailed analysis but also between mining machines and vehicles to the others in case of automation or autonomous mining systems. Stable communication in the mining industry and particularly in underground environments are essential for increasing safety and productivity, support fast and secure transportation and facilitating logistical processes, ensuring continuous and smooth operations.

Several different communication technologies and protocols exist related to the mining field, each with its unique characteristics, advantages or limitations. This article focuses on two essential technologies: Long Range (LoRa) as a technology since years and new technology of the fifth generation (5G) of cellular network will be presented and discussed in this article, which show significant differences in their properties and applications in various scenarios.

The choice between LoRa and 5G depends on the specific requirements of the application. By examining these two technologies, one gains insights into the extremes of wireless communication capabilities, from LoRa to transmit over long distances at low power to 5G for its high-speed and real-time data transfer. This can play an important role for understanding the limits and possibilities within wireless communications required in the mining industry.

Exploration

**Rüdiger Giese, Helmholtz-Zentrum Potsdam Deutsches GeoForschungsZentrum GFZ
The application of underground seismic methods for the characterization of clay rocks**

Clay rocks are one of the possible rock types for the storage of nuclear waste. The study of their mechanical, thermal, hydraulic and chemical properties is therefore of fundamental interest, particularly for ensuring the long-term stability of underground storage facilities. Various underground laboratories in Europe are dedicated to researching these properties of clays, including the rock laboratory operated by swisstopo in Mont Terri (Switzerland) and the one operated by IRSN (Institut de Radioprotection et de Sûreté Nucléaire) in Tournemire (France). At both sites, the Helmholtz Innovation Lab „3D Underground Seismics (3D-US)“ and the GFZ section „Geophysical Imaging“, in cooperation with the operators of the laboratories, carried out seismic measurements to characterize and monitor tests in the clay rocks.

Seismic source and receiver systems developed in the 3D-US Lab at the GFZ were used for these underground measurements. The seismic sources are impulse and vibration sources that can be used both along the drifts and in boreholes. Depending on the exploration target and its distance from the measurement site, signals with frequencies of 80 to 3600 Hz are excited. The good reproducibility of the seismic signals excited by the controlled mechanical sources is a good basis for monitoring processes in the rocks. The signals are recorded by 3-component (3C) geophone receivers, which are located at the tips of rock anchors that are screwed into previously glued aluminium sleeves in 1 m or 2 m deep boreholes along the drifts. 3C receivers are also inserted into longer exploratory boreholes as a geophone chain consisting of up to eight measuring modules with the aid of a fibre rod. Different receiver spacings of a half to several meters can be realized in the boreholes. With to the modular acquisition technology of the 3D-US Lab, various measurement geometries are possible for the exploration of the surroundings of underground structures, such as drifts to boreholes or cross-hole surveys. The data obtained is evaluated using tomography and 3C migration methods.

Our contribution presents examples of subsurface seismic measurements from the Tournemire and Mont Terri underground sites that demonstrate the use of subsurface seismics to monitor a borehole-based thermal and hydraulic stimulation experiment in a fault zone and to explore structures in the claystone and neighboring formations. As a result, similarities and differences in the seismic wave transmission of the Opalinus Clay Formation in Mont Terri and that of the Toarcium in Tournemire will be compared.



Sebastian Lüning, K-UTEC AG Salt Technologies

A new geophysical method to better image the steep flanks of salt diapirs

Steep slopes of salt diapirs are typically very hard to image by traditional seismic exploration methods. As part of a project with a Dutch salt cavern field operator, the Geophysics department at K-UTEC Salt Technologies has now introduced a new method that allows to map the steep geometry and flanks of salt domes much more precisely than before. For this, we are using a combination of hybrid VSP and surface seismics, two methods well known from oil & gas exploration.

The two methods complement each other in their strengths. The improved imaging yields significant advantages for salt cavern operators: The more precisely the geometry of the salt body is known, the more effectively salts can be extracted, making better use of the hitherto complicated flank areas. This subsequently also creates more underground storage capacity. As a result, efficiency and sustainability of salt mining is increased and the production costs of mining and storing energy sources are reduced.

Andreas Knobloch, Beak Consultants GmbH

**EIS: Exploration Information System –
Linking of mineral systems and mineral prospectivity mapping**

The „Exploration Information System“ (EIS) project, funded by the European Union (EU) Horizon Europe research and innovation-funding programme, aims to discover new sources of critical primary raw materials within the EU by combining mineral systems modelling and mineral prospectivity analysis methods.

As exploration data continues to emerge, the need for efficient data analysis becomes crucial, considering the high cost of data acquisition. Efficient analysis of expensive exploration data has become crucial and recent advancements in artificial intelligence and machine-learning algorithms within geographic information system (GIS) platforms have enabled the integration of geological knowledge and exploration data into complex mathematical models for predicting the existence of new mineral occurrences.

The EIS project promotes a hybrid approach that utilizes mineral systems modelling as the foundation for mineral prospectivity modelling. A crucial component of the EIS is a library of geological fingerprints representing diverse types of mineral systems. These fingerprints are used to identify the most relevant mapable geoscientific features essential for successful prospectivity analysis.

The project focuses on three mineral systems as case studies: cobalt minerals in volcanogenic massive sulfide (VMS) systems, lithium-tin-tantalum-tungsten minerals in granite/pegmatite-related systems, and rare earths-cobalt minerals in iron oxide copper-gold (IOCG) systems. Selected mineral deposits within the partner countries of the EU serve as study or test sites, and reference sites in South Africa and Brazil, specifically the Li-bearing pegmatite in the Orange River Pegmatite Belt and the Carajás IOCG province, provide additional insights.

This project aims to enhance access to critical raw materials in Europe by providing new information on critical mineral systems and efficient data analysis tools, ultimately expanding knowledge of existing deposits within Europe. The development of new digital exploration tools will accelerate the discovery of mineral deposits (such as Li, W, Ta, Co, and REE) within the EU.

An ideal exploration information system comprises components for different stages of mineral prospectivity analysis. The presentation will showcase the newly developed “EIS Toolkit”, which includes among others preprocessing tools and validation tools, but also new data analysis methods by incorporating artificial intelligence with machine learning and deep learning. In addition, it will be highlighted how geo-models and mineral systems modelling is being integrated into mineral prospectivity mapping.

Finally, the first beta release of the open source “EIS QGIS Plugin” consist of a collection of software tools for semi-automated exploration targeting in Quantum GIS.

Keywords:

mineral systems, mineral prospectivity mapping, geographic information systems, open source, critical raw materials

ENHANCING EXPLORATION EFFICIENCY WITH DIGITAL TOOLS

Enabling New Sources of Critical Raw Materials with New Tools for Green Technologies

COLLECTING DATA

Data is collected at different scale with different survey methods (geology, geochemistry, geophysics, remote sensing)



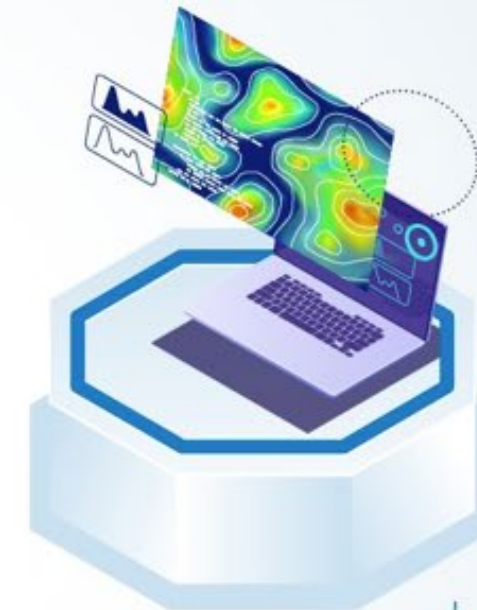
DEFINING MINERAL SYSTEMS

Mineral proxies are being created using the available collected data depending on the defined mineral system



EIS TOOLKIT

The EIS Toolkit is a set of data and tools for data pre-processing, exploratory analysis, predictive modelling and results evaluation



EIS WIZARD & EIS QGIS PLUGIN

The EIS QGIS Plugin includes the developed EIS Toolkit algorithms and a user-friendly interface in QGIS with the EIS Wizard, streamlined into one workflow

NEW MINERAL DEPOSITS DISCOVERED

EIS reduces exploration risks predicting potential new sources of critical raw materials for green technologies. It also minimises the environmental footprint of mineral exploration

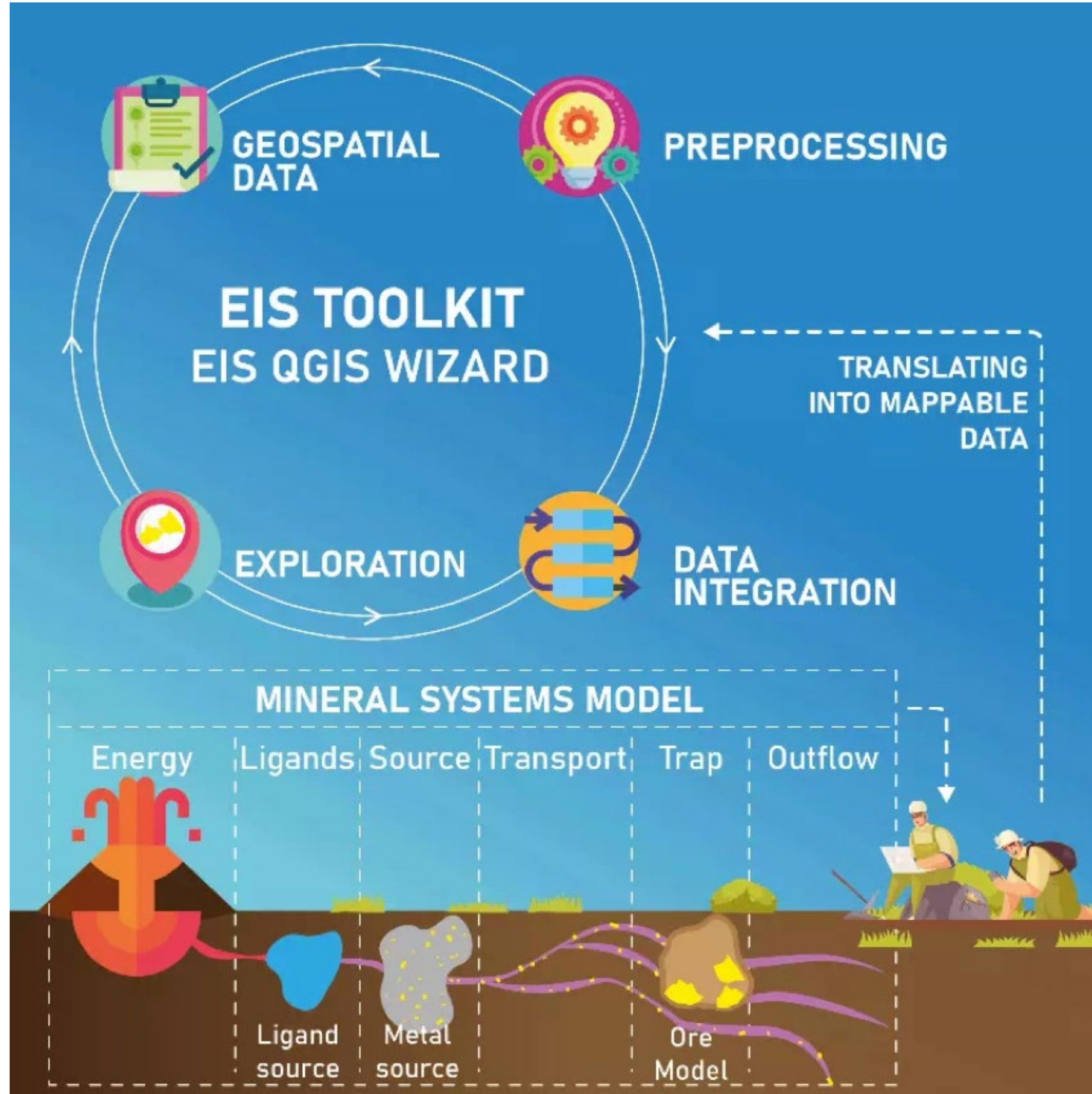


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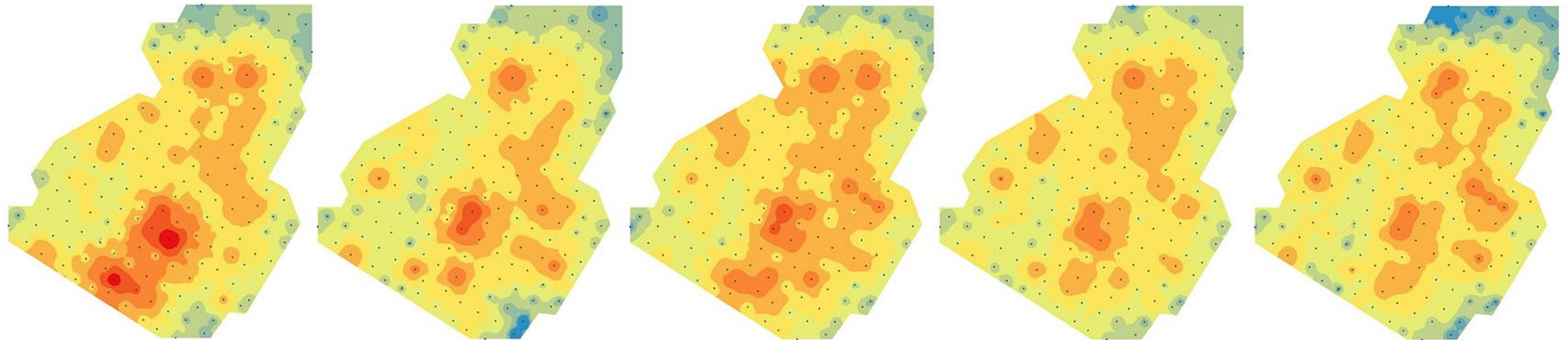


Egbert Jolie, fluxtec UG

High-resolution gas emission mapping for exploration and monitoring of georesources

Gas emissions at the Earth's surface are fingerprints of processes in the deep or shallow underground. They are characteristic of a variety of natural systems (e.g. geothermal resources, volcanoes, tectonic rifts), but can also occur as a consequence of human activities and installations (e.g. boreholes, mining, landfills, gas storage). Common endogenous gases are carbon dioxide, methane, hydrogen sulphide, but also radioactive elements such as radon. The comprehensive analysis of emission rates and gas composition provides valuable insights into the characteristics of georesources and is an integral part of modern exploration and monitoring concepts^{1,2,3} (Fig. 1).

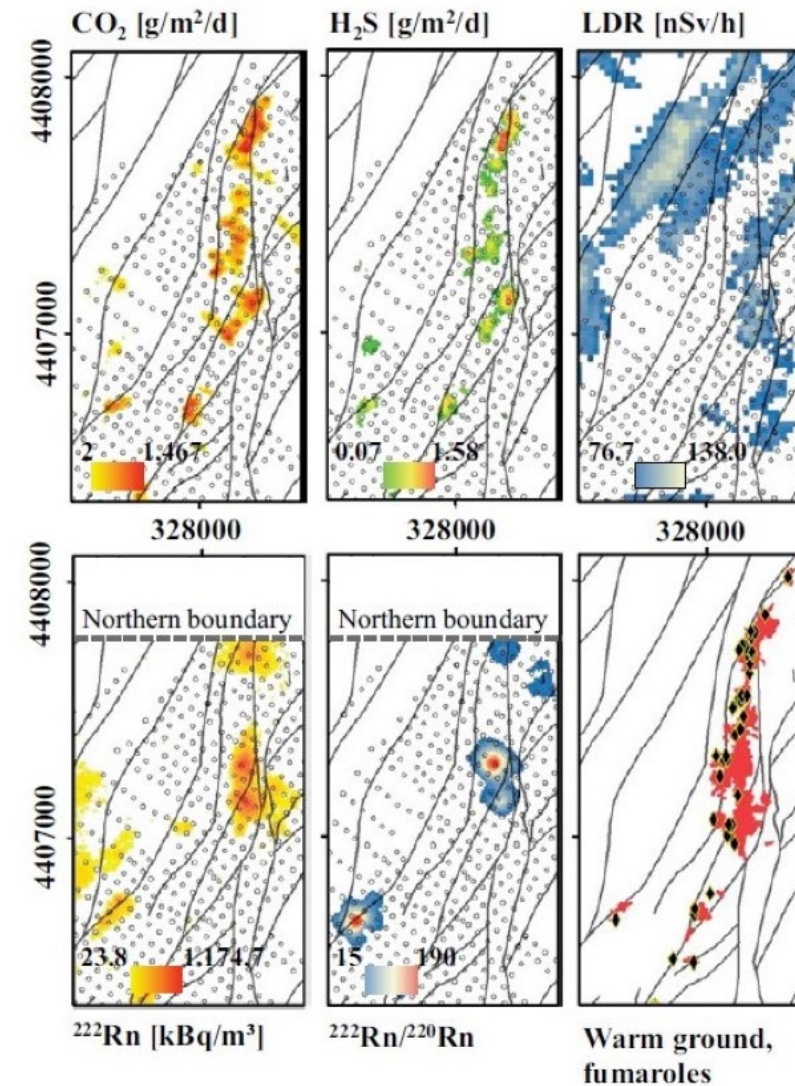
Our key motivation is to reduce exploration risks in the development of georesources. We offer tailor-made, multi-scale and affordable solutions from single point to reservoir scale surveys. State-of-the-art technologies and innovative workflows for data acquisition, processing, and visualization enable results in real-time.



Gas emissions can be systematically analyzed by using extensive measurement networks with predefined measurement locations - usually in the order of several thousand points. With flexible sampling grids, we can analyze large areas of several square kilometers. With our portable and flexible equipment, data can be collected even from areas that are difficult to access (Fig. 2). Results can be provided in all common data formats and are complementary to common exploration data. We also offer reprocessing of existing data. We offer environmentally friendly and non-invasive technologies for the safe and sustainable management of the geological subsurface.



Monitoring degassing processes at a high spatial and temporal resolution with systematic approaches improves the understanding of (i) undesired changes in gas storage systems, landfills or carbon capture and storage facilities, (ii) geothermal systems and their response to geothermal production and stimulation, (iii) borehole integrity and (iv) processes at major fault zones with high seismic risk. To understand the dynamics of georesources, we offer multi-component soil gas monitoring with time-lapse (Fig. 3) and continuous monitoring methods³.



- High-resolution gas emission mapping for any industry
- Flexible multi-parameter analyses (e.g. carbon dioxide, methane, Radon, Thoron, isotopes, ground temperature at specific depth)
- Mapping of geothermal surface activity
- Identification of structural discontinuities in the subsurface
- Evaluation of potential reservoirs and geothermal well siting
- Leakage detection (borehole integrity, waste disposals, mining)
- Full-package of data acquisition, processing, and visualization
- Time-lapse and continuous monitoring

Panel Discussion Geothermal Energy

Gregor Dilger, Bundesverband Geothermie

How can deep geothermal energy support the heating transition in Germany?

Deep geothermal energy can make a major contribution to supplying Germany with heating and cooling energy. There are currently 41 plants in operation in Germany; 32 of these are heating plants that provide district heating (and in some cases also cooling energy), while a further 7 plants provide a combination of thermal energy and electricity. The installed capacity currently amounts to 407 MW. The potential is much higher. The “Deep Geothermal Energy Roadmap” of the Fraunhofer and Helmholtz Association (Bracke / Huenges 2022) estimates a market potential or total technical potential of “well over 300 TWh of annual energy or 70 GW of installed capacity” for hydrothermal geothermal energy (use of thermal water horizons). This corresponds to 25 % of the total heat demand. In addition, there is the potential of petrothermal geothermal energy (use of hot, initially dry rock layers) as well as underground heat storage (more than 500 TWh per year) and near-surface geothermal energy.

The UBA study “Kommunaler Klimaschutz durch Verbesserung der Effizienz in der Fernwärmeversorgung mittels Nutzung von Niedertemperaturwärmequellen am Beispiel tiefeingeothermischer Ressourcen” (Sandrock et. al. 2020) shows a technical supply potential of up to 118 TWh/a for hydrothermal geothermal energy and up to 211 TWh/a for petrothermal geothermal energy.

Over 100 deep geothermal projects are currently under development. They all rely on good framework conditions. Accelerating the approval process and securing investments in drilling projects are important measures to support the industry during the market ramp-up. The lecture will present the current status of these measures envisaged in the German government’s geothermal campaign as well as other industry proposals to improve the competitive situation.

Ingo Forstner, Bundesverband Erdgas, Erdöl und Geoenergie e. V.

Doing the right things right: tools for a smooth rollout of deep geothermal

Deep Geothermal energy can evolve into a major factor of the energy transition. It has the potential to grow into a vital component for electricity and especially heat generation in Germany and all of Europe, supplying base load environmentally friendly energy.

During the past couple years, the general view on deep geothermal rightfully has changed from “do we need this after all” to a broad consensus of “how fast can we grow it”. This development is a major step forward. But it still requires an upgrade to “how can we grow it fast and sustainable”:

Currently the industry is very small – just 1,6 TWh of heat in 2023 in Germany, roughly 0.1% of the heat market. It is also fragmented. Larger operators with multiple projects are still rare. Project execution involves various planning, exploration, drilling, and topside companies working together. Typical projects are characterized by a complex stakeholder setup. Often the responsible, risk-taking operator is new to this type of project.

Uncertainties of the local geological situation add to overall risk. In sum, deep geothermal currently is a market with risks upfront and hence one that requires solid planning and execution for its success – both from an individual project view and as an industry. Then it can realize its potential for a smooth and sustained growth.

Projects are typically one-off rather than factory-belt-style and standardized processes largely haven’t been established yet. This nascent industry hence can benefit greatly from tools that reduce risk and also aid in planning and executing the project. Besides geological data and financial and regulatory support, it is consistency and structured processes can ensure this industry to not just quickly grow today, but to do so sustainably and live up its full potential as a major part of the energy transition in the long run.

While there are still some gaps, several of such tools exist or are in the making. For example, several state geological surveys have published guides, the BVEG with partners offers 1-day workshops, and the EU-georisk project describes various risks and mitigation measures on their website.

The BVEG also has created some free tools to aid the smooth rollout of deep geothermal – with focus Germany. For example, BVEG offers technical guidelines such as its wellbore integrity guideline specifying also geothermal specifics. Also, the “Leistungsspektrum Geothermie” is an annotated generic project plan with detailed 134 substeps from cradle to grave, also featuring a Gantt-chart. The latest addition currently in review is a guideline on how to approach evaluating geological risk. The process described there helps to identify if you should drill that costly well or not.

Dr. Johannes Birner, Senatsverwaltung für Mobilität, Verkehr, Klimaschutz und Umwelt Berlin
Exploration measures in Berlin for deep geothermal energy

Berlin wants to become climate-neutral by 2045 at the latest. Deep geothermal energy can play an important role in achieving this ambitious goal. However, there is currently very little data available for Berlin’s deep underground, which is why the risk of finding deep geothermal wells is correspondingly high. The Berlin Senate has therefore adopted a comprehensive exploration program with a volume of over €100 million in the form of the Deep Geothermal Energy Roadmap, which is based on 12 boreholes and a Berlin-wide 3D seismic survey.

Daniel Acksel, Geosysteme/Prof. Dr. Ingo Sass, Deutsches Geoforschungszentrum
Heat transition in Berlin/Brandenburg with deep geothermal energy

The implementation of Germany’s continental deep drilling programme between 1987 and 1995 with one of the deepest drillings in the world (9101 m) is a moonshot project in the geosciences. Fundamental new insights were gained, new methods and relevant impulses for new drilling methods were developed, which have had an impact for decades. The “International Continental Drilling Programme”, ICDP, has ensured scientific connectivity at an international level. New challenging large-scale geoscience projects are being realized or planned.

With the Helmholtz Association’s strategic investment “Geothermal Laboratory in the Crystalline Basement (GeoLaB)”, a generic underground laboratory for deep geothermal research in fractured crystalline bedrock is being established in Germany. At European level, the Krafla Magma Testbed (KMT) initiative is attempting to set up the world’s first magma Centre and drill into a magma chamber.

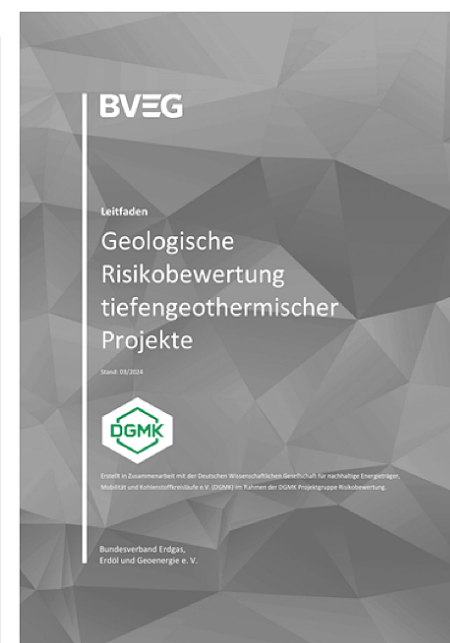


Wellbore integrity guideline

Overview of steps of a deep geothermal project

	Phase I: Preparation	Phase II: Exploration	Phase III: Production	Phase IV: Post-Mining
A	General interest	Setting up the operating company legally and organizationally	License application	Deconstruction and Plug & Abandonment planning
B	Project idea	Commissioning of a feasibility study	One or more operating plans for construction and operation of the surface part of the plant	Deconstruction above ground
C	Preliminary studies	Financing of the project and securing insurances	Construction of the plant	Plug & Abandonment (P&A) of the wells
D	Start of continuous public relations	Membership in a solidarity mining damage compensation fund	Commissioning of the plant	Release from mining supervision
E		Permit application	Operation	
F		Operating plan/plans for preliminary geophysical exploration		
G		Geophysical and other preliminary exploration		
H		Probability-of-Success (POS) Study		
I		Clarification of the usability of the property		
J		Operational plan/plans for the first well		
K		Well site construction and drilling of the first well		
L		Operational plan/plans for the second/further wells		
M		Drilling of the second/further wells		
N		Circulation testing		
O		Reservoir simulation		
P		Continuing public relations work		

Generic project plan: Overview of major steps



Guideline on geological risk

Overall, the results of these outlined efforts in the area of basic research can be translated into applications. For example, the “Deep Geothermal Energy Roadmap for Germany” has resulted in concrete political activities that are being implemented with the federal government’s geothermal campaign for a successful heat transition in Germany. Research institutions such as the GFZ can provide scientific support for the transformation process. This is possible above all because an outstanding research infrastructure can be utilized.

Laboratory experiments such as those conducted at the high-pressure, high-temperature 3D true triaxial press facility (TRICC) are being used to build up a rock data set that is urgently needed for geothermal applications. Thermal, hydraulic, mechanical and chemical processes in the earth’s crust can be simulated down to a depth of 4 kilometers. In-situ research platforms make it possible to transfer process understanding from the laboratory to the reservoir dimension.

Digital underground models are essential for the exploration, development and sustainable utilization of the reservoir. At the upper end of technological development and utilization are commercially led demonstration projects such as the “Geospeicher” Real laboratory in Berlin Adlershof or the geothermal development of Potsdam.



Andre Zucker, Anger’s Söhne

Innovative exploration for raw materials and geothermal exploration in urban areas

1. Company presentation
2. Related projects
3. Review exploration in the past:
 - Planing possibilities
 - Typical well designs
 - Drilling techniques
 - Rig types
4. Current state of the art for exploration
 - Planing possibilities
 - Typical well designs
 - Drilling techniques
 - Rig types
 - Legal requirements
5. Outlook for the near future
 - Planing possibilities
 - Typical well designs
 - Drilling techniques
 - Rig types
 - Legal requirements
6. Are there possibilities to combine raw material and geothermal exploration?



Ground Control

Prof. Dr. Jörg Benndorf, Technische Universität Bergakademie Freiberg
Prediction and Monitoring Methods of Ground Movements above
Underground Gas Storage in the Context of Environmental Impact Management

Underground gas storage facilities are a fundamental pillar of the energy transition in Germany and Europe. Irrespective of this, they have an impact on the surrounding environment. One of the elementary effects is ground movement due to cavity convergence underground. The ability to forecast and monitor these precisely is not only a decisive prerequisite for safe, socially and environmentally compatible operation, but also for the acceptance of such measures by the general public. Current development concepts envisage the storage of hydrogen, which will change storage and withdrawal cycles. Furthermore, the capacity of underground storage facilities would have to be increased several times over. Consequently, the behavior of ground movements will also change. At the same time, very dense spatio-temporal data is now available for monitoring ground movements. The presentation provides an insight into current developments in methods for ground movement monitoring, forecasts and applied AI for the management of ground movements in the context of environmental impact management.

Maria-Barbara Schaller, GGB mbH
Long-term monitoring of backfilled salt mines –
New wireless rock pressure measuring system

From disused mine workings in salt mines, the ingress of mine water, possibly left behind water, chemicals that may have been left behind and stored pollutants, as well as the risk of movement or deformation of the rock. The monitoring the pressure conditions to assess the deformation processes is therefore often unavoidable.

To date, sensors with wired data transmission of measurement signals and power supply have been used for this Purpose:

Due to the high demands on the mechanical and corrosive robustness of the cable connections and the tightness of the cable bushings against liquid pressure such cable-based systems are technically very complex, cost-intensive and can only be used for a monitoring period of up to several decades.

Against this background, the IAB, GGB GmbH and the IBeWa engineering partnership in an AiF-funded research project to develop a wireless measuring system for a wireless measuring system for piezoelectronic pressure monitoring.

The measuring system consists of:

1. the measurement sensors including data acquisition and, if necessary, in-situ data processing,
2. the bedding mortar adapted to the measurement task for coupling the measurement sensor to the rock mass or the surrounding backfill,
3. electronic control of the measuring system and energy management, and
4. wireless data transmission through the rock to an underground measuring station.

The specific conditions of a force-fit installation of the measuring sensor in the form of a stress cylinder in the rock and the long measurement periods make the development of a suitable stress transducer with a special geometry that deviates from known pressure measuring pads and bedding mortar.

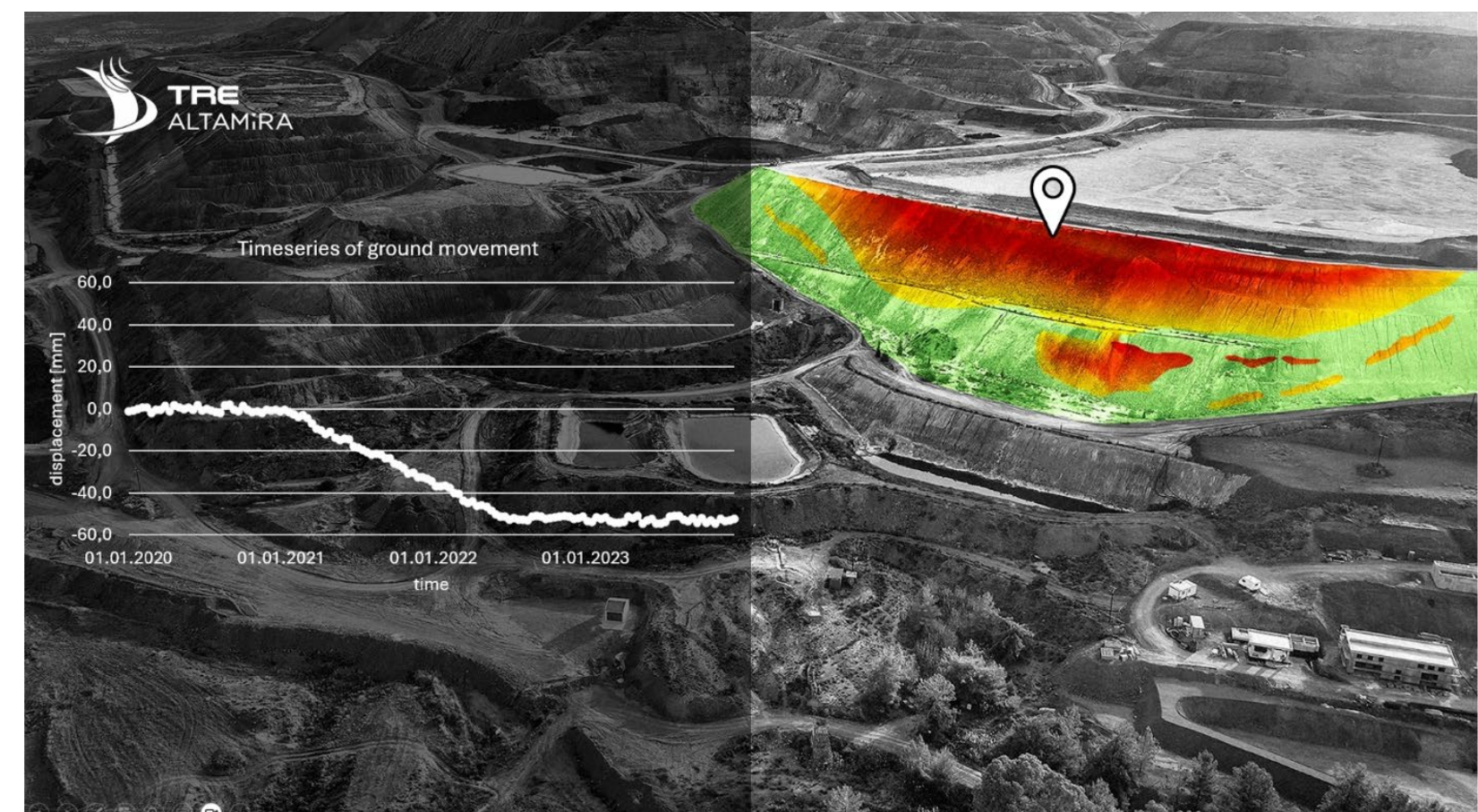
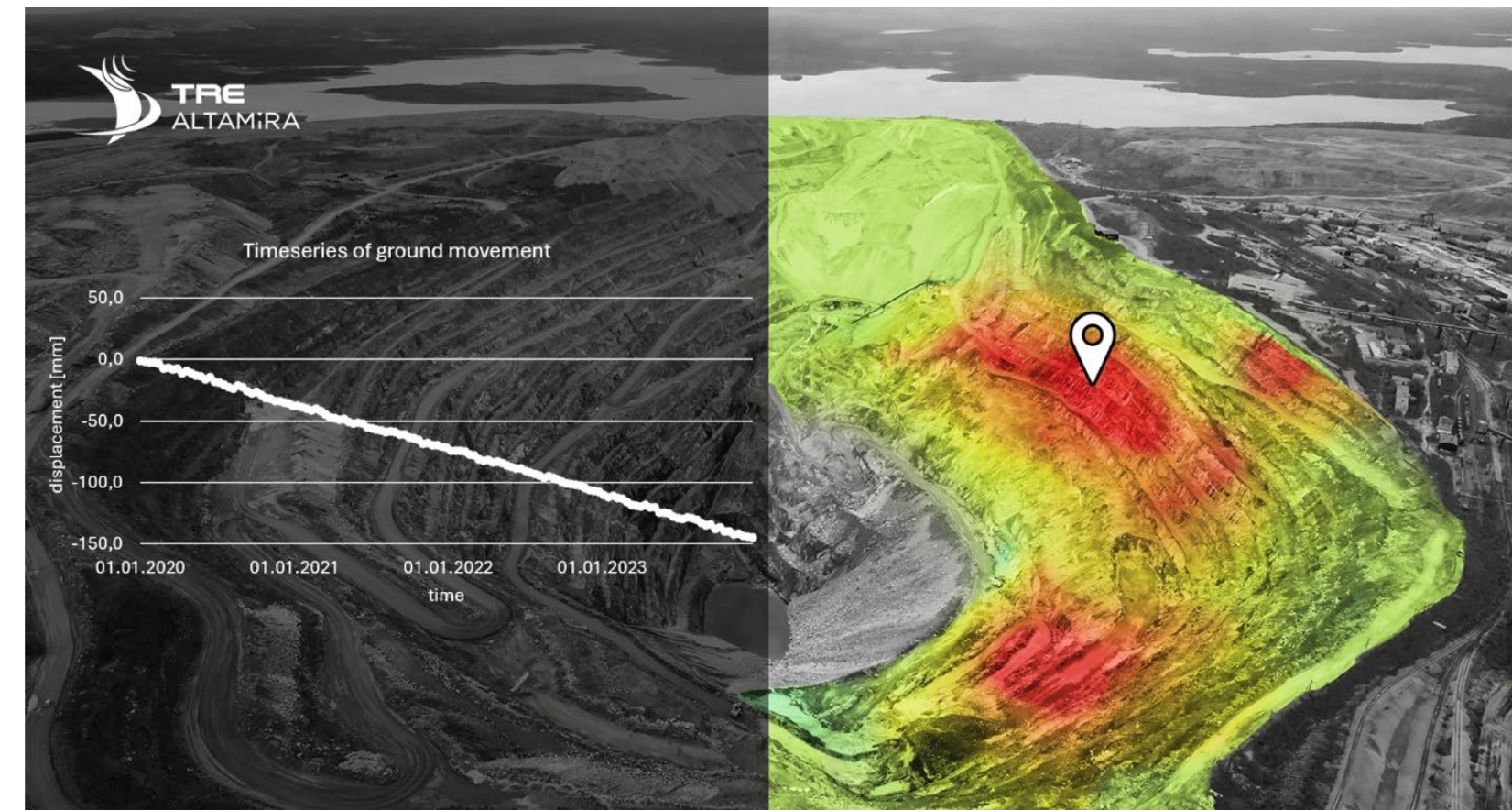
The result was a pressure system under the conventions of stress-free surface elements, which are arranged in a ring shape and thus - with a minimum of hydraulic fluid and reduced temperature sensitivity - a pressure transmission to a piezoelectronic pressure sensor. The presentation of the concept, the development results achieved and the testing of the measuring system through to successful instrumentation and commissioning at BGE, Bundesgesellschaft für Endlager, are the main focus of the presentation.

Jan Anderssohn, Tre Altamira
Mining related ground and structural movement measurements from space

Interferometric Synthetic Aperture Radar (InSAR) uses data from radar satellites to remotely perform displacement monitoring (Ferretti, 2014). InSAR has been proven as a cost-effective solution to cover a wide range of mining activities with the possibility to measure and spatially characterize ground motion behaviour with up to millimetric accuracy.

The results include dense point clouds of deformation measurements coupled with a history of movement through time. Advanced InSAR techniques provide frequent (e.g. biweekly), spatially dense measurements of displacement to monitor ground movement and are widely used in the mining sector, for the monitoring of open pits or tailings facilities as well as whole mine assets. Like for any other monitoring methods, the availability of data (satellite constellations), along with advancements in algorithms and the continuous update of offered products, are a crucial factor.

Additionally, both users and the market must be sufficiently mature to embrace these technological advancements. From this standpoint, recent trends appear promising, as highlighted in the upcoming presentation. However, coal mines exhibit unique challenges due to their frequent surface changes, and the presence of dense vegetation introduces decorrelation effects, reducing measurement accuracy.



Mining Projects

Silvio Engelmann, Dr. Dominic Demand, CDM Smith SE
Analyzing heavy rainfall hazard of a mining heap: stability, surface runoff and erosion

Located in Ensdorf, close to the Saar river, the Duhamel spoil tip complex with its adjacent sinking pond is one of the largest spoil tips of the former coal mining industry in the Saar region, with a height of around 140 m and an area of approx. 77 ha. The Duhamel spoil tip, created by the operation of the Saar mine, is surrounded by infrastructural facilities and residential buildings. The Saar polygon, which can be walked on, is a landmark visible from afar on the slag heap plateau. The slag heap is characterized by complex geotechnical conditions. These result from several tailings ponds surrounded by dams, in which flotation sludge from the wet processing of the coal was deposited, and inhomogeneous mine dumps with different grain distributions and residual coal content.

The increase in extreme precipitation events made a hazard analysis necessary for the first time for the final state of the spoil tip. In a pilot project, a concept was therefore developed together with the authorities for a holistic analysis of the risk of heavy rainfall (100-yearly, 1% annual probability of occurrence), which, in addition to stability, also deals with surface runoff and the issue of erosion.

The modeling of the surface runoff and the resulting temporary flow paths and flooding areas during heavy rainfall was carried out using a 2D hydrodynamic model. Two scenarios (runoff coefficients) were considered in the model in order to take into account the complex geotechnical conditions of the spoil tip and the resulting high heterogeneity. The resulting heavy rainfall hazard map made it possible to identify the areas that would be particularly affected by flooding resulting from the runoff of the spoil tip. In addition to the depth and extent of flooding, the map also shows the flow velocity and direction.

Based on this data and assumptions about the soil surface directly after remediation (without vegetation) and from grain distribution curves of the tailings material, an erosion model was set up to specifically locate the erosion and deposition of fine material during this heavy rainfall.

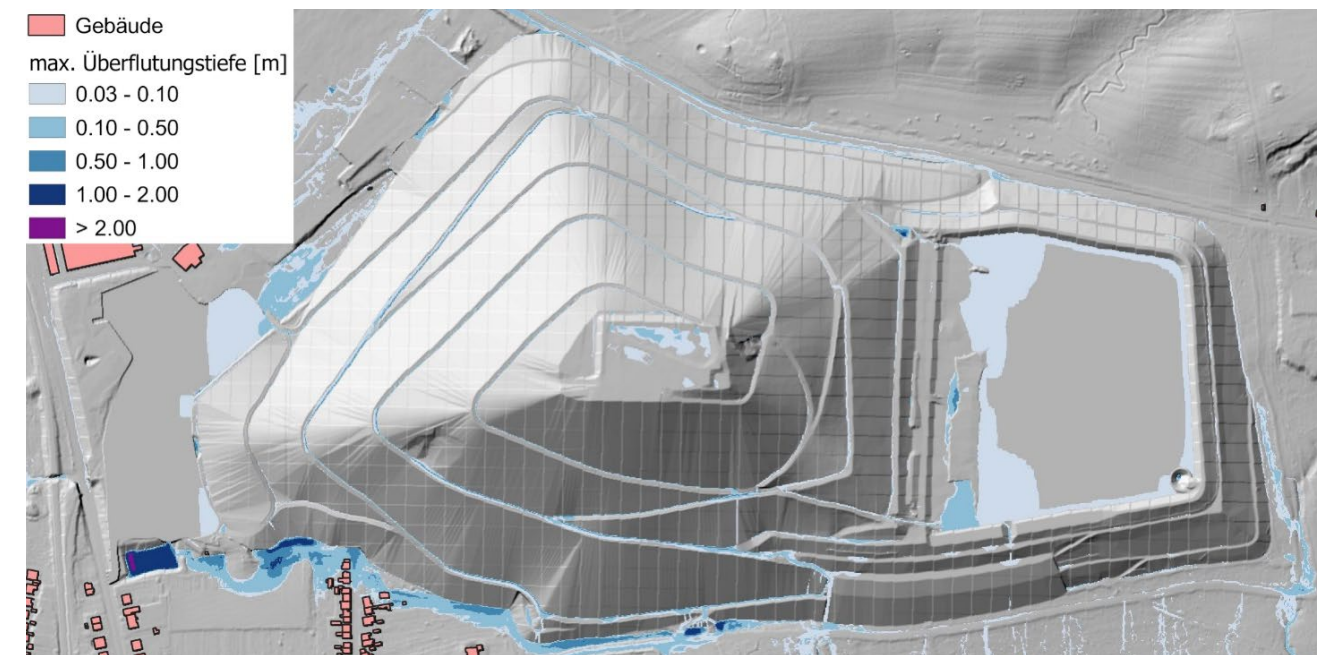
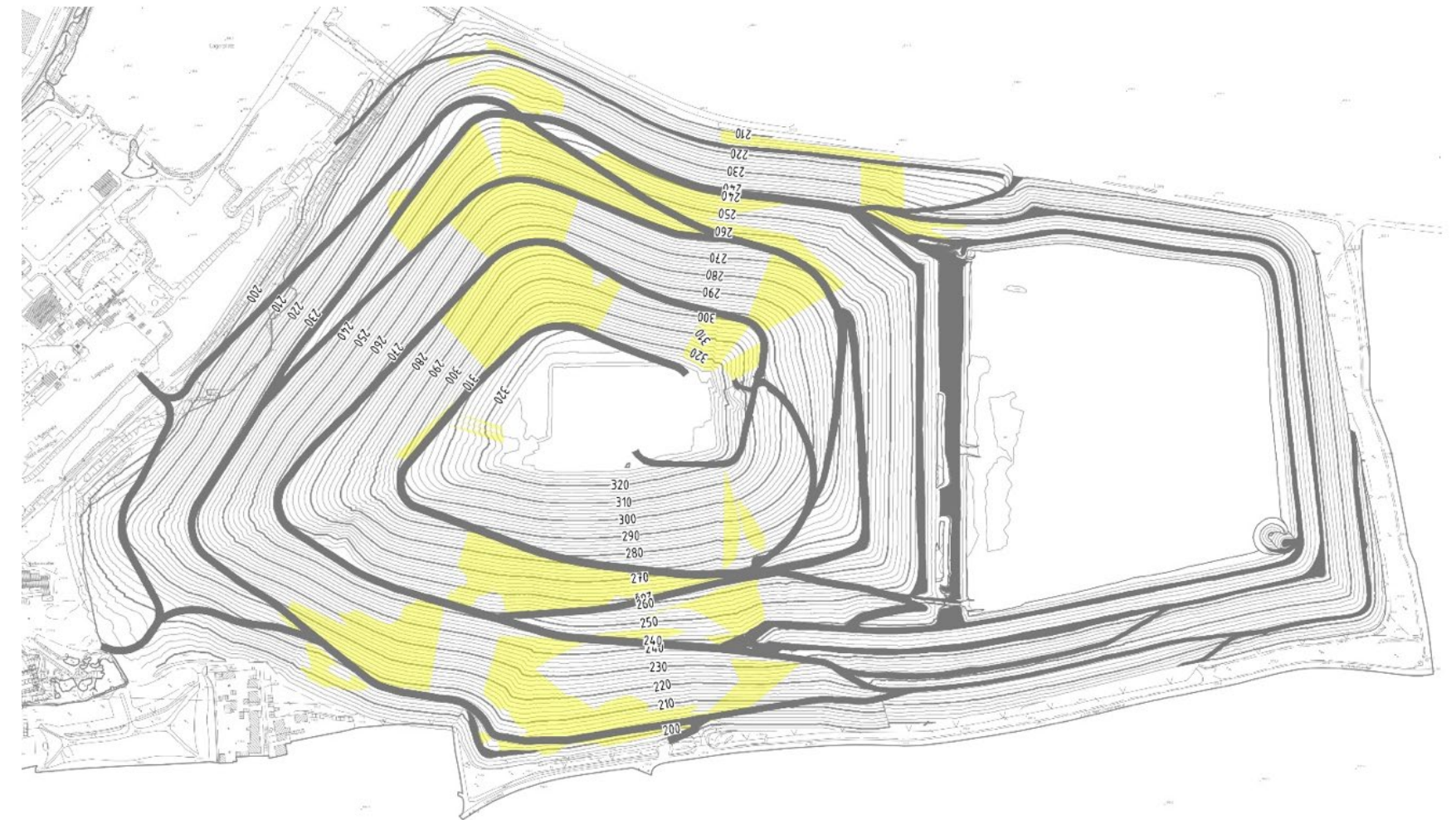
To assess the effects of a heavy rainfall event on the seepage water line, a calculation of the seepage water velocity and volume (percolation) of the water infiltrating into the body of the spoil tip was carried out. Analytical and numerical stability investigations were carried out using the maximum spoil tip water levels determined on this basis and in comparison with water level measurements. In particular, sliding bodies in the spoil tip base area and in the contact areas of the dams as well as near-surface slope-parallel skin slides were considered. As a result, potentially landslide-prone areas were identified, where a shallow landslide could occur as a result of heavy precipitation events in the absence of vegetation. The stability of the base of the embankment and the pond dams is not endangered by the heavy rainfall event and the resulting ingress of water.

The results of the hazard analysis are used to plan the remediation process and the final state in a risk-minimising manner. The combined hazard analysis of a complex spoil tip situation with regard to stability, surface runoff, erosion and deposition can be used as a concept for similarly challenging projects in the future.

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Michael Cofalik, THYSSEN SCHACHTBAU

Conversion of the Concordia dewatering system into a backup site during ongoing pumping operations – concept and realisation

Coal mining ends, the water remains.

The RAG sites intended to manage the eternal task of “mine dewatering” are currently being converted to modern dewatering wells.

The concept of well dewatering is that no underground operating facilities are retained. Maintaining the underground mine with all its infrastructural facilities as well as the necessary inspection, maintenance and repair costs for smooth underground operations are the main factors determining the operating costs of the respective facilities.

As part of this reorganisation, the active central water drainage system (CWDS) at the Concordia site with its shafts 2 and 6 was converted into a backup site for the future.

Backup sites (reserve wells) are shafts equipped with casing pipes that allow access to the mine water. In case of an emergency, submersible centrifugal pumps can be put into operation at these backup locations. The pumps are lowered to a defined level while suspended from a pipe. All the necessary technical equipment is installed above ground if required.

Thyssen Schachtbau GmbH was contracted to convert the CWDS Concordia into a back-up site. The concept particularly addresses the issues of shaft hoisting technology, additional shaft installations, the installation of casing pipes and the backfilling of the shafts with a cohesive construction material. The existing rescue concept was implemented in the conversion concept.

Pumping operations on the 8th level had to be maintained during the reconstruction work. The material supply and a ropeway to the 8th level were set up via shaft 2 (retracting). Shaft 6 (extending) was used for ventilation and as an escape route with a slow travelling system (0.55m/s) during the conversion. The mine was ventilated continuously by the existing underground main pit fan until the mine workings were discharged.

In addition, the limited space available above ground and neighbouring residents were factors that had to be taken into account at both locations with regard to construction site logistics and possible noise emissions.

During the last mining operation on 12 December 2022, both shafts were sealed explosion-proof at the same time. The backfilling operations started afterwards. Shaft 2 was equipped with two DN 1400 nominal diameter casing pipes during backfilling. Shaft 6 was backfilled with a cohesive construction material so that it could be re-drilled. The backfilling work on both shafts will be completed on 22 December 2023.

Maximilian Beyer, Sympatec GmbH

Optimization of milling process by real-time particle size analysis

Successful combination of proven sampling technique with best suited on-line sensors
A mines yield depends on the ores grade and on the degree of the minerals liberation and subsequent concentration. Liberation however is linked to the enclaves' size and hence, the milling stage of the ore is one of the decisive dressing steps in the entire ore dressing process. Too large particles don't liberate the minerals while overmilling on the other hand wastes time, energy and complicates subsequent processing steps. Accordingly, the particle size of the mineral slurries requires special attention and should be controlled in real-time.

Real-time Monitoring of the particle size distribution requires a few carefully implemented procedural steps, utilizing feasible methods. Starting with a representative sampling at a mass throughput of several tons per hour of the grinding plant. As sensors typically don't record the entire production flow, sampling of a statistical relevant amount of material is needed. Conclusively, rugged and wear resistant design is one of the leading features such samplers need to meet. Often, it is desired to analyse several mass flows from different mills with only one analyser. Hence, sample-distribution systems or Multiplexers are necessary.

Again, wear-protection, long life- and up-times as well as low maintenance are of main interest here. And finally, the sensor itself should be capable to analyse these sample-flows quick and reliable in its original, statistically relevant and representative amount, without any preliminarily sample treatment or sample dilution. Nonetheless, the quality such as resolution, precision or reliability must not suffer.

In the following, such a 3-stage-concept consisting of primary sampler, secondary sampler (Multiplexer) and ultrasonic extinction based sensor will be presented and dedicated installation examples will be shown.



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Partners

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on the basis of a decision
by the German Bundestag

1.1 German Federal Ministry for Economic Affairs and Climate Action

Web: www.bmwk.de



1.2 BDI - The Federation of German Industries

The BDI is the umbrella organization of German industry and industry-related service providers. 39 industry associations, 15 state representatives and more than 100,000 companies with around eight million employees make the organization the voice of German industry. The BDI works for a modern, sustainable and successful industry in Germany, Europe and the world.

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Exhibitors



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2.2 allmineral

allmineral develops machines and systems for processing gravel, sand, coal, slag, ores, and recycling materials. Customers benefit from tailored solutions and extensive expertise.

Through continual optimization and innovation, allmineral delivers highest quality and durable products. With a focus on resource-efficient technologies, allmineral emphasizes dry material processing for a sustainable future.

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2.5 BGE - Bundesgesellschaft für Endlagerung

BGE is the federal company responsible for radioactive waste disposal. By ensuring the safe disposal of radioactive waste, BGE contributes to the protection of people and environment and solves a sociopolitical task. This includes the retrieval of radioactive waste from the Asse mine and its decommissioning, the decommissioning of the Morsleben repository and the commissioning of the Konrad repository. This also includes the selection of the best possible location for the final disposal of high-level radioactive waste and a product control that ensures that only authorized waste containers are stored. In addition, BGE conducts national and international projects with our subsidiary BGE TECHNOLOGY.

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2.6 Branchenverband Steinkohle und Nachbergbau

The German Coal and Post-Mining Association (bsn), previously known as the German Coal Mining Association (GVSt) until it was renamed on 1 March 2021, is the trade association, employers' association and collective bargaining party for the German coal mining industry, which is now in the post-mining era following the end of coal mining.

As a trade association, the bsn represents the interests of its members in matters relating to post-mining activities, with a focus on mine drainage, environmental protection and land reclamation, as well as in other issues relating to former mines, such as shaft stabilisation and rehabilitation. To this end, the association cooperates in central and umbrella organisations in the German federal states, at German federal level and at European level. It engages in dialogue with political and administrative bodies.

As an employers' association, the bsn is the collective bargaining party for the German coal industry in the post-mining era and supports its members in matters of employment law, social law and

company pensions. An important milestone was the conclusion of a comprehensive post-mining collective agreement, which was signed in mid-2021 and replaced the collective agreements for the German coal industry with effect from 1 January 2022. In addition, the bsn performs tasks relating to the autonomous administration of mining-related social insurance institutions. At employers' association level, the bsn is also involved in the formulation of the framework conditions for its member companies through its participation in professional and umbrella associations.

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2.7 Castalytics

Castalytics GmbH focuses on applied artificial intelligence across various industries. Through the Castalyze(TM) method, internal and external data are interconnected to identify valuable patterns and relationships using precise self-learning algorithms. This allows companies to gain insights into business management, unlock untapped business potentials, and shape their future business. Castalytics builds on the experience of eneracast in the fields of Power Forecast/Analytics and Big Data Management.

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2.8 CDM Smith

Making the World Better, Safer & More Resilient CDM Smith is a privately owned engineering and construction firm providing legendary client service and smart solutions in water, environment, transportation, energy, facilities and geotechnics. Passionate about our work and invested in each other, we are inspired to think and driven to solve the world's environmental and infrastructure challenges.

We offer classic engineering services, consulting, planning, construction, and project management all around the world. With more than 600 employees in numerous branches in Germany and worldwide with more than 6,000 professionals and experience in over 100 countries.

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2.12 DMT GROUP

Excellence and innovation – that is the claim of DMT GmbH & Co. KG (DMT GROUP) as an independent, globally active company for engineering services and consulting in the markets of “plant engineering and process engineering”, “infrastructure and construction” and “raw materials and energy”. The aim is to create sustainable added value for all clients. Knowledge, digitalization and internationalization are the key to this. As the leader of the engineering division of the TÜV NORD GROUP, DMT GROUP contributes over 280 years of experience, acts as a holding company of 13 subsidiaries with over 1,100 employees from more than 30 locations, acts in partnership, trustfully, solutionoriented, sustainably and ethically, realizes hundreds of projects around the globe every year, is involved in dozens of mostly international innovation projects and thus ensures the success that customers expect all over the world under the guiding principle of Engineering Performance.

DMT GmbH & Co. KG

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Web: www.dmt-group.com



2.13 DMT ENERGY ENGINEERS

DMT ENERGY ENGINEERS offers customized consulting and engineering services on the path to a more sustainable business. Our focus is on manufacturing SMEs across all industries, logistics companies, and municipal enterprises. As a subsidiary of the TÜV NORD GROUP, we stand for top quality.

Working in close collaboration with our client, we find sustainable solutions, providing economic stability and legal certainty. Our experienced and interdisciplinary team, currently comprising around 60 employees, brings nearly 600 years of energy expertise. Whatever solution our client requires, we act as energy experts, bringing together the necessary planning, engineering and monitoring expertise. We accompany our client from initial consultation through implementation, ensuring legally compliant data monitoring and coordinating external service providers.

DMT Energy Engineers supports Energy4Climate NRW in critical raw materials and resources for the energy transition.

Channeled through Energy4Climate we advise the Ministry of Economic Affairs, Industry, Climate Action and Energy of the State of North Rhine-Westphalia on critical raw material demands, supply chains, processing and recycling topics for the energy transition.

The main aims of the advisory services are to secure the future of the business location NRW and to form international cooperations in line with a successful energy transition in the federal state.

DMT Energy Engineers

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Germany

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rohstoffe@ext.energy4climate.nrw



2.14 EIS –

Exploration Information System

EIS - Exploration Information System

Mail: contact@eis-he.eu

Web: www.eis-he.eu

Contact Person:

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2.15 ESSER-WERKE

Since 1948, Esser-Werke has specialized in the development and manufacture of highly wear-resistant conveyor line systems.

We supply companies such as mining companies, gravel and sand works, chemical industry, glassworks, plant engineering and concrete pumps. Our products are developed in close cooperation with our customers and can be individually adapted to the applications.

ESSER-WERKE GmbH

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2.16 Germany Trade & Invest

Germany Trade & Invest (GTAI)

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Web: www.gtai.de (German)

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Director Rohstoffe

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2.17 HAZEMAG

We are your global partner in the mining industry for innovative solutions and sustainable success, supported by product innovations, application experiences, and technical excellence.

We take the time to understand requirements and deliver solutions. HAZEMAG stands for innovation, resourcefulness, and sustainability. We stand by our customers to solve complex challenges.

HAZEMAG Systems GmbH

Phone: +49 160 969 973 70

Mail: erik.bach@hazemag.de

Web: www.hazemag.com

Contact Person:

Mr Erik Bach

Managing Director



2.18 Herrenknecht

With the experience of more than 6,200 projects, Herrenknecht is a technology leader in the area of mechanized tunnelling technology. The product range includes tailor-made machines for traffic, supply and disposal tunnels, technologies for pipeline installation as well as drilling equipment for vertical and inclined shafts and deep drilling rigs. The Herrenknecht product portfolio is completed by a broad range of equipment for the areas of mining and exploration.

HERRENKNECHT AG

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IMDEX™

2.19 IMDEX

IMDEX is a leading global mining technology company that enables drilling contractors and resource companies to safely find, define and mine orebodies with precision and at speed.

Why IMDEX?

When you partner with IMDEX, we give you the knowledge to model and mine with confidence. Our technology offering spans across the life of a mine, from exploration to extraction. Our drilling optimisation products, rock knowledge sensors and real-time data and analytics provide you with all the benefits of working with one trusted technology provider for a complete solution.

Our Strengths

- Market leader across our technology portfolios
- One trusted technology provider
- Integrated range of solutions for exploration to extraction
- Award-winning cloud-based software IMDEXHUB-IQ™
- World-class R&D facilities
- Global presence with local on-site support in all major mining regions

Solutions

Our unique end-to-end solutions for the mining value chain integrate IMDEX's leading product brands. Together they enable drilling contractors and resource companies to drill faster and smarter, obtain accurate subsurface data and receive critical information in realtime. End to end solutions include:

- Software
- Drilling Optimisation
- Downhole Navigation
- Structural Geology
- In-Field Analysis
- Driller Operable Geophysics

Why one solution provider?

IMDEX can provide a unique, integrated suite of technology and intelligence solutions. These solutions support our customers to improve productivity, reduce costs and gain access to relevant, reliable information for critical decision making, anywhere and at any time.

IMDEX Limited

Reflex Instruments Europe Ltd
United Kingdom

Web: www.imdexlimited.com

Contact Person:

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Civil Engineering Europe
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2.20 Institute for Advanced Mining Technologies (AMT)

RWTH Aachen University

In research, teaching and transfer, the AMT headed by Univ.-Prof. Dr.-Ing. Elisabeth Clausen is committed to safe, efficient and responsible raw material extraction through the automation, digitalization and electrification of mining machines and processes.

With its interdisciplinary, application-oriented and industry-oriented research and development, the AMT team is not only a strong and reliable partner of regional companies but also part of Germany's as well as Europe's top research.

At the exhibition booth, you will have the opportunity to learn about the "Human. Centred Climate Smart Mine" and current technological developments as well as research, teaching and transfer activities and to discuss possibilities for collaboration.

AMT –

Institute for Advanced Mining Technologies
RWTH Aachen University

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2.21 K-UTEC Salt Technologies

K-UTEC AG Salt Technologies

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2.22 Montanuniversität Leoben

Montanuniversität Leoben
Resources Innovation Center Leoben

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2.23 RAG Aktiengesellschaft

RAG Aktiengesellschaft

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2.24 RIEGL International

RIEGL International GmbH

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2.25 Röhrenwerke Kupferdreh Carl Hamm

Röhrenwerk Kupferdreh
Carl Hamm GmbH

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2.26 Rohstoffwissen!

RohstoffWissen! – Initiative zur
Förderung der Rohstoffkultur e. V.

The German NGO “RohstoffWissen! –
Initiative zur Förderung der Rohstoff-
kultur e. V.” bundles and spreads
as a neutral and independent party
scientifically founded information from
the entire raw material industry.

The aims of the NGOs are to create a
broad awareness and acceptance of raw
materials, to educate the public about

the connections between raw material ex-
traction and its use to reduce unfounded
reservations in the population about the ex-
traction of raw materials in general, to sup-
port political and other decision-makers in
a fact-based and sustainable raw materials
strategies, and to facilitate the situation of
domestic raw material extraction and pro-
cessing by a much broader support
in society.

RohstoffWissen! – Initiative zur
Förderung der Rohstoffkultur e. V.

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2.27 Ruhr Montan Group (RMG)

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2.28 Schachtbau Nordhausen

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2.29 Technische Hochschule Georg Agricola

For more than 200 years, natural resources have shaped the special profile of our university Technische Hochschule Georg Agricola (THGA). Today we have continued our legacy of industrial roots in a future-oriented way. At the Research Center of Post-Mining, experts explore how the complex tasks related to the closure, recultivation and follow-up of former mining regions can be managed responsibly. The scientific team focuses on future potential. Therefore, they are working together on an interdisciplinary basis in four research areas:

- Perpetual tasks and minewater management
- Geomonitoring in post-mining
- Material sciences for the preservation of industrial heritage
- Reactivation and transition

The research activities currently focus on the tasks arising in connection with the discontinuation of active coal mining in Germany. That said, post-mining is by no means limited to the mining areas located in the Ruhr, Saar and Ibbenbüren districts. The Research Center see this as a global remit, and one that has potential for every other branch of mining throughout the world.

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2.30 TSU

TSU – Verein für Technische Sicherheit und Umweltschutz e. V. with

TSU Gesellschaft für Technik, Sicherheit und Umweltschutz mbH

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2.31 Technische Universität Bergakademie Freiberg

Technische Universität Bergakademie Freiberg, Faculty of Geosciences, Geoengineering and Mining

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2.32 TRE ALTAMIRA

TRE ALTAMIRA provide millimetric-accurate displacement measurements used in a variety of private and public sectors including Civil Engineering, Geohazards, Mining and Oil & Gas.

Our technology is completely remote and can be easily integrated into operational plans, supporting in-situ instrumentation measurements. We benefit from the expertise of more than 100 employees working in our offices in Milan, Barcelona, and Vancouver, as well as in our regional offices in Peru, France and Australia.

TRE ALTAMIRA is committed to providing the best solution to support our client's needs with costeffective solutions.

By detecting, measuring, and monitoring geophysical phenomena such as subsidence, uplifts, landslides, and seismic faults, we help our clients to assess risk, improve safety and optimise operations.

TRE ALTAMIRA S.L.U.

Còrsega 381-387

08037 Barcelona

Spain

Web: www.tre-altamira.com



2.33 Umweltleistungen

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Fax: +49 351 886-5774

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2.34 Verband Bergbau, Geologie und Umwelt e. V.

The Association of Mining, Geology and Environment (VBGU), an employers association, works since more than 30 years as a stakeholder of its currently 57 ordinary member companies (representing entrepreneurs of the branches especially geotechnics, mining, consultancy and companies which offers special services in mining).

The VBGU represents the general economic and socio-political interests of its members and supports them in areas such as tariff, research and development as well as training and further education.

VBGU provides for member companies access to economic and political decision makers at federal level and state level.

VBGU itself is The VBGU is registered in the lobby register of the Bundestag, is well connected and a member of several employer associations and non-governmental bodies in the Federal Republic of Germany in ranges of labour law, waste legislation, mining law, environmental law and water rights.

Our Association accompanies with its member companies i.a. for over 30 years the successful reclamation of mining legacies from uranium mining in Saxony and Thuringia, which is designed by Wismut GmbH.

Since 2022, the VBGU has been cooperating closely with the industry association Steinkohle und Nachbergbau e. V. (bsn) and founded two expert committees with the latter on the topics of „old mining“ and „mine water“.

With our member companies we will “together, create a sustainable future”.

VBGU e. V.

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10178 Berlin
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Mail: info@vbgu.de
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2.35 VDMA-Mining

VDMA-Mining

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Web: vdma.org

Contact Person:
Christoph Danner
Phone: +49 69 6603-1270



2.36 Wismut

Rehabilitation of uranium ore mining legacies in Saxony and Thuringia
Wismut GmbH is a federal government-owned company operating in Saxony and Thuringia. Its principal business is the decommissioning, cleanup, and rehabilitation of uranium mining and processing sites.

The Wismut Project has emerged as an important international reference project for state-of-the-art remediation technologies in conjunction with the rehabilitation of radioactively contaminated sites.

Wismut is also an important partner on the regional level that makes a substantial contribution to foster the economic development of sites under remediation.

The company's sole shareholder is the Federal Republic of Germany, represented by the German Federal Ministry of Economic Affairs and Climate Action. Since its foundation in 1991, the company is headquartered in Chemnitz/Saxony.

More information can be found here:
www.wismut.de

Wismut GmbH

Jagdschänkenstraße 29
09117 Chemnitz
Germany



2.37 Women4Metals

Women4Metals is a pioneering grassroots initiative that was launched in 2019 by employees of Aurubis (a recycling, smelting, refining & fabricating company of copper and other metals). Its primary objective is to enhance the representation of women in the metals industry and ensure equal opportunities for individuals of all genders.

The initiative meanwhile operates across the industry, establishing a network that aims to increase visibility and provide support for women in production, specialist and leadership roles.

By promoting an inclusive corporate culture, Women4Metals is actively driving positive change in the metals industry through collaboration with and support by companies, associations, and individuals.

Women4Metals

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Mobile: +49 172 2558134

Web: www.women4metals.com



Mediapartners



3.1 GDMB

GDMB Gesellschaft der Metallurgen und Bergleute e. V. (short: GDMB) is THE platform for experts of the non-ferrous industry in the German-speaking market and fosters the technical/scientific knowledge exchange among metallurgists and miners of industry, science and administration. Instruments are technical committees and dedicated seminars, the largest conference for non-ferrous metallurgists in Europe - the European Metallurgical Conference (EMC) and specialist journals, namely World of Mining - Surface & Underground and World of Metallurgy - ERZMETALL.

With all its instruments, GDMB contributes to the harmonization of depth of integration of technical, processual or organizational solutions for major contemporary challenges.

GDMB Society of Metallurgists and Miners e. V.

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3.2 GeoResources

The GeoResources publishing house supplies technical visitors from all over the world with information on all aspects of the subjects of GeoResources – work in soil and rock, extraction of raw materials, mining, tunneling and geotechnical subjects. The news are distributed in English and German via the online portal www.georesources.net. In addition the portal offers English and German online journals with articles dealing with new developments, interesting projects and basic themes. The journals are available as printed versions as well.

The GeoResources editorial team has long-term technical and editorial expertise. The GeoResources publishing house collaborates with professional technical translators.

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3.3 International Mining

International Mining (IM) is a global publication covering mining and minerals processing technology, methods, equipment and services. Read principally by the mining industry itself, it helps extractive operations, both surface and underground, keep abreast of the latest innovations and solutions to help them lower costs, increase performance and availability, enhance safety and of course maximise production. This includes everything from better maintenance and site audits, through to autonomy and digitalisation. From juniors through to the largest mining groups with multiple locations, mine managers know they can rely on IM to keep them in the know.

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Team Publishing
2 Claridge Court
Lower Kings Road
Berkhamsted
Hertfordshire
HP4 2AF
United Kingdom
Web: www.im-mining.com



3.4 Madencilik Türkiye

Established and managed by a team of engineers with several years of experience, Madencilik Türkiye Magazine, Turkey's first and only mining magazine, was initially published in September 2009. The magazine stands out with its rich sectoral news content. Furthermore, it encompasses the entire process of mining, starting from exploration to extraction, all stages of production, and post-mining rehabilitation. Additionally, our magazine includes advertisements and company introductions related to all departments serving mineral explorers and producers. Comments written by industry professionals and magazine editors contribute to the sector's development. With its widespread distribution network and audience, Madencilik Türkiye provides a unique platform for company promotions.

Madencilik Türkiye is the best alternative for companies looking to introduce their activities to the Turkish mining sector.

For more information, please contact:
info@mayeb.com.tr

Madencilik Türkiye Dergisi
(madencilikturkiye.com)



www.miningindustryprofessionals.net

3.5 Mining Industry Professionals Network Forum

The Mining Industry Professionals Network Forum is the new and fastest growing Mining related community in the world and the industry's only spam-free, independent curated Forum for intelligent conversations with mining thought leaders. Professionals in and serving the mining industry worldwide are invited to join the Mining Industry Professionals Network.

Mining Industry Professionals
Network Forum

<https://miningindustryprofessionals.net>



3.6 Mining Weekly

Mining Weekly is a leading provider of global mining news. Mining Weekly provides in-depth coverage of mining projects and personalities shaping the mining industry. Each day, regional email newsletters, as well as a global edition, provide a convenient news roundup of mining developments around the world.

Contact:

Phone: +27 11 622 3744

Mail: subscriptions@creamermmedia.co.za

Web: www.miningweekly.com

MINING REPORT Glückauf

3.7 Mining Report Glückauf

Mining Report Glückauf is one of the leading technical and scientific journals for mining, raw materials and energy. Containing industry surveys and studies, and in-depth reports on mines, mining companies, mining regions, issues and key technical trends, Mining Report Glückauf primarily aims at key decision makers in the mining industry and mining administration. In addition, Mining Report Glückauf is available at administrative authorities, municipalities, research and testing institutions as well as at universities. Mining Report Glückauf is regularly published in English and German and with special issues in Russian and Chinese. The Mining Report Glückauf is distributed at international key events and exhibitions worldwide.

The main topics dealt with in Mining Report Glückauf are:

- Mining: Planning, development, operation and decommissioning of mines below and above ground.
- Post-mining: Land recycling, land reclamation, water retention, reuse.

- Raw materials: Exploitation of raw materials (coal, ore, salts, rare earth, natural stone, gravel and sand).
- Energy: Energy policies, energy sector, energy feedstocks, energy supply.
- Work safety, occupational health and safety, environmental protection in the mining industry.

All Mining Report Glückauf articles can also be found online at www.mining-report.com.

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3.8 RDB

The RDB e. V. is the association of engineers, technicians and managers in all branches of mining, in wide areas of the raw materials industry and processing in surface and underground mining, in authorities, planning offices and institutes, in technical colleges, technical colleges and universities.

The RDB e. V. stands for:

- Professional training in technical, scientific and socio-political areas
- Exchange of experience in applied techniques and working methods
- Safeguarding the interests of the profession

The RDB e. V. is committed to:

- Maintaining and preserving mining traditions
- Preservation and promotion of mining camaraderie

The RDB e. V. offers:

- Free subscription to the bi-monthly trade journal "bergbau"

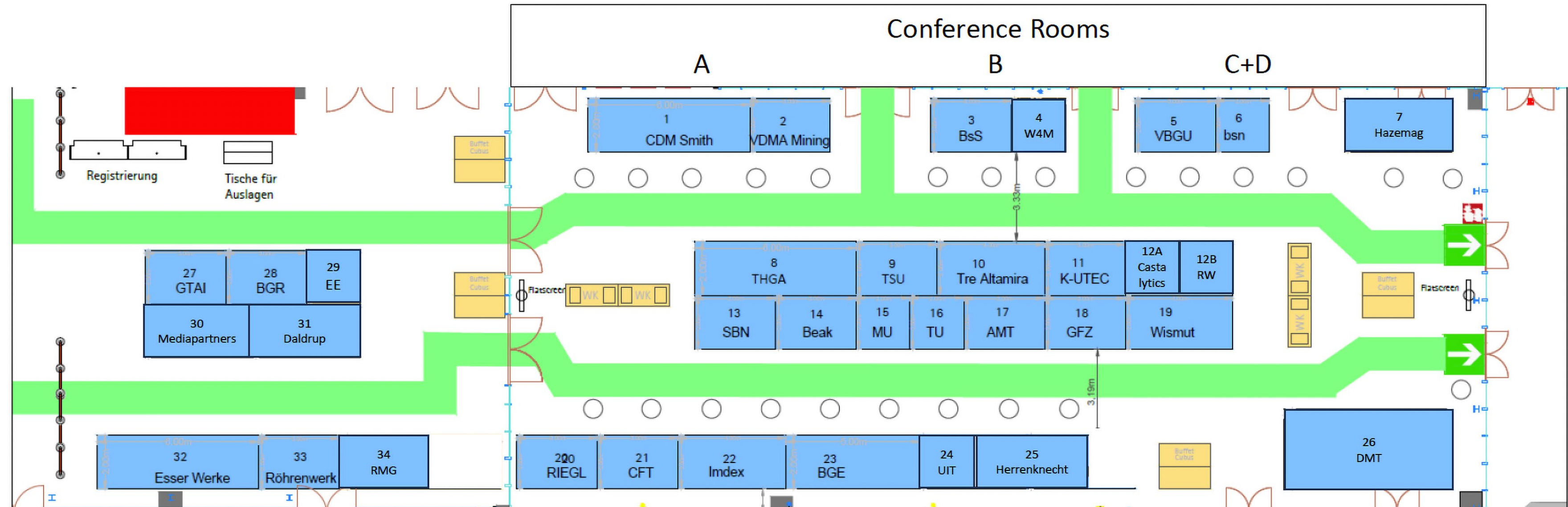
The RDB e. V. promotes:

- Legal protection and counselling in legal issues arising from the employment relationship or social security provision

RDB e. V.
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| 6. bsn – Branchenverband Steinkohle und Nachbergbau | 14. Beak Consultants/
EIS Exploration Information System | 24. Umwelt- und Ingenieurtechnik | 34. RMG Ruhr Montan Group |
| 7. Hazemag/allmineral Aufbereitungstechnik | 15. Montanuniversität Leoben | 25. Herrenknecht | |
| 8. Technische Hochschule Georg Agricola | 16. TU Bergakademie Freiberg | 26. DMT | |
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| | 18. GFZ – Deutsches GeoForschungsZentrum | 28. Deutsche Rohstoffagentur (DERA) in der Bundesanstalt für Geowissenschaften und Rohstoffe (BGR) | |

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Save the Date
June 18 and 19, 2026

DMT

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