DMT

Conference Proceedings

13. MiningForum
Kassel, June 18th to 19th 2015

MINING FORUM 2015

MINING FORUM 2015

We extend a warm welcome to all decision makers, experts and specialists of the sector to the MiningForum 2015.

Glückauf!

Dear ladies and gentlemen, dear guests and friends of the MiningForum,

Following a tradition that is now in its 26th year, we have invited you to the 13th MiningForum. We are delighted that you have decided to accept our invitation and we offer you a warm welcome, this time to Kassel, the home of the documenta international art exhibition and the headquarters of our event partner this year, K+S AG.

The search for a conference centre led us to the 'Kongress Palais Kassel'. A very impressive building from the outside and one that is likely to get people asking about its history. The hall was built between 1911 and 1914 from a prize-winning design by the architects Ernst Rothe and Max Hummel. The monumental neoclassical entrance columns are a remarkable highlight. The hall was used even before its official opening in 1914 as part of the celebrations held to mark the thousand-year anniversary of the city of Kassel in September 1913. It is still used as a civic centre today and has the capacity to host 2,000 guests. Despite our best efforts we haven't yet succeeded in attracting that many people to attend the MiningForum ... but we're working on it.

Even though mining is a very traditional industry and even though this conference is being held in a building laden with history, the aim of the MiningForum is to highlight and discuss technical issues and innovation in mining today and for the future. We have decided to continue with the pattern set at the previous MiningForum in Leipzig so as to broaden our field of vision. Presentations from the international field complement the presentations from the national sphere. We are particularly pleased to welcome guests from a number of mining nations and we look forward to exchanging experiences with them and contributing to an international transfer of knowledge. As a way of improving mutual understanding we are, for the first time, offering simultaneous interpreting of the presentations and discussions in German / English.

More than 200 participants have registered for the 13th MiningForum.

Lying ahead of us we have a total of 50 presentations in 7 parallel sections. The 'Miner's Evening' in the 'Alte Brüderkirche' at the end of the first day will offer a chance to relax and share in stimulating conversations.

Kassel, as the home of K+S AG, was chosen as our conference city because of its mining connections. K+S, with more than 14,000 employees worldwide, is the largest producer of salt globally and is one of the leading international suppliers of potash. The K+S company has very kindly offered those who have registered the opportunity to visit the underground operations at the amalgamated mine of Werra on the third day.

Between the presentations, the specialist discussions, the collegial interaction and the tour opportunity, we are certain that you'll find the programme interesting and engaging.

I would now like to hand over to Prof. Dr Eiko Räkers, the Chairman of the Board of DMT GmbH & Co. KG, a company of the TÜV Nord Group, who is going to open the 13th MiningForum officially.

Prof. Dr. Apel
Head of Mining Consulting & Engineering, DMT GmbH & Co. KG

Dear ladies and gentlemen, dear guests,

I would also like to offer you my warm welcome to the MiningForum 2015.

This year we are hosting the conference for the 13th time and, although we've held on to the tried and tested elements and classic topics, you'll notice that some changes have been introduced. We are delighted to take a step towards making the event more international, by offering English-language presentations and translations.

As part of the official opening of the 13th MiningForum, I would like to give a few insights into the changes and developments both in the natural resources sector and at our company, DMT.

The global raw materials and commodities industry is, like other sectors, subject to economic fluctuations. The 13th MiningForum is being held at a time when many working in this sector are facing huge challenges. I am therefore especially pleased to see you all here today and to welcome so many participants, sponsors, exhibitors and partners.

Low raw materials prices mean that investors across the globe are less willing to put their money into new mining projects or to purchase new or additional facilities and equipment. Political trouble such we are currently seeing in the Ukraine, and the resulting sanctions against Russia, make commercial access to these important markets difficult or even impossible. It is not only the specialist mining companies that are suffering from slow business – mining suppliers, and exploration, consulting and engineering companies are also finding it hard.

What opportunities do we have?

Because production in underground mines and, for the most part, in opencast mines is continuing under the pressure of efficiency improvements and cost optimisation, despite the fall in prices, a number of opportunities are now arising to support companies as they seek to optimise their operations.

The awareness of the need for better safety and environmental protection measures, which is growing slowly across the globe, and the recultivation of former mining sites also offers business opportunities that the sector as a whole can tap into.

Any potential positive effects from these opportunities are currently overshadowed by the negative effects resulting from the unwillingness of investors to invest. However, based on the long-term, global demand for raw materials we can assume that business will improve at some point. The only question is when.

What's important now is not to lose sight of the future!

DMT serves not only the natural resources markets. In recent years we have boosted business in other areas, such as building and infrastructure, plant engineering and instrumentation.

In order to streamline and optimise development of these other areas, DMT has undergone restructuring. Our portfolio extends to engineering, exploration and mining consulting, testing and monitoring, as well as plant and facilities engineering, and manufacture of measurement technology and sensors.

Through diversification, and by utilising the competencies and capacities of the DMT Group combined with intensified and focused sales measures, we have succeeded in partially compensating for the currently disappointing business in mining.

But now let's turn back to the MiningForum. This series of conferences goes back many years and has been organised with the aid of a number of partners. It is proof of how important it is for us to offer a platform for national, and nowadays international, scientific and technical exchange so as to make it possible for participants to transfer knowledge and expand their networks and to showcase ourselves in our main market of mining and raw materials.

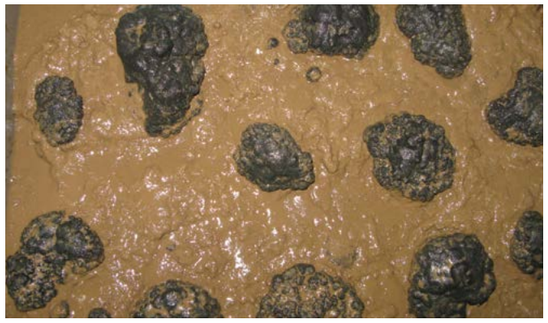
May I remind you that, in addition to the MiningForum, DMT hosts a range of expert conferences in Essen, on topics such as foundation engineering, post-mining management and underground waste repositories, which offer our customers, partners and competitors an opportunity to share experience.

And with those remarks I now open the 13th MiningForum and wish you all a thoroughly interesting conference with lots of new contacts, inspiring discussions and useful ideas for your business.

Prof. Dr. Räkers
Chairman of the Board of DMT GmbH & Co. KG

Exploration of Deep-Sea Mineral Resources

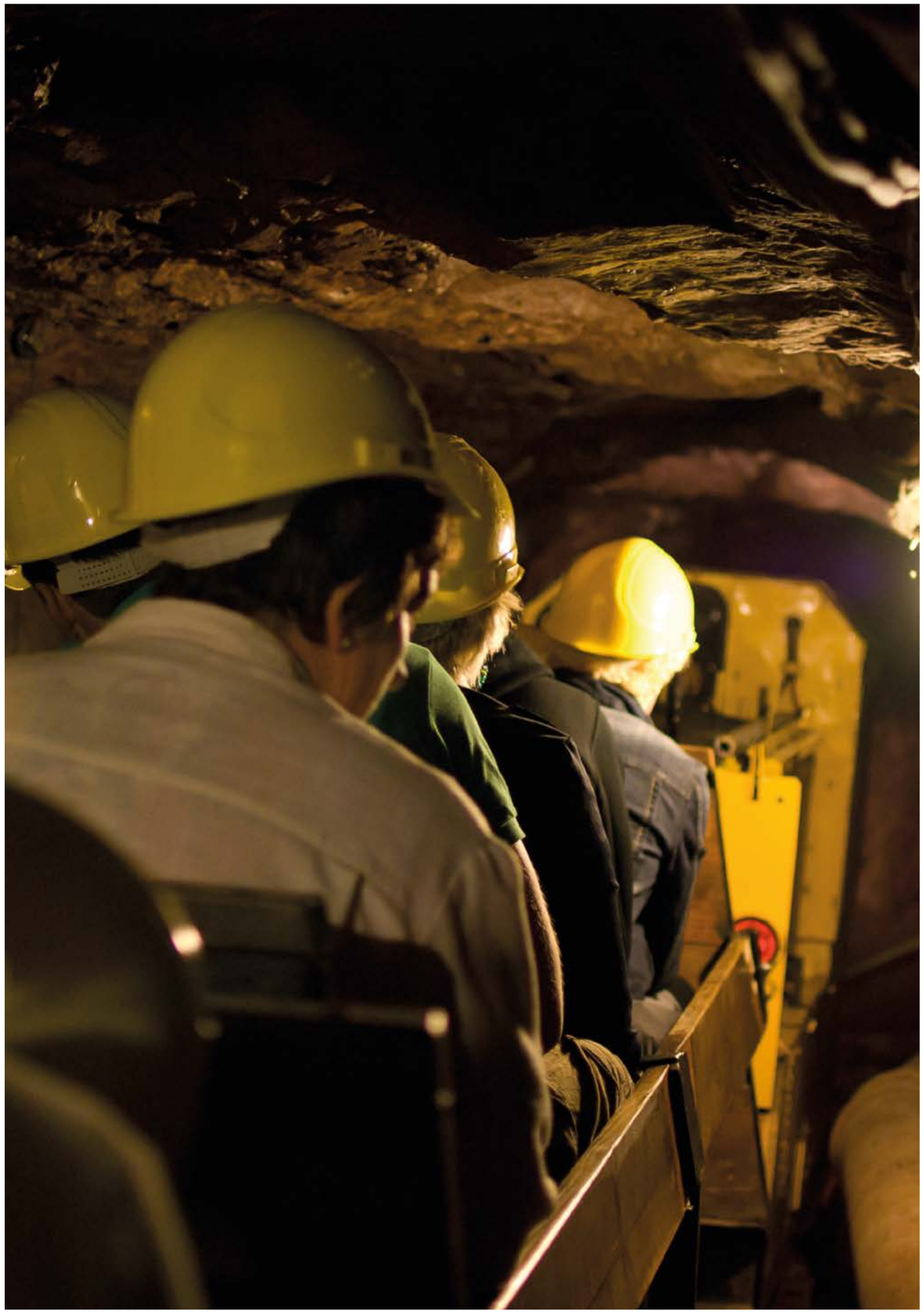
For many years there had been an awareness of the existence of deep-sea mineral resources. It was however only in the late 1960ies until their economic potential was recognized. Based on the expectation of unlimited supplies, the following decades saw the deep sea in the focus of numerous expeditions and research programs. Most campaigns initially concentrated on manganese nodules which consequently became rather well explored. Even a pilot mining test was performed by private enterprises. Several years later, massive sulphide deposits of the deep sea were investigated following the discovery of hydrothermal vents with their vigorously active black smokers which in the world‘s oceans occur frequently. In the late 1980ies and 1990ies, new on-shore discoveries have slackened the economic interest in marine resources. Recently, with increasing worldwide demand for many mineral resources, the topic, resources and supply‘ has regained attention. Revived research work is by now actually based on a much better understanding of marine processes and regional settings as well as a continuously improving database.



After the UN seabed convention came into effect in 1994, eight countries have applied for and were granted exploration licenses for manganese nodules in the open ocean beyond national jurisdiction, i.e.: China, Japan, India, Korea, France, Russia, Germany, and a consortium of Eastern European Countries. Although exploration activities are progressing, mining of nodules has not yet started. Despite the proof of large resources, major challenges such as the development of environmentally acceptable state-of-the-art mining technologies still have to be solved. At present, precious metals from massive sulphides in marginal basins of the SW Pacific are the focal point of industrial activities. Particully the Solwara deposit in the EEZ of Papua New Guinea has been broadly explored and is at the brink of being commercially mined. The International Seabed Authority (ISA) provides the necessary framework for mining activities. A third major type of marine mineral resources are cobalt-rich crusts. These crusts are slowly growing precipitates covering many submarine ridges, seamounts, and plateaus. They feature some similarities to manganese nodules but due to higher concentration in consistency, continuous coverage, and thickness, they are significantly more economic. Occurrences are most advanced in the Western Pacific, where large old seamounts and guyots are most frequent. Though there are indications of remarkable amounts of valuable trace elements in these crusts, industrial interest has yet to evolve. Concepts for mining technologies are presently under development. Again, the framework for exploration and mining of such resources has to be adopted by ISA.

Germany, represented through BGR, actually holds two exploration licences from ISA, one for an area rich in manganese nodules in the Pacific, one for occurrences of polymetallic sulphides in the Indian Ocean. The Hamburg based DeepSea Mining Alliance (DSMA), founded in 2014, is set for opportunities to boost initiatives towards exploitation of deep sea minerals.

H.-J. Kümpel, M. Wiedicke
Federal Institute for Geosciences and Natural Resources (BGR),
Hannover, Germany



Can the mining industry in Germany provide a secure and sustainable raw materials supply in the future?

In view of the increasing tightening of the EU environmental legislation or rather of frame conditions for the mining company industry as well as the public demands for more say and early involvement into the projects of mining, but also in projects of the industry, investors and planners would be well advised to lead the discussion with those affected by the project at an early stage and on a broad basis. Very often, this leads to an extension of the authorization procedure, partly with an uncertain issue and therefore an increase of costs. Citizens‘ initiatives, civil movements and the right of action of environmental organizations make the projects and their realization difficult. Politics reacts cautious in these processes that are often for better frame conditions for the industry and the investors. More and more mining projects - almost raw material independent - have negative connotations of the public opinion and are often prejudiced or shown too one-sided in the media, especially via the Internet. Certain hostility towards industry can be realized in Germany, recently. Of all things, the basis of the value chain of the industry shall be withdrawn. The industry is significantly responsible for Germany‘s prosperity over the past 70 years, inter alia by the processing of raw materials from the local mining industry.

From the view of the industry, the proponent of a project or rather the investors, the question often arises, if the mining can make a contribution to the value chain in Germany in future?

The presentation refers to the conditions of the location Germany and for the local mining. The challenges are clear, new equipment and technologies require a mineral planning, also in Germany. The access to critical raw materials for future technologies must be secured in Germany. Therefor stand the raw materials initiative of the Federal Republic and exemplary of the Free State of Saxony. In dialogue with the general public, acceptance and understanding for the local mining and the extraction of raw materials must be secured. Clarification and education can sharpen the understanding for the mining and reduce the hostility towards industry in Germany, particularly in the younger generation. New innovative approaches and methods of the raw materials production must be approved and not prevented at early stage of research. An efficient use of the local raw materials is offered.

We should furthermore use the locational advantage of Germany with short ways to the processing industry, with a good infrastructure. The raw materials production is carried out in this country in non-conflict region. Our mining is safe compared with the mining of other countries, matches highest environmental standards, the level of education of the employees in the mining sector is high and the companies meet stringent requirements in terms of occupational safety. The raw materials production in Germany is based on sustainability.

If we preserve these conditions, the mining can also continue in future to make its contribution towards a safe and sustainable supply of raw materials and the value creation in Germany! Our companies organized in our Association of Mining, Geology and Environment e.V. are at the disposal of this task also in future.

Glückauf!

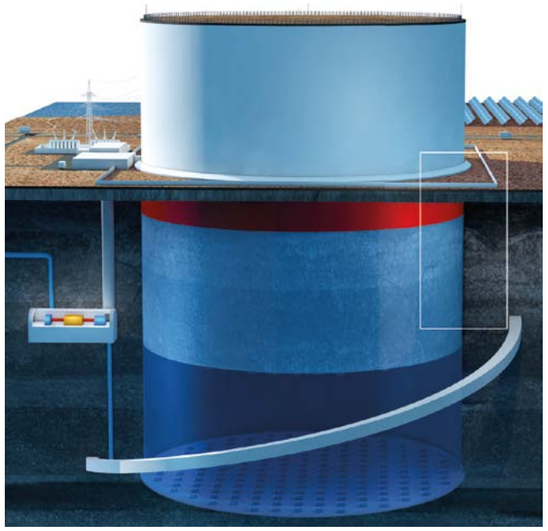
Alisch
VBGU – Verband Bergbau, Geologie und Umwelt e.V.

Requirements for geological site conditions for the construction and operation of a Hydraulic Rock Storage

The Hydraulic Rock Storage (HRS) is a new system to storage energy in large quantities, with a typically capacity of several GWh. The system is based on the hydraulic lift of a natural rock mass, which is exposed from its natural environment. This cylindrical mass of rock, with a radius in the scale of one hundred meters and a height twice as large, is exposed by methods of conventional mining. To access the bottom, a spiral-tunnel for the supply will be driven down to the maximum depth. The bottom surface is then exposed by drilling parallel tunnels in the shape of a comb. The remaining supporting webs are only cleared when appropriate concrete pylons are built in the aisles for supporting the overlying mountains.

The side surface of the piston is driven from above to below in the drilling and blasting method. The bulk material is brought via slide holes down and transported to the surface via the supply tunnel.

All surfaces must be carefully sealed against water flow. During the construction phase the oppressive mountain water must be held; during operation an overpressure of approximately 40 bar is built up in the cylinder space that can raise the piston. In this case, the water may not penetrate into the rock.



For the realization of a HRS it is economically crucial that the surfaces are made with the least possible technical anchoring to reduce cost. Therefore are preferable geological formation has only little fracture and advantageously has horizontal crack surfaces. We find such rocks for example at the places where cliffs can have a very high angle of repose. Geologically it is not necessarily limited to granite and plutonic rocks as well sedimentary rocks can achieve sufficient strength.

Another boundary condition for the construction of a HRS in populated areas may be the sight influence on the landscape. This is ensured when the HRS is built in a disused quarry. One often finds quarries were the rock was removed down to the border of erosion. At this depth, one finds then largely intact rock with suitable strength. The construction effort to enhance the walls of a HRS is then considerably reduced. In addition, such places are easier to approve politically, as an already used mining area exists. With a suitable depth of the mining pit the disturbance of the line of sight is also low when the piston is pumped up.

During operation, the piston is raised in the cylinder with water pressure; the side walls of the cylinder absorb and dissipate the pressure forces. One challenge is the appropriate coupling of the concrete cylinder wall with the surrounding rock. A transfer of the compressive forces by armouring the bulb wall is not possible, as this would mean an economically not justifiable expense. In the area, were the mobile seal touches the surface, an alternating load is a mechanical stress for the surrounding rock, because the piston is usually raised and lowered on a daily basis. In this area, additional measures such as injections might be needed to improve the strength of the rock.

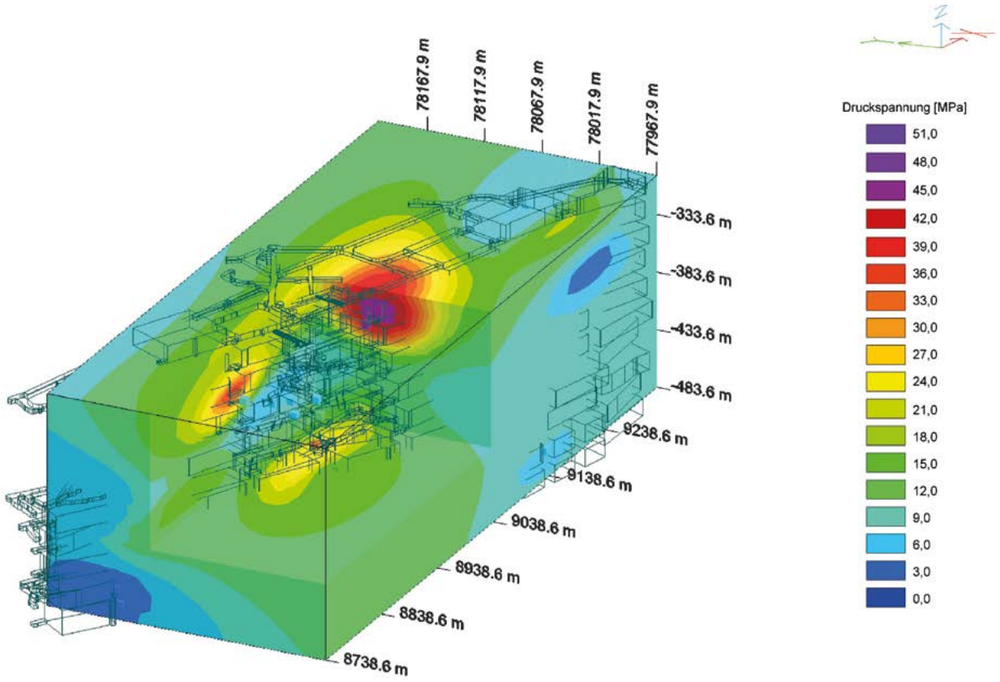
Prof. Dr. Heindl
Heindl Energy GmbH;
Bißmann
DMT GmbH & Co.KG

Geotechnical supervision and brine monitoring in the Asse II mine

The Asse II mine is a 100-year-old potash and rock salt mine located in Lower Saxony. After raw material extraction had discontinued, it was taken over by the Federal Republic of Germany in 1965 and has been used as a repository for low-level and intermediate-level radioactive waste between 1967 and 1978. Subsequently, R&D work was conducted until 1995 on behalf of the Federal Ministry of Education and Research.

The rock-mechanical situation inside the mine is marked by high deformation rates resulting from the pillars and crowns having been dimensioned too small and from the mine having not been backfilled for decades. This has led to considerable damage to the load-bearing elements and in the overburden to the south. Due to deformation processes in the construction area at the southern flank, an excavation-damaged zone has formed around the mine openings and the rock salt barrier serving as protective shield has been damaged. Since 1988, at the latest, this has led to the inflow of brines from the overburden into the mine. This development was accompanied by a strong increase in the level of the pillar cross compression rates and with some delay by enhanced subsidence at the surface. Already from the 1980s, comprehensive geotechnical and geophysical instrumentation was carried out for the rock-mechanical monitoring of the entire mine.

To stabilise the load-bearing system, the mining districts in the construction field at the southern flank were backfilled with salt grit until 2004. Although the stabilising effect to the load-bearing system already began to set in while the backfill was being introduced, the level of the pillar cross compression rates was already at a very high level. To counteract the risk of a brine inflow escalation, to maintain the suitability for use of the mining districts being operated and to further stabilise the load-bearing system, one started to backfill the roof clefts in the mining districts and residual cavities with Sorel concrete in 2009. To observe and control the backfilling measures and to assess the suitability for use of the infrastructure areas, local monitoring areas were established and accordingly instrumented.



A complex monitoring program of geotechnical, geophysical measurements and mine surveys results from the presented facts for the Asse II mine. In the following, selected measuring systems and examination methods will be presented and explained in detail in the lecture with the help of examples:

- Stress measurements to determine the load situation
  - Stress measurements by means of pressure sensors in the pillars
  - Pressure sensors in salt stowing
- Displacement measurements to determine the deformation behaviour
  - Position measurements
  - Height measurements (at the surface and underground)
  - Extensometer measurements in pillars and roof areas
  - Inclinometer measurements in pillars
  - Convergence measurements in galleries and mining districts
  - Crack observations with the help of 3D-fissurometers and plaster marks
  - Inspection of control drillings
  - Permeability measurements to evaluate the level of excavation damage
- Geophysical measurements
  - Recording of fracture mechanisms with the help of microseismic sensors in the mine and overburden; furthermore, a microacoustic measuring system is being tested for the observation of local damaging processes
  - Geo-radar measurements for the exploration of interfaces

The saline solutions flowing in from the overburden are collected on several levels. The rates of collected brine, their concentration and temperature are continually recorded in order to evaluate the hydrogeological risk. Furthermore, the brine composition is determined and evaluated geochemically.

The Asse-GmbH has its own laboratory for conducting the chemical analyses of the brines and for quality assurance purposes of the construction and stowing materials.

Köhler, Teichmann
ASSE GmbH

Exploration of the geological environment within the context of the Sectoral Plan for Deep Geological Repositories in Switzerland

Nagra has the task of preparing and implementing solutions for safe disposal of radioactive waste in Switzerland that ensure the protection of humans and the environment. The procedure is regulated by the Sectoral Plan for Deep Geological Repositories. In Stage 1 of the process, six geological siting regions were identified as being suitable for a deep repository. In Stage 2, additional investigations were carried out to bring the knowledge of the siting regions to a similar level to allow a safety-base comparison to be carried out. This comparison at the end of Stage 2 led, in January 2015, to two siting regions being proposed for further investigation in Stage 3. The results of Stage 3 will form the basis for selecting the region for which a general licence application will be submitted.

Evaluation of the siting regions requires a large number of geological datasets. In the feasibility demonstration project for high-level waste (Entsorgungsnachweis), it was shown that the results of a high-resolution 3D seismic campaign, together with a deep borehole, provided sufficient information on the geological situation in Northern Switzerland to allow reliable conclusions to be drawn on e.g. fault inventory, depth, thickness and tectonic situation of the host rock.

Detailed geological investigations are currently being planned for the two proposed siting regions Jura Ost und Zürich Nordost. A high-resolution 3D seismic measurement campaign is planned for the Jura Ost region; this will cover the optimised disposal perimeters for the high-level (HLW) and low- and intermediate-level (L/ILW) repositories and will show the locations of bounding tectonic faults. A 3D seismic campaign was already carried out in the Zürich Nordost region in 1997 as part of the Entsorgungsnachweis project for high-level waste. The new disposal perimeter for L/ILW is not completely covered by these measurements and the existing seismic network will therefore be extended towards the north-west. Several exploratory boreholes are planned for both siting regions.

This presentation outlines the geological situation in the investigation areas and explains the planning of the field work.

Dr. Hertrich
NAGRA

Success by Know How – Exploration of a Turkish subbituminous coal deposit from the grass roots to the JORC compliant 3D model

The English translation of the text was not available at the time of publication. The original text can be found in the German section under A14 Erfolg durch Know How – Die Exploration einer türkischen Hartbraunkohlen – Lagerstätte von grass roots bis zum JORC-fähigen 3D Model.

Dr. Gielisch, Gräßel
DMT GmbH & Co. KG

Sinking of 2 freeze shafts for Uralkali's Ust-Jaiwa Potash Project in Russia

The global potash production is consistently increasing for many years. In particular in the last decade this lead to increasing capital spending of the potash mining companies into exploration and the construction of new mines, not only in the major potash regions in Sasketchewan and the Russian Perm region, but in many other regions worldwide as well.

The no.1 potash producer worldwide, the Russian Company Uralkali, is currently building the new Ust Jaiwa mine in Berezniki (Perm Region). Deilmann-Haniel was awarded the center hole drilling, the project design and the construction of two shafts with a finished diameter of 8 m and 422 and 465 m final depth, respectively.

Both shafts require ground freezing of the top 245 m. The shafts are cast iron tubbing lined in the freeze section and water is sealed off by a combination of wedge rings with wooden pikotage and a chemical seal. The salt section of the shafts are lined with a concrete liner and a flexible backfill.

The five and half years schedule allows for the shaft sinking and lining, several stations and the installation of the shaft steel for the permanent hoisting systems.

Apart from the technical particularities of this project the special challenges for a German mining contractor coming along with a project of that size and nature in Russia will be addressed in this presentation.

Greinacher, Otten
Deilmann-Haniel GmbH

Investigation and management of groundwater resources for solution min-ing in the Danakil Depression (Ethiopia)

The Danakil Depression represents the northernmost part of the East African rift system and has been the focus of numerous geological investigations during the last century. More recently several international companies have commenced work on developing mining operation for Potash, which is principally used in the production of fertilisers. The depth of the potash strata and other conditions do not allow for open pit mining, therefore solution mining has been chosen as the preferred mining method. Solution mining requires high water volumes as a solvent for the solution leaching process, and consequently a special water exploration program was initiated at the beginning of 2012. The water exploration program comprises the construction of wells for observation of water level and water quality, pumping tests and geophysical investigations. A hydrogeological study on aquifer characteristics, the climatic conditions, the catchment areas and the groundwater recharge has also been carried out.

This paper present the initial results of the local hydrogeological conditions and the available groundwater resources identified in the alluvial fan system on the western boundary of the Danakil Depression.

1. Introduction

Allana Potash Corporation, based out of Toronto, Canada intends to develop a Potash mining operation in the Danakil Depression, Ethiopia by means of solution mining. This mining method requires a steady and reliable supply of fresh to brackish water.

The following activities were carried out in order to assess the water resources of the area:

- Preliminary evaluation of catchment areas and satellite imagery to delineate the study area,
- Analysis of meteorological and climatic data, geological maps and existing reports,
- Preliminary hydrogeological interpretation and estimation of the available ground water volume,
- Definition of areas with potential to meet the water demand of fresh to brackish water for solution mining over a time period of at least 30 years,
- Geophysical investigations (transient and Slingram electromagnetics – very important for first selection of drill points),
- Planning and supervising a drilling program for observation and production wells, pumping tests and water analysis,
- Development of conceptual geohydraulic model,
- Bankable Feasibility Study reporting (on hydrogeological resources),
- Design of the production water-well field and layout.

2. Geographic situation

The hydrogeological investigation region is located in the north-eastern part of Ethiopia within the tectonically and volcanically active Danakil depression. This depression strikes roughly North-South. To the west the mountains rise up to 2500 masl in a transition to the Ethiopian Highlands. To the east of the investigation area a salt plain without runoff is situated at an elevation of approx. -130 masl.

At the foot of the western mountain escarpment an alluvial fan area exists, which is fed by several river systems. This belt is approx. 2 km wide in the vicinity of Mount Dallol with a slope of about 2.5° and 20 km wide at the Saba river alluvial fan with a slope of < 1°. Following the topography all rivers run from west to east towards the plain.

According to the surface runoff catchment areas perennial and temporary river systems are present in the study area. Two permanent rivers flow into the Depression: in the north, close to the Ethiopian-Eritrean borderline and near Saba village. There are several other streams in this region which flow only during or shortly after rain events. Some perennial natural fresh water springs can be observed in the river system westward of Mount Dallol. The measured water discharge was estimated at 0.5 m^3/h.

As a consequence of its geographical position, close to the equator and with an elevation below sea level, the investigation area is characterized by an extremely arid climate. Generally the temperature are constantly above 25 degrees Celsius and can reach up to 60 degrees Celsius during the dry season. During the year precipitation can occur during two distinct rainy seasons. Major rainfall can be recorded from July to August, and minor rainfall from February to March. Precipitation in this arid cli-mate zones is very erratic and can be absent altogether in some years, as has been the case in 2012 during the investigation study period.

Each river system flowing into the Depression belongs to a unique catchment area. The surface areas of the catchments in the hydrogeological investigation region range between 70 to 80 km^2. According to calculations based on digital elevation models the catchment area of the northern perennial river system measures 4,000 km^2, the southern Saba river system has a catchment area of 1,000 km^2. Whereas these larger catchment areas reach up to the Ethiopian highland with its high annual rainfall, the minor catchment areas drain only the mountain range adjacent to the plain.

3. Hydrogeological investigations

3.1 Geophysics and Satellite derived geological structural analysis

During 2012 a geophysical survey of the alluvial fans was carried out. The spatial distribution of electrical resistivity along profile lines was measured as being a typical indicator for groundwater bearing sediment bodies. Slingram electromagnetics (EM) was applied for depths up to 40m and Transient electromagnetic method (TEM) for the depth interval of 40-300 m. It was possible to differentiate between dry soil from ground surface to water table, fresh/brackish water saturated sediment and sediment/rock saturated with saline water using the combine geophysical methods.

It appears that in most of the fan structures a large aquifer is present with varying salinity. The TEM / EM – investigation was an important step for optimizing the positioning of drilling points.

3.2 Drilling and well construction

Based on the geophysical results the position and depth of drill points were defined. From May to December 2012 a total of 18 observation wells at 9 locations, as well as 3 pumping wells were constructed by the company NBB, Hamburg. All observation wells were constructed with 4” PVC casings and secured at the top with a steel pipe and a specially designed keycap. The PVC pipes of the water production wells have a diameter of 12” and are equipped with pumps, riser pipes and well heads.

3.3 Pumping tests

For all production wells pumping tests up to 168 hours were carried out with a pumping capacity of up to 110 m^3/h. The deduced hydraulic conductivity varied between 1.2 * 10-3 and 5.5 * 10-4 m/s and is appropriate for groundwater flow and pumping. The pumping tests show that the groundwater table recovers completely at the end of the test. Therefore the requirements for continuous water supply and the development of a well field are met.

4. Available groundwater resources

4.1 Groundwater storage

Based on the evaluation of the TEM/EM-profiles the medial thickness of water bearing alluvial sediments can be estimated at 30 m - 40 m between the basement rock of the westerly mountain range and the salt plain in the Danakil depression. In all probability a groundwater reservoir exists in the investigation area with a length of ca. 20 km and a median width of 2 km.

With these figures considerable renewable groundwater resources were detected and partially proofed. It should be noted that the usable volume can be influenced by quality parameters such as chlorides that may lead to brackish conditions.

4.2 Groundwater recharge by precipitation

The direct groundwater recharge by precipitation in the Danakil Depression is nearly zero. In the large topographical catchment areas (of the Regali River and the Saba River) in the western bordering mountains the rainfall increases rapidly in the direction of the highlands. The catchment areas directly upstream from the Potash concessions are much smaller.

For all the catchment areas discharging towards the Danakil Depression it can be assumed that a large part of the total surface water and groundwater discharge eventually reaches the Depression. Surface water runoff only occurs during or after intensive rainfall events in the mountains, depending on the size of the catchment area. However, a part of the precipitation will recharge the groundwater and flow, with a time delay, through permeable layers and faults in the direction of the alluvial fans bordering the Depression. The amount of groundwater recharge resulting from rainfall is difficult to estimate without long term monitoring.

4.3 Subsurface influx from the western mountains

The estimation for the subsurface influx into the alluvial fan area was based on the results of geophysics, drilling, pumping tests and water level measurement. With the help of the measured water level in all available wells a water table contour map was constructed for the water bearing area between the western mountains and salt depression in the east. The water level decreases 12 m from -114 masl to -126 m masl, over a distance of approximately 2.5 km. From October 2011 until December 2012 there was no relevant precipitation in the investigation area and there was no surface flow in the dry riverbeds. However a steady water level and gradient was observed during this period. This stable ground water gradient is an indication for a permanent subsurface influx to the groundwater bearing alluvial fan structures. The 168 hours pumping test on one of the production wells at a rate of 108 m^3/hour showed that the aquifer completely filled up again on completion of the test. For the quantification of the water influx Fugro developed a common principal geohydraulic model with the following structure and parameters.

- one layer (2D)
- one conductivity 7 * 10^{-4} m/s (average rate from the pumping tests)
- geological base -145 m masl
- varying evaporation rates up to 3600 mm to a depth of water table of 0,5 m
- no direct recharge caused by precipitation in the fan area

The evaporation area was identified with help of a DEM and the groundwater table.

In order to maintain the detected hydraulic gradient it is required to have a subsurface influx from the west. This result is an important indication for considerable influx of water through large fault structures. Geohydraulic connections between catchment areas of the Regali river, located further to the west and the alluvial fan areas are conjecturable.

The water demand for solution mining seems to be assured in terms of quantity. Whether the water demand can be actually met also depends on the water quality in the future well fields.

4.4 Hydrochemical status of groundwater and usability for solution mining

The laboratory tests of the groundwater samples collect from the study area shows widely varying salinity in the aquifer. The mineralization is equivalent to specific conductivities between 2 and 187 mS/cm. The main parameters for salinity are sodium, chloride and local calcium. The Deuterium/Oxygen-18 results for the sampled water show mostly an indication of old concentrated water types. The Tritium analyses confirm this for groundwater in the deeper parts of aquifer and closer to the Danakil depression. Some of the wells have a clear indication of young water, however the generally low Tritium input level in this region presents a difficulty in that older recharge with an age from 40 up to 150 years is not distinguishable from very old fossil water.

4.5 Design of well fields

Regarding the hydrogeological and hydrochemical situation four potential well fields with approximately 50 production wells are planned subject to following criteria:

- Adequate thickness of water filled aquifer
- Situated at the mouth of a river or wadi / canyon
- Relevant fault structures are present for potential groundwater transfer
- Sweet or brackish water has been detected or is expected

In one of the well fields an aquifer stress test with 5 wells and a pumping rate of 500 m^3/h has been finished in March 2015. Based on the results of this test a 3D-geohydraulic model was constructed to concretize the real influx and recharge into the used aquifer system.

Abbreviations

DEM	Digital Elevation Model
EM	Electromagnetics
masl	meters above sea level
NBB	Nord Bohr und Brunnenbau GmbH, Hamburg
TEM	Transient Electromagnetics

Dr. Bednorz, Brinschwitz
FUGRO Consult GmbH
Wilkinson
Allana Potash Corp

Mining and Soil conservation – natural gas production in Lower Saxony as an example

1. Natural gas production in Lower Saxony

Lower Saxony is the number one gas producer in Germany. In 2014 10 billion cbm natural gas have been produced, this generated jobs for about 3700 employees in the petroleum and natural gas business and gained 476 million Euro in mining royalties for the national budget.

Beside the actual resource of the natural gas methane, numerous adherent natural resources are extracted from the deposits: Nitrogen, hydrogen sulfide, carbon dioxide, gas hydrate (including BTEX), NORM, water and also mercury. Particularly mercury has recently been in public dispute.

2. Contents of natural gas, mercury as an example

In technical conversations the previously mentioned contents of natural gas are considered, thereby the focus is often on mercury as key component. The mercury contents in the raw gas of Lower Saxony (Rotliegend, Karbon) are between 300 and 5800 µg/m³.

In the gas dehydration units on the production sites the mercury content of the natural gas is significantly reduced to meet the quality requirements of the gas providers.

Looking closer at the development of a gas field it is obvious that a closed system does not exist from the beginning. Immediately after the exposure of a potential gas deposit by drilling the deposit undergoes a production test. Thereby large quantities of raw gas are conveyed and flared. In the past the test were conducted without a dehydration unit.

Therefore it was assumed that mercury has been released and could be detected in the soil surrounding the borehole. Due to its chemical properties mercury in metallic state remains bond in the upper soil layers over a long period. The oil and gas producing companies have conducted exploratory soil analysis on mercury based on the production history of the natural gas deposits in 2010 to 2012. As a result can be concluded that the mercury content of soil is in general significantly above the geogenic background values, partly also above the soil specific precaution values of the national soil protection law and the decree on contaminated sites, but below usage specific test and trigger values.

Production incidents and test results of third parties required in 2014 a technical inspection of the situation by the LBEG.

The inspection showed that beside the release by flaring also tanks and in particular the cleaning of vessels should not be underestimated as source of mercury. The LBEG has therefore, in cooperation with the involved government departments, established a statewide research program to detect the contamination of soil in the surrounding of active natural gas production sites.

3. Research program of the LBEG

Since 2006 the LBEG brings the state geological survey and the mining department under one roof. Thereby the respective competences in regards to natural gas production technology but also to assess and evaluate soil contamination are available. Considering this a program to examine all natural gas production sites in Lower Saxony has been established in cooperation with other technical state authorities (consumer protection-LAVES, water- and environmental protection-NLWKN, health protection-NLGA). This program comprises the taking of soil and sediment samples in the surrounding of the production sites, their chemical analysis (e.g. heavy metals, BTEX, hydrocarbons, PAH), the evaluation of the results in regards to soil protection laws as well as gathering, sighting and systematization of relevant data of companies and from files and archives of the LBEG. These are preliminary assessments forming the base for detailed assessments to be imposed on companies where required. The internal project start was in February 2015. Supporting orders for sampling and chemical analysis as well as technical evaluation will be granted in Mai 2015. Beside the soil assessment the LBEG will also order immission sampling.

4. Summary

Lower Saxony is the leading natural gas producer in Germany. The LBEG is supervision and admission authority and conducts this role now and in future with responsibility. Therefore we focus also on established technologies where the release of hazardous substances cannot be ruled out. We take this commitment serious and want to establish a reliable basis of information to evaluate the environmental impact in a professional way.

The project has commenced, the first step with the assessment of 200 sites in 2015 and 2016 has started.

A reliable evaluation of the actual environmental impact will earliest be possible based on this sample.

Sikorski, Rieche, Larres, Dr. Schneider
LBEG – Landesamt für Bergbau, Energie und Geologie

The Saxonian Raw Materials Strategy – Motivation, Status-quo and Outlook

The English translation of the text was not available at the time of publication. The original text can be found in the German section under B12 Die Sächsische Rohstoffstrategie – Motivation, Stand und Ausblick.

Heymann
Sächsisches Staatsministerium für Wirtschaft, Arbeit und Verkehr

Rehabilitation of abandoned Wismut sites in Saxony – Challenges in the years to come

The enacting of the Wismut Act by the German Bundestag on December 12, 1991 as well as the foundation of Wismut GmbH on December 20, 1991 laid the foundations for the termination of uranium ore mining and the subsequent rehabilitation of mining and processing sites operated by SDAG Wismut on the territory of the former GDR. This gave rise to one of Europe's largest environmental restoration projects involving a great number of objects to be remediated in the Free States of Saxony and Thuringia.

However, this approach did not take account of those sites which had been operated by SAG/SDAG Wismut prior to December 31, 1964 and had been re-transferred to their respective local authorities. Besides a wide range of objects located in the Free State of Thuringia, mining legacies of that kind situated in the Free State of Saxony basically comprise abandoned mining sites in the Ore Mountains and in the Vogtland area as well as mine dumps and plant areas of former uranium ore processing facilities. Such properties and objects, as distinguished from properties and objects under the "Wismut core remediation", were abandoned decades ago, and some have undergone severe structural changes due to different types of reuse. Yet these legacies are equally hazardous to man and the environment as the more recent sites. As a matter of principle, necessary remedial actions to be conducted here shall be implemented on land and property owned by third parties, which requires significantly different approaches to design and handling.

The Administrative Agreement between the German Federal Government and the Free State of Saxony of September 05, 2003 created the prerequisites for remediating what is known as formerly abandoned Wismut sites and making the properties concerned available for future sustained and safe reuse. Starting from "priority objects", the remedial effort has been guided by the need to address the greatest hazard potentials and matters of greatest urgencies. In this way, numerous underground and above ground hazards were eliminated during the period 2003 - 2012, involving costs of € 78 million. As a result of a survey which was conducted at the same time, the need for remediation and the expenditure involved were identified on an object-related basis. This process led to the signature in 2013 of an Extended Administrative Agreement with a term ending in 2022 and a total budget of € 138 million. Wismut GmbH was tasked by the Free State of Saxony to organise and implement these complex remedial projects as project executing organisation.

In this capacity Wismut GmbH is in a position to adopt a uniform approach to meet the numerous radiological, geotechnical, and engineering challenges of the rehabilitation ahead. In addition to this, specific site conditions and licensing prerequisites will put high requirements on individual project planning and implementation. Technological innovations, in particular with regard to above ground remedial work, risks due to unsurveyed and unmapped mine voids as well as increasingly complex hazard potentials posed by former exploration and producing mines provide the backdrop for design, planning and steering remedial operations at individual sites. Not to mention the handling and safe disposal of radioactive materials generated as part of the cleanup: these are the challenges to which Wismut GmbH as project executing organisation and their contractors will have to rise in the future.

The talk highlights the rationales as well as the approaches adopted so far to the cleanup of formerly abandoned Wismut sites in Saxony and exemplifies current and future challenges and indicates meaningful approaches to the successful continuation of an environmental restoration campaign that will not undo the early phase of intense uranium mining but rather remove the negative impacts of these operations and provide the spadework for sustainable development.

Speer, Dr. Mann
Wismut GmbH

Sinkholes above abandoned mines – valuation and rehabilitation

Sinkholes can take a wide variety of forms and dimensions. Overall several hundred sinkholes go down in Germany year by year.

Statistical studies of events have demonstrated a broad frequency distribution during the year, particularly depending on weather influences. However, sinkholes can happen at any day and at any hour. Sinkholes represent a negative impact to public safety. It should be also noted, that processes of leaching and redistribution are active in surrounding rocks. The fracture mechanisms of a natural collapse and of a collapse above an abandoned mine are almost identically. In many cases the two types of damages cannot always be separated by means of phenomenological appearance. Geotechnical investigations and valuations including mine surveying should clarify, which mechanisms and types of cavities have caused the existing damage primarily. These subject-specific valuations in compliance with the hydrogeology are the substantial basis of efficient mining technical renovation. In addition, there is an assignment to a natural or an artificial cavity, resulting responsibilities for the insurance law and the authorities.

The professional valuation shows ever: Sinkhole is not the same sinkhole. As part of an analysis relevant to security there are questions asked to a numerical viewing. It should be noted basically, that a temporal prediction of sinkhole events is not possible. Mathematical models can only be used with sufficient knowledge of geotechnical rock parameters. The knowledge of genesis, conditions of cap-rock and water flow are essential for effective sinkhole rehabilitation. A major factor as well is the current use of the day surface.

If the geotechnical and mine conditions are known, suitable rock horizons are easy to determine for the rehabilitation. These solid rock horizons are favorable for the correct installation of a plug.

Dr. Meier
TU Bergakademie Freiberg

Shaft filling at RAG – Technical options for future requirements

Introduction:

In the course of the decommissioning process of the German coal industry, shafts of disused mines are filled permanently stable. The chosen filling method depends very much on the future requirements that the shaft will have to meet. Over the years full or partial filling has been the standard technique for the permanent preservation of mine shafts. The decision as to which of the two methods to use was simply based on economic considerations. By implementing the long-term water management concept, nowadays the decision between full filling and partial filling will depend very much on two important technical requirements that have to be met by the fill column: one is water migration and the other is to gain access to the mine water. Another important part of the shaft filling is, in addition to the technical aspects, the quality control of construction materials used.

Quality surveillance system for filling material:

The material destined for the long-term preservation of mine shafts is subject to the provisions of the Underground Waste Stowage Ordinance (VersatzV, 24/07/2002, amendment 25/08/2004). In the past, manipulation allegations against RAG, the technical experts and the companies concerned, have meant that there is now much greater focus of public, the approval authority as well as other relevant ministries and regional offices for nature, environment and consumer protection to the aspect of quality assurance. RAG has now developed its own quality assurance plan for aggregate materials in order to ensure maximum security and transparency with respect to the quality and origins of the aggregates used for shaft filling projects.

Shaft filling techniques:

Different filling methods are used depending on the future requirements that the shaft will have to meet. The key distinction is essentially between full filling and partial filling (with and without specific requirements). In the case of full filling – where there are no requirements imposed as to the subsequent role of the shaft – a cohesive building material (durable and inherently stable) is tipped into the shaft and allowed to fall under gravity to fill the area between the very bottom of the shaft and the shaft cellar. Partial filling, in which the column of fill is set on an abutment, is employed at those sites where it is more cost-effective than full filling or where special requirements apply, such as water migration and to gain access to the mine water. Shaft filling with incorporated clad pipes is a special technique used for partial filling operations. In this case the clad pipes are set into the concrete filling so that submersible pumps can later be lowered down, as in a well, in order to pump out the mine water.

Summary:

The concept for the long-term optimization of mine water pumping regimes at disused collieries has also led to a major re-think of shaft filling operations. The conventional practice of full filling – that until a few years ago was used almost exclusively for the long-term preservation of abandoned mine shafts – has now become the exception. The fill column becomes a technical structure that has to take on important functions associated with the coal industry‘s long-term burdens and responsibilities. The planning, execution and monitoring of these shaft filling measures represent a real challenge for everyone involved.

RAG has the experience and the know-how to meet these requirements.

Kampen
RAG Aktiengesellschaft

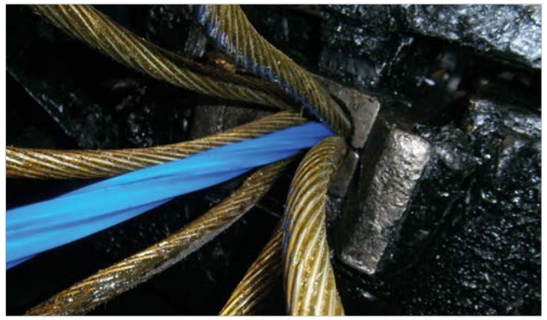
Development of hybrid ropes for deep shaft mine hoisting applications

The underground mining industries are trending to deep depths, typically greater than 3000m in single hoisting operation. The weight penalty of steel wire rope increases with depth and becomes a significant part of the breaking load for depths greater than 2000 m. The operating weight of a steel wire rope is at the expense of a decreasing payload hoisted in the deep shaft operation. There is a growing need to explore lighter alternatives; firstly a fully synthetic fibre rope and secondly a hybrid solution that combines steel wires and synthetic fibre.

Using fibre ropes as substitute for steel ropes is an attractive solution but a number of challenges still remain with regards to robustness and handling in service. Developing a hybrid rope solution which is steel and fibre combination rope where the fibre in the rope is an integral load bearing member offers the advantage of combining the robustness of steel and weight saving properties of fibre.

The concept of combining steel wires and high strength fibres is not new. Several patents and publications have been published on different concepts of combining steel wires and high strength fibre in a rope. One of the main challenges in hybrid rope development is to combine steel wire and high strength fibre such that both contribute effectively at rope operational loads and break loads of the rope.

This paper describes Bridon's approach and concept to develop hybrid hoist ropes for the deep shaft mining industry. The hybrid rope design consists of high strength fibre for the rope core and steel wire outer stands. The principle task is to achieve load sharing between steel and high strength fibre across the whole operating load range. The primary target is to increase the strength to weight ratio of a hoist rope. The mines will have an option to increase payloads at their mines and increase productivity or maintain existing payloads and achieve significantly higher working lives on their ropes.



In this paper, an overview of Bridon's first steps towards the development of a practically usable hybrid hoist rope for the deep shaft mining industry is provided. After extensive laboratory tests yielding positive performance results, two ropes have been supplied to an ultra-deep shaft underground mine for field test.

Heinrich, Mohanraj
BRIDON International GmbH

The world‘s largest Hoisting Machines with Integrated Drive

Yitai Group recently awarded SIEMAG TECBERG with an order in the double-digit million euro range to install four shaft hoisting machines at the company‘s new coal mine in Inner Mongolia, known as the Hongqinghe project. The project marks a new cooperation between SIEMAG TECBERG and Yitai Group as a worldwide flagship project. Two of the four machines are skip winders, each with integrated 9 MW motors. These mine winders are the biggest ever supplied by SIEMAG TECBERG, and are the largest in the world to feature a motor integrated in the drum. The extremely compact design will help Yitai Group to reduce investment costs associated with the new colliery. What‘s more, the carbon footprint of the integrated machines – with double winding at full load but only at half speed – is smaller than that of a conventionally designed plant thanks to the 0.5 % efficiency increase.

The space-saving design, comfortable inspection and maintenance, and lower costs for the foundation are some of the many customer benefits of the integrated machine. The other two winders are used to transport personnel and equipment underground:

SIEMAG TECBERG is equipping the mine with two service hoists. The entire automation control and monitoring systems, the medium-voltage and low-voltage control panels, the shaft signaling equipment, the loading and unloading facilities, spare parts, and commissioning and training are also part of delivery.

In detail SIEMAG TECBERG delivers two 6-rope Koepe hoisting machines with a friction-pulley diameter of 5,000 mm will be tower-mounted and erected at a production shaft which has a diameter of 9.5 meters and a programmed annual hoisting capacity of 15 million tons of hard coal. This capacity will be assured by the application of two skips with a payload of 50 Ions each.

The service shaft, with a diameter of remarkable 10.5 meters, will also be equipped with 6-rope and 4-rope tower-mounted Koepe hoisting machines. friction-pulley diameter of 5,600 mm and 2,250 mm, as well as with special conveyances, i.e. one double-deck large cage with counterweight and also a pair of special double-deck transport cages. The duties of the service shaft include men riding, transport of material and the transport of large equipment into the underground mine or back to the surface. With a payload of 60 tons, these plants will belong to the largest of their kind.

The scope of supply does not only cover all conveyances for the four plants, but at the same time also the underground loading devices, the unloading devices at the surface, the brake systems of the type ST3-F with double constant retardation and the cage-locking device. In cooperation with the partner SIEMENS shaft-hoisting installations for the production hosts are built for the first time with a drive power of 9.000 kW and this with an integrated motor of the latest design.

The right company for the job

High reliability and availability are critical for Yitai Group. And as such, a very short ROI is particularly important. SIEMAG TECBERG was able to fulfill this requirement, as proven by excellent references and a very professional team in China. An integrated winder offers the customer numerous advantages e.g. regarding the constructional dimensions, excavation work and foundation loads, statics, and power transmission onto the ropes, easy maintenance.

Albrecht-Eckardt, Schubert, Hofmann
SIEMAG TECBERG GmbH

Methods to increase the availability of mine winders

The presentation describes different methods to increase the availability of mine winders. A common way of realisation is to install redundant systems. As a second method the minimisation of shut-downs and the reduction of shut-down-time need to be considered.

We will show and explain different solutions with references of already-proven installed systems or engineered concepts.

The importance of availability sometime depends on the type of the winder. For production winders the amount of hoisted material is the key figure. For service winders mainly the safety of personnel needs to be considered, not to forget the availability to transport people under every circumstance. The actually loaded skip or fully manned cage needs to be moved to the surface. Furthermore rock hoisting or personnel transportation for a longer time at nominal load need to be guaranteed, even with partly damaged electrical equipment.

Sometimes it seems that words like “safety”, “availability” or “price” don’t match, however, we will show you how these aims can indeed be combined. Especially for smaller winders, such as auxiliary machines or service winders, an installation of redundant system is pricewise unpractical. For these types of winder we can show a couple of alternative solutions.

Newer concepts for small to middle size winders, especially for low voltage solutions, are able to increase availability without the need to double the investment for a redundant system. This presentation focuses on converters, cooling systems, winder automation and instrumentation. A centrepiece for the increase of plant availability is online-tracking and condition monitoring. Not just single components for e.g. converters but the complete system will be considered. We are going to show concepts and solutions implemented in different countries, for example Asia, Europe and South Africa.

Gebhard
Siemens AG

Management Tools Mining in the Opencast Mines of Vattenfall Europe Mining AG

At present, the annual production in the five Lusatian opencast mines of the Vattenfall Europe Mining AG comes to approximately 65 million tonnes of raw lignite. The lignite is used for power generation in the power plants of the Vattenfall Europe Generation AG in the mining region and / or processed to briquettes and pulverized lignite in the refining plants.

Presently, the mines in Lusatia are characterised by one specific feature, in each of the mines the lignite is extracted from one seam. Approximately 400 to 500 million m³ of over-burden have to be removed per year to mine the above mentioned quantity of raw lignite; this corresponds to an average overburden : coal ratio of 8 : 1.

Overburden removal is exclusively done by overburden conveyor bridges and heavy-duty opencast mine machines with attached belt conveyor systems; coal is mined with heavy-duty opencast mining equipment and belt conveyors.

The previously targeted development of mining equipment for opencast mines has presently reached objective limits with regard to capacity and availability.

It is now necessary to look at the process flows and to identify potentials for further optimisation of secured production results meeting the demands at optimised costs.

Mining processes are influenced by a number of partially competing general conditions and parameters. Optimization of these connections requires complex approaches and the use of models, computing technology and respective sensor and/or actor technology including safety functions of heavy-duty opencast mine equipment. The models and operating parameters are directly influencing the production process and in increasing scale also the planning with regard to the results and conclusions.

Presently, this direction of work is followed by the German lignite companies in a similar approach, but they independently develop and implement directions of work, specifications regarding the content and functionalities.

This paper describes the specific processes within the Vattenfall Europe Mining AG.

For more than 6 years, Vattenfall Europe Mining AG has been developing and stepwise implementing production management instruments for examining the overall mining process on different levels. This involves the whole production process from planning, production management to post-processing.

In addition, these components essentially contribute to maintaining the safety level of the mine equipment with the above mentioned high capacity requirements. This is in particular important because the long-term planning of opencast mine operations and in particular the systems engineering are going far beyond the formerly scheduled utilization time.

The modules also provide bases to take present and future requirements into account with regard to influencing and expressively considering environmental aspects concerning the storage of materials in overburden dumps and waste disposal sites.

Vattenfall takes a role as provider of ideas and driver of the development in this respect because such tools and applications are not completely and / or in their process-related complexity available at the market.

In 2005, Vattenfall Europe Mining AG started to develop such tools specifically tailored to the demand of the opencast mines and to use them comprehensively. First single elements were fixed as special subjects. These topics include key issues in the operational planning, implementing and safety areas.

Each of these instruments is realized as pilot solution and adopted for further applications. The modular design enables linking with superordinated processes.

Besides pure economic evaluation criteria, environmental aspects require more and more the use of such process illustrations.

At the example of the management instrument “Technology Workplace Mining“ the report describes approach, stepwise extension, complexity and present state of development.

Glück Auf!

Scholze
Vattenfall Europe Mining AG

Partial Automation of a Belt Stacker for Unmanned Operation of the Intermediate Conveyor

The English translation of the text was not available at the time of publication. The original text can be found in the German section under B22 Teilautomatisierung eines Bandabsetzers für den mannlosen Betrieb des Zwischenförderers.

Dr. Martin
Actemium BEA GmbH
Müller
MIBRAG mbH & Co. KG

Radar-based Collision Protection and Assistance Systems for Ship Loaders

The English translation of the text was not available at the time of publication. The original text can be found in the German section under B23 Radarbasierter Kollisionsschutz und Geräteführerhilfe von Schiffsbeladern.

Augustin, Dr. Winkel
Indurad GmbH
Wilde
SANDVIK Mining Systems

Asset Performance Management in Mining – Setting a New Standard

Over the past 20 years, the use of maintenance technology, such as condition monitoring, has grown tremendously in the mining industry. In fact, its use has grown at such a fast rate that often technicians and reliability engineers aren't sure what to do with all of the information being generated. Some forward looking mining companies are now leveraging 21st century Asset Performance Management (APM) systems that consolidate into a central repository technical reliability indicators and condition monitoring data to deliver key performance information that is easily understood by all.

Today, maintenance productivity and costs are well understood by mine management. These costs are a significant portion of the operating budget, often as much as 20 to 50 percent. Mine owner-operators learned in the 1980s that maintenance planning and scheduling increases productivity, lowers costs, and makes mines safer. The earlier you can detect a problem, the more time you have to plan and schedule.

Condition monitoring systems have been prevalent in the mining industry since the early 1990s. Mines now use a plethora of condition monitoring systems, including oil analysis, thermography, mobile asset health data, plant data historians, vibration, ultrasound, operator inspections and PM inspections. Yet, condition monitoring systems typically operate in silos. A huge amount of data is stored but, unfortunately, is not accessed or used in a way that the average technician can easily see or understand to prevent failures. With so many condition monitoring systems, along with visual inspections and planning and scheduling, why is so much new work discovered through failures? Are we planning and scheduling the right work?

An asset performance management (APM) system such as Bentley AssetWise APM brings maintenance systems performance and reliability knowledge together in one easy-to-view system. It collects online condition and operations data, as well as visual inspection data that users collect on operator cards or during routine preventive maintenance inspections. The system integrates with the mine's computerized maintenance management system (CMMS) or enterprise asset management (EAM) system such as SAP PM, Oracle EAM, Ventyx or IBM Maximo. Data that used to be sitting in thousands of columns and rows in many different systems can now be viewed centrally in one asset health dashboard. The data is trended, and can be consolidated, analyzed and measured. The information is actionable since the systems are now all connected and paper check sheets are now automated.

Mechanical and electrical expertise is in demand in mining around the world. Mining companies are sometimes afraid to invest in training technicians for fear that if we train them, they will leave with their knowledge. When good technicians retire, their knowledge of the assets they worked on is lost. A best practice today is to document their expertise in an APM system. But don't stop there, don't just document it. That would be like leaving the RCM analysis results sitting on a shelf. There's much more to an APM system in terms of implementing the reliability program and managing all the data that comes from implementing the program and monitoring asset health on a day-to-day basis.

APM systems are setting a new standard for managing assets in the mining industry, and they should be mandatory in all mines. When establishing a new mine, the time to begin a reliability program is when the equipment is first received. Baselines can be created in the initial stages of startup. Failure modes and job plans should be created and available at a glance. Those operating an existing mine should think of APM as the most cost-effective strategy for extending the life of aging assets. They should view APM as the best way to get more from existing assets while reducing costs, cutting fleet numbers, and, at the same time, getting more production.

APM is also aligned with ISO 55001, the new standard for asset management. This new standard is the way of the future for the sustainability of mining operations.

Heckmann, Engels
Bentley Systems Germany GmbH

Replacing Traction Sheave and Break in the northern Extraction of Shaft Unterbreizbach I

The mine plant Unterbreizbach and the associated potash factory is located in the Free State of Thüringa and belong to the combination factory Werra of the K+S GmbH. The underground production amount to 4.5 million tons crude salt per year with a potash content up to 19 percent K2O. Nearly 3 million tons of crude salt supported on the shaft hoisting at shaft 1 Unterbreizbach in the factory Unterbreizbach and will be processed into fertilizer. Another 1.5 million tons crude salt are transported through an underground transportation to the potash factory in Hesse. The hoisting is provided at the shaft 1 Unterbreizbach on two hoists with each two associated skips. The Koepe wheel of the northern carrier was produced as a spoked construction in year 1908 and was used first as an bobbin. After different conversions it is a Koepe hoist at shaft 1 Unterbreizbach since 1972. The Koepe wheel has a diameter of 6.5 meters and is powered by a DC-motor with a power of 2280 KW. Due to the shape of the Koepe wheel it achieves a payload of 12.5 tons and a speed of 13 m/s. With 763 meter driveway results a hauling capacity of 400 tons per hour.

Because of the following aspects was an exchange of the Koepe wheel with brake necessary:

- the fatigue strength of the Koepe wheel is exceeded because of an long operating time and today`s design criteria's,
- at the spoked construction arise increased crash formation,
- a bad corrosion protection and an obsolete and unregulated brake technology (shoe-type-brake)

In the end this lead to the decision for a modernisation.

The technical design revealed that the new Koepe wheel was planned as a solid bowl construction executed with an integrated brake area. The brake system was a delay regulated dish brake system with three plus four channels designed. This system is a spring-loaded-hydraulic brake. The existing Koepe wheel bearing was replaced through a slide bearing with recirculated oil lubrication system and a hydrostatic traction. After appropriate preparatory work on the system and the manufacturing of the new components followed a rebuild of a Koepe wheel and brake in August 2013.

The conversion time was three weeks and ended with the permit through the mining authority at the 26. August 2013. After a successful commissioning is the conveyor nearly faultless in use and extracted about 4 million tons crude salt in the factory Unterbreizbach.

Armbrust
K+S Aktiengesellschaft

Security Measures in the Belt Conveyor at the site of Hattorf in pit HW

A part of the main conveyor belt of the Hattorf/Wintershall mine, owned by the K+S KALI GmbH, had to be renewed. The existing standing support was severely damaged due to a loosening of the roof. In order to achieve this, the existing support was stripped down and a 30 m long flexible support was assembled.

This specific mining area is endangered by carbon dioxide and during the mining of the gate roads several CO_2 outbursts occured. Due to a former outburst in this place the roof structure is very specific and the road heights vary from 10 to more than 20 m. The road height and the danger of further roof loosening made other roof securing measurements, like roof bolting, impossible. The only possibility to secure the main conveyor belt permanently was to reestablish / rebuild a new support.

The new design is based on a typical arch yielding support. The spacing between the single archs is 0.5m and reinforced by special clamps. Due to the danger of further roof loosening the new support could not be raised at the destined location. Therefore, it was erected in several segments in a safe area and pulled on tracks to its destination where the single segments got connected. Altogether, 5 single segments were raised and connected. On top of the support a complete metal sheet lagging was installed. On the lagging two additional layers of brattice (sealing foil) were applied to ensure additional sealing of the support. Moreover, the support was “cushioned” by a 2 m thick layer of fine salt.

The support was calculated to withstand the force of a falling mass of 2 m^3 of rock salt from the height of 11 m. To reduce the falling height and the punctual force of the impact a layer of 2 m of fine salt was put on the support.

There was only a short time frame available for the dismantlement of the old and the assembling of the new support. It had to be realized during the 2 weeks lasting summer shutdown. Therefore, the necessary works had to be divided into 3 separate sections. The preparatory operations like the dismantling of the damaged support, the preparation of the working site and the cementation and bolting of the sliding tracks took place within 3 weeks before the summer shutdown.

The assembly of the new support was achieved during the shutdown and the “cushioning” with fine salt was subsequently brought in while the conveyer belt was already in use again.

The main works, besides the “cushioning” with fine salt was assigned to KOPEX-PBSz.

Dr. Weber
K+S Aktiengesellschaft

Installing a new mine winder at Fuerstenhall shaft for the K+S owned Siegfried-Giesen reserve mine

Just before Christmas 2012, and following an extensive procurement procedure, THYSSEN SCHACHTBAU GmbH was awarded the contract to renew the mine winder at the Fuerstenhall shaft, which is part of the Siegfried-Giesen reserve mine. Siegfried-Giesen reserve mine consists of four operational districts served by the shafts Siegfried-Giesen, Glueckauf-Sarstedt, Fuerstenhall and Roessing-Barnten. The four shafts range from 750 m to 1,050 m in depth and the mine was producing crude potassium salt up to the year 1987.

K+S AG has been keeping Siegfried-Giesen mine open as a reserve facility since 1987. The mine, which lies between Hildesheim in Lower Saxony and Hanover, will therefore be available for the production of the remaining potash at some future date.

With a view to maintaining potash production in Lower Saxony in the long term K+S AG carried out feasibility study in 2010-2012 aimed at examining the technical and economic conditions under which mining could be resumed at some future point. The study indicated that such a venture would have good prospects of success.

The next step was to clarify the licensing and approval situation by undergoing a regional planning procedure, which was concluded in November 2013 with a positive outcome. The preparations for the mine planning approval process then began immediately after, with a final investment decision not expected before 2016.

As the surface facilities had been extensively decommissioned at all four mine sites K+S AG took the decision to go ahead with upgrading one of the shafts, in parallel with the upcoming studies and investigations, so as to create an efficient access point from which an underground survey could be made of the mine workings. The Fuerstenhall site, at the south-western edge of the small town of Ahrbergen, is one of the four accessible openings to the underground workings.

While the other three shafts could only be entered using a mobile winch, Fuerstenhall still had a fixed winding system dating back to the 1960s. This installation had a winding speed of about 0.4 m/s and was able to provide permanent access to the mine. As this winding system could no longer meet today‘s requirements (not only was it outdated but it had too small a conveyance and an inadequate performance, with a winding time of more than 20 minutes) the decision was taken to upgrade the installation by installing a modern winder.

The aim was to install a system with a winding cage capable of transporting up to 30 persons at 4 m/s and a payload of up to 13 t at 1 m/s. The existing drum hoist was also to be replaced by a modern winding machine. Various modifications and rebuilds were also to be carried out as required on the surface headgear installation and underground pit bottom facility. At the end of December 2012 THYSSEN SCHACHTBAU GmbH was commissioned to carry out all this installation and construction work. The shaft winder was to be supplied by TS subsidiary OLKO-Maschinentechnik GmbH, while Siemens was to be responsible for providing all the electrical technology.

Work at the site began in April 2013. As K+S still had to use the shaft for its own personnel and materials movements during the early morning shift, the work had to be carried out during the evening and night shifts. After works at the shaft and the bottom landing at the 750 m level the surface foundations for the new headframe, comprising a steel structure below pit-bank level along with the first section of the headframe to a height of some 7 m could be assembled. Work was also carried out at the same time on the installation of the electrical equipment for the new winding machine, including a state-of-theart control cabin. This phase of the project was to be undertaken without restricting winding operations in the shaft. When all the work that could be undertaken while maintaining the existing winding system had been completed at the beginning of December 2013, the guide ropes and winding rope were discarded, the cage dismantled and the old winding machine shut down, part dismantled and lifted from the winding house by means of a mobile crane.

The new winding machine was installed in early January 2014. The old rope-pulley system on the 7- metre platform was dismantled as the work went ahead on the new winder. The new rope pulley was then fitted into place after the remaining parts of the new headframe had been installed inside the air funnel. THYSSEN SCHACHTBAU, OLKO-Maschinentechnik and Fairport Engineering worked closely together to design an overwind protection system that would ensure a reliable and safetyengineered delay in every operating mode, despite the very restricted space conditions and short braking paths.

During this time the required control and signalling equipment was also installed at the bottom frame and in the headframe. As this work was under way the only access to the mine was provided by the temporary winder in Siegfried-Giesen shaft. At the end of January the new winding machine turned for the first time and after undergoing a preliminary inspection test the new winding rope was pulled on. The new rope was then used to fit the four guide ropes and the new hydraulic rope tensioning system was put into operation. The project was completed with the installation of the new twin-deck cage conveyance.

Rosga
OLKO-Maschinentechnik GmbH;
Weißenborn
Thyssen Schachtbau GmbH

Assessment of SIL-evaluation for the Software of a breaking control according to IEC 61508

Compared to other large mining equipment like in open-cast mining, in Germany hoisting plants are not subject of the EC machinery directive. Also the current version 2006/42 EG explicitly excludes hoisting plants because of their special safety characteristics.

So far the production and operation of hoisting plants is subject of “technical requirements on shaft and hoisting plants” (TAS), issued by the mining authorities of the German Federal States, last revised in 2005 (currently in revision).

Since 2002 a basic standard of functional safety is in effect with the IEC 61508. It gives requirements on hardware and software in complex function and is valid for hoisting plants in non-European countries.

While for the hardware of safety-related systems a quantitative proof of reliability in form of a Safety Integrity Level SIL is required, a qualitative assessment is necessary for safety-related software since 2011 in form of evaluation tables.

The 10th, 11th and 12th Bergbauforum already discussed the determination of the Safety Integrity Level for hardware of safety devices in open-cast mining equipment and hoisting plants. Now a SIL-evaluation for software of a safety function can be presented for the first time using the example of a breaking control from a German manufacturer for a non-European application.

Considering IEC 61508-3 Annex A with the included notice on the impossibility of specifying an algorithm for every application and regarding the described history of the examined breaking control, the methods which are used in the examination are compared to those given by the standard.

In dependence on the procedures in IEC 61508-3 a proof of validation was performed on the basis of the described requirements, the performed and documented Examinations. The Safety Integrity Levels of the examined software resulted in SIL2.

Prof. Dr. Gerlach, Steinfeld
TSU e.V. – Verein für Technische Sicherheit und Umweltschutz

Industry 4.0 in the Mining Industry – the future of the digital mine starts today

The mining industry faces several challenges at the moment and there are no indications that these challenges will let up anytime soon.

Increased digitalization has improved the efficiency of many industries. New technology and a holistic approach can also apply to the mining industry. This vision is known as “Industry 4.0” or “Internet of Things”.

A rock solid automation is the basis for further efficiency increase measures. The automation should use the latest technology, should be flexible and adaptable as well as future-orientated thank to the use of standards. Self-sufficient units existing in a mine have to be networked using the latest communication technology.

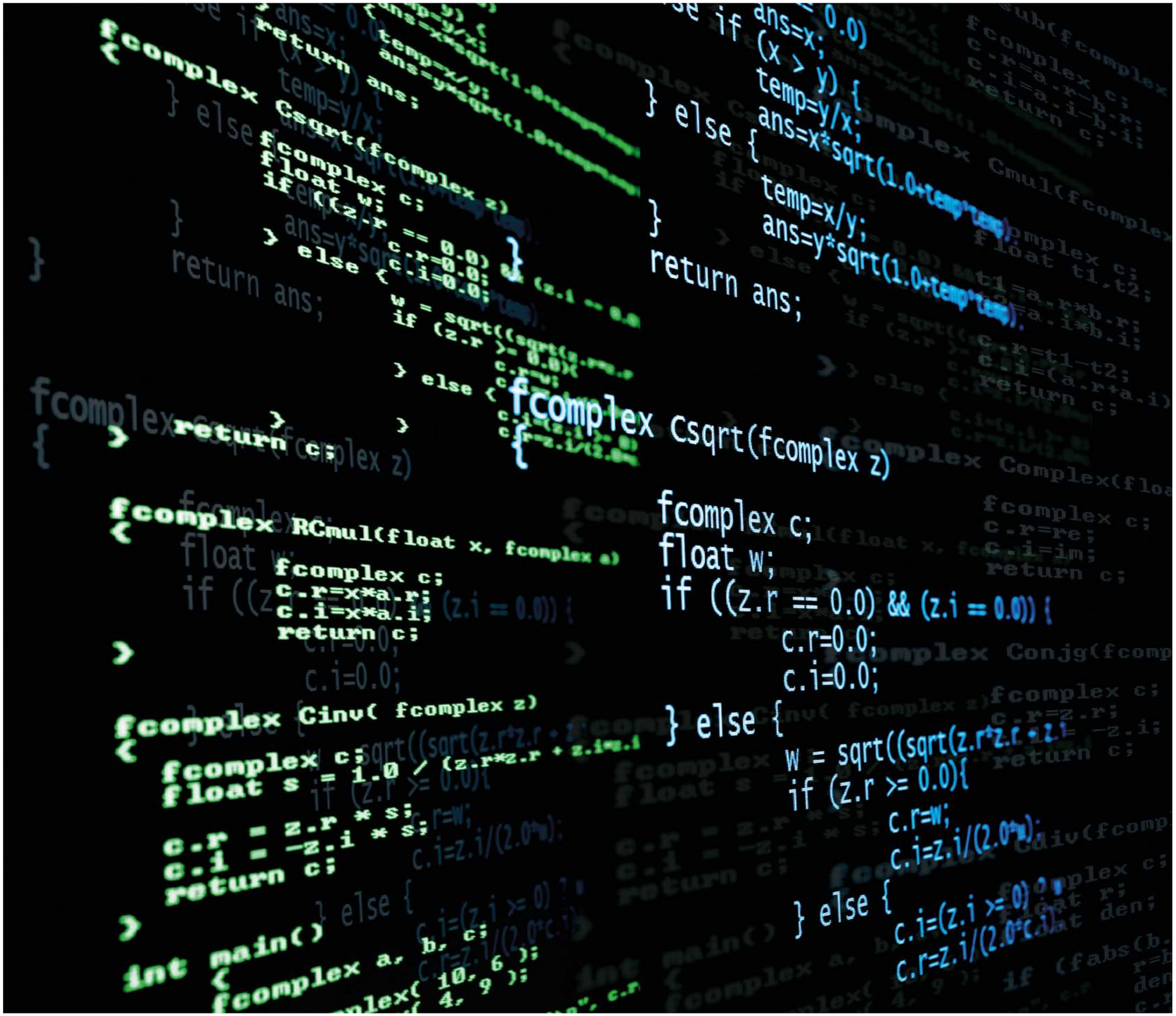
However an isolated view of efficiency improvement in this area is not sufficient anymore. The key is network of sensors, measuring devices and scanners, industrial machines and automation systems. Digitalization is the essential technological driver for this.

Digitalization already starts in the planning phase of a plant. From basic engineering to detailed engineering via commissioning up to the operation of the whole plant, data has to be exchanged and communicated between devices and centrally administrated. Software tools like Comos are capable of handling object-oriented data and support digital engineering.

Within the scope of additional digitalization in enterprises, special attention has to be paid to the safety aspect of the plant across the whole company. A wide range of products and services is available to ensure extensive safety in the industry. The concept comprises: plant security, network security and system integrity.

All these solutions are available today and they have been already successful employed individually at mining sites. Now it is time to bring all of them together. Those who embrace a higher degree of digitalization will increase their flexibility and be able to quicker adjust to changes in the market.

Walther
Siemens AG



Current Research for Mining 4.0

The german term “Industrie 4.0” is currently on everyone‘s lips. But what is really behind it? In 2006 the german federal government has defined a “High-Tech Strategy” with the aim of becoming the global innovation leader. The term “Industrie 4.0“ is one of ten projects for the future in the context of the “New High-Tech Strategy”.

For the development of future technologies a reliable, sustainable and transparent raw material supply of the economy is important. Economic strategic commodities allow industrial production processes and innovations and are therefore essential for the high-tech location Germany. In order to deal more effectively with these finite and hard available resources, recycling must increase and, where possible, have to be replaced with better available resources.

Set against this background, the term “Bergbau 4.0“ combines Industrie 4.0 and the current research and development program of the BMBF for new raw material technologies. The term wants to make clear that the German mining supplier industry can only survive on the international market if they combine reliable technology with high-tech and innovative business models to new products.

This paper discusses the background and the definition of Bergbau 4.0 and connect it to the latest research for the German mining machinery industry. Selected research projects will be presented and a concept will be discussed how the mining suppliers could transfer this know-how to new products and services.

Bartnitzki
RWTH Aachen

Safe Mining Worldwide: VISION Zero & 7 Golden Rules for Secure Mining

340 million accidents at work happen worldwide every year, only counting those leading to more than four days absence. 360,000 end fatal. Two million people more die every year due to work-related diseases. To sum this up: around 2.4 million people die every year because of work conditions.

Among many risky industries, mining stands out. While mining represents just 1% of employees globally, it represents 8% of all occupational fatalities.

Mining operations go along with a variety of hazards, ranging from equipment and vehicles to various substances such as dust, mercury and other chemicals, poor ventilation, inadequate space and overexertion. What does this mean?

- It means a tremendous loss of productivity.
- It means enormous problems in quality.
- It means a lack of motivation due to unsafe work conditions.
- It means a disastrous public image of the whole trade, and of many particular businesses.
- And, most of all, it means human suffering, families losing their loved ones – and their suppliers!

We can make mining sustainably safer, but we need a successful strategy to do so. A high potential lies in Vision Zero. Vision Zero is a prevention strategy for a safe future without fatal or serious occupational diseases, work accidents and traffic accidents. Vision Zero’s holistic elements cover technology, workplaces, rules, and people as fields of action. By focussing on severe and fatal accidents, its application increases the level of safety and health overall.

The presentation will discuss well-proven methods and tools to achieve this ambitious, but realistic aim, including the introduction of “The Seven Golden Rules” of ISSA Mining, which can help to implement the Vision Zero Strategy worldwide.

These Seven Golden Rules are:

1 Take Leadership and Commitment
2 Identify Hazards and Risks
3 Set Safety and Health Targets
4 Ensure a Safe System
5 Use Safe and Healthy Technology
6 Improve Qualification of the Miners
7 Invest in People

The presentation will demonstrate examples showing that the Vision Zero strategy is not an illusion but a realistic goal, which can be achieved in mining.

Ehnes
ISSA Mining, BG RCI

Blended learning, a concept and its implementation using the example of fork lift trucks training

The technical training of RWE generation SE employees in Germany, is realized by Technical training Department, realizing approximately 10,000 training programs per year in 350 different types of events.

Most of the technical training programs are for Craftsmen, technicians and engineers of various disciplines. The predominant form of training is classroom training.

For these very different target groups were different blended learning solutions developed and put into practice. Base for the learning environment is a moodle learning platform, a virtual classroom vitero and a portfolio management system mahara; online training models, Simulators and Web 2.0 tools complement the concepts.

Why did we chose a blended learning concept?

About 85 workers annually need a fork lift truck training. Since September 2013 the former two-day training was replaced by a Blended Learning Concept. In the former training the participants were trained on the first day in theory and tested afterwards.

On the second day the practical training with 2 fork lift trucks took place. With 12 participants the effective driving experience of the learner on the forklift including practical driving test was about one hour. Participants had to spend time with watching without achieving a substantial learning effect.

The new training concept had to comply on one hand with the demands of the DGUV principle 308-001 and on the other hand the transfer orientation should be increased with new learning techniques.

Here, the theoretical learning goals are mediated on a moodle learning platform. The contents are divided into several sessions, added with various media such as WBT's or videos. The participant manages its pace of learning.

After each lesson the participant gets feedback by answering some questions. Within a month the participants must have worked through the theoretical content. In averagde about 4 hours (50 % less time for learning) were needed, which leads to a considerable reduction of time and costs by the new concept.

Many of the participants have no Internet at the work place, so they get a Tablet PC with all necessary permissions are available for the required period. This also allows learning anywhere and anytime.

After completing the theoretical sessions, the one day lasting classroom training starts combined with theoretical and practical components. Participants are paired into groups that work through learning modules. The learn how to handle electric low lift trucks, completed by films for fork lift truck use and occupational safety work, they also perform complex test drives in fork lift truck simulator. Two other groups get practical driver training with individual exercises, in handling and driving a real fork lift truck.

Following the theory test and the road test according to DGUV principle 308-001 occurs.

The effective driving experience, including practical driving test, could be increased from one hour to three hours.

So far we have trained 170 employees under the new approach. As feedback could be received good to excellent reviews. In addition, other benefits could be generated for the participants.

Through the required self-study, an increased self-motivation of the participants could be observed in addition to the self-learning skills. Learning with PC and several media increased media competence.

Initial difficulties of individual participants were solved by telephone coaching. Social skills could be improved by using the integrated forum on the learnin platform.

Further synergies

The whole questions inside the WBT is also used for a profiling tool. Already trained staff can annually process the questionnaire in order to a query of existing knowledge and to raise awareness others in the subject matter. This tool can be used as merely complementary to anually instruction "drive fork lift trucks".

Individual chapters from the WBT can be used for further training, for example: bridge and gantry crane operators, truck loading crane; as well as for training, such as the Machinery Directive, the Pressure Equipment Directive or the Ordinance on Industrial Safety.

Conclusion

All above-mentioned goals have been achieved with implementation of the new learning concept. Learning of theoretical content by small learning sequences and the long period in which participants heve been angaged, achieved an increased learning transfer.

The costs of work time and for coaches could be reduced by 25 %.

Since september 2013 about 170 participants have been implemented in 21 trainings, that resulted in a reduction in costs of approximately € 27,000.

Stock, Schnitzler
RWE Generation SE

Virtual technologies for the maintenance of open-cast mining equipment – The potential of a virtual learning environment for the exchange of the ball bearing on a bucket-wheel excavator in Hambach open-pit mine

RWE Power AG's bucket-wheel excavator 289 was given its first "face-lift" after over thirty years of operation in Hambach open-pit mine. A scheduled overhaul entailed installing a new ball bearing in the giant's slewing superstructure. At the least, a good 5000 tons have to be lift and moved. The 279 stainless steel balls had to be replaced while constantly subjected to a high load. The challenge for engineers and technicians was enormous since each of the 279 balls weighs 135 kilograms, has a diameter of 320 millimeters and bears 18 tons.

Virtual technologies from the Fraunhofer Institute for Factory Operation and Automation IFF were instrumental in the speedy and correct completion of the maintenance action.

Therefore work processes were planned, discussed and evaluated with help of a virtual interactive 3D-model. Since the giant excavator's ball tracks normally only have to be replaces after thirty years of operation, securing know-how is all the more important.

The project resulted in a virtual 3D-model of the bucket-wheel excavator that contains more than 100 steps for the assembly and disassembly of the ball bearing. Each step is connected to additional technical information and key data, such as the height the superstructure is raised and the tools used. The VR experts integrated further information on photos, videos, assembly manuals or design documents at relevant points, thus compiling a virtual manual and documentation. It is the basis for the planning and execution of such maintenance actions and can be used as a documentation tool as well as to support training actions.

Haase
Fraunhofer Institut
Topp
RWE Power

Looking at the mechanical stability of a drilling unit

The English translation of the text was not available at the time of publication. The original text can be found in the German section under A45 Betrachtung der mechanischen Stabilität einer Bohranlage.

Dr. Reiser
TSU e.V. – Verein für Technische Sicherheit und Umweltschutz

EIT Raw Materials – The new EU Knowledge and Innovation Community for Raw Materials

The raw material-related challenges of the EU were tackled by a package of European initiatives – and – for the first time since the European Community on Coal and Steel, positive signals for the raw materials sector and a political will for a re-industrialization of Europe can be observed. Compared with the world powers, the USA, China and Russia, the supply of the EU with existentially important mineral raw materials is clearly considerably lacking behind. Whereas, China, the USA and Russia produce about 47 % of world trade of mineral raw materials (Iron and Ferro-Alloy, Non-Ferrous Metals, Precious Metals, Industrial Minerals & Mineral Fuels), the EU produces only 5,5 %. These results not only pose strategic risks to the EU´s supply, but also to the future industrial development of the EU, which, in any case, is in a critical phase of economically essential re-industrialization.

The aim of the consortium KIC Raw MatTERS (Tackling European Resource Sustainability) makes it necessary to take action and to look across the borders.

The Montanuniversitaet is a successful, excellent and implementation-oriented university with its Core Competence in the Value Cycle Mining, Metals, Materials, Manufacturing and Recycling. The Montanuniversitaet recognizes the global commodity challenges and welcomes the European initiatives and will therefore make a substantial contribution to the solution of key challenges in the raw materials sector.

The ESEE region (East & South-East Europe), where almost 100 million Europeans live in countries like Albania, Austria, Bosnia-Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Greece, Hungary, Kosovo, Montenegro, Macedonia, Romania, Serbia, Slovakia and Slovenia is of utmost importance to the European Union from a political point of view (cohesion, regional development, „Candidate Countries“ and „potential candidates“) and from an economic point of view (security of supply, economic value, employment). The ESEE region is of particular interest due to its unique geological potential and unique potential on secondary raw materials, which makes it also highly relevant in connection with the European commodity strategy.

The ESEE region is geographically and culturally in the immediate and logical scope of the Montanuniversitaet. The promotion of sustainable development in the ESEE raw materials sector is a specific and motivating task for the Montanuniversitaet, which can also serve as an expert in terms of experience and skills.

Thus, the Montanuniversitaet is strongly involved in these European initiatives and is currently developing an effective ESEE – cluster strategy on raw materials, for example:

- Forming a community of industry, research and universities in the ESEE Region
- Aiming at a comprehensive inventory of primary and secondary deposits, abandoned mines, mining enterprises, universities and R&D, reprocessing of known data
- Bridging the gap between high potentials and industrial activities.
- Aiming at compressing information and feasibility studies to bridge the gap between high potentials and industrial activities, junior mining company concept
- Developing industrial projects from primary and secondary resources to generate an added value for the ESEE Region in terms of economic value and in terms of employment
- Developing new mining design for small scale mining
- Exchange of information on Horizon 2020, European Regional Development Fund, European Social fund, Cohesion Fund

Therefore Montanuniversitaet will act as a facilitator between the actors in the ESEE Region and the actors in the KIC. The above mentioned activity is work in progress; new partners from industry or academia are warmly invited to participate.

Prof. Dr. Moser
Montan Universität Leoben

Role of Mining Consultancy for Startup Investors

Turkey's Fina Energy acquired 70 % shares of Polyak Eynez Mining Co., an SPV holding exploration phase mining licenses in Soma Coal basin of Turkey, in 2014 following a DD period of 20 months. The underground mine development actively began subsequent to the grant of operating permits in August '14, targeting the first coal throughput in late 2017 and aiming to an ultimate capacity of 5 m tons annually.

Fina Energy is a part of Fiba Group of Companies, a conglomerate operating mainly in financial and service driven sectors. In this respect, Fina heavily utilized exterior consultants' know-how in mining and technical issues during the DD period. Even after the acquisition Fina and Polyak, as a startup mining company, supported the newly formed mining team with technical assistance from top level engineering consultants.

Both during the pre-acquisition and development phase, DMT has been the primary consultant-partner of Fina Energy and Polyak. The scope of partnership included employment of DMT in project based studies, as well as receiving continuous on-demand support to the management and to the technical team.

In addition to DMT's international reputation in technical competency, the key decision factor for Fina Energy to co-operate with DMT was its independency from any equipment supplier or mine operator. As soon as the initial relationship was established, then another feature came in: that is DMT's highly experienced and client-friendly local office in Turkey, assisting in smooth communications and resolutions. Moreover, DMT experts' ability to arrive at the Polyak mine site from their HQ in a single day in case of urgency significantly contributed to the effectiveness and efficiency of the consultancy services.

DMT has provided the following works during the DD period to Fina Energy:

a) Geological consultancy:
- Examination of the existing drills and exploration activities
- Determination of new drills locations for verification
- Consulting on internationally acknowledged SOPs for drills and reporting
- Advising in Borehole-geophysical logging parameters and application
- Measurement and evaluation of gas content

b) 2D Seismic study:
- Assessment of candidate contractors' equipment and capabilities
- Designing and determination of seismic study parameters – assisting the tests
- Operational bird-dogging to the contractor via periodic site visits
- Data processing
- Interpretation

c) Review of studies prepared by local advisors
(Items (a) and (b) eventually led to the JORC accredited resource report for Polyak site.) And the below for Polyak post acquisition:

d) Support design for inclined drifts:
- Evaluation of geological and geotechnical data
- Strata modelling and numerical analysis
- Selection of applicable supports

e) Consultancy on vertical shaft construction
- Providing guidelines for the pilot drill and required geotechnical tests
- Evaluation of geological and geotechnical data
- Strata modelling and numerical analysis
- Geotechnical assessment of the candidate contractors' shaft sinking method in terms ofsite specific applicability (including on-site investigations in China)
- Preparation of shaft support design
- (Next: Construction audits)

(Project pipeline: Review of and Expanding on Mine Plans, Consultancy on Surface Facilities Layout)

Fina Energy/Polyak and DMT has displayed a fine example of co-operation between a financial investor and a mining consultancy firm in the pre-acquisition period, and the same continues as between a startup mine company and an engineering services provider. Such partnership not only helps Polyak with adapting the best industry practices in its current operations but also serves a long term vision to be a world-scale mine operator via importing know-how to the developing in-house team.

Engin, Kutay
Fina Enerji Holding A.Ş., Türkei

The Circum Minerals Dallol Potash exploration project – mining at the hottest place on the habitated earth

Circum Minerals Limited, incorporated in 2011, has acquired the rights to explore within a potentially significant potash deposit in the Danakil Depression of Ethiopia. The area covered by the current exploration license is comprised of two leases held before in the name of G&B Central African Resources Limited. These two leases are referred to as Danakil (324.7 km2) and Bada (40.4 km2) with a combined area of 365.1 km^2.

The results of an extensive exploration drilling program undertaken by Circum during 2013 and 2014 and results from previous drilling conducted in 2011 and 2012 as well as chemical assays of the drill cores and results from downhole geophysical measurements have been incorporated into a resource model which was used to estimate the mineral resource and facilitate preliminary mining and also processing studies. In conjunction with Circum's geological and technical team, K-UTEC has developed a number of potential exploitation scenarios for this resource which includes a preliminary estimation of capital and operating costs within a 43.101 Detailed-Feasibility Study. The subsequent modelling of cash flow has facilitated a preliminary economic assessment.

All this has been done under the extremely hostile work situation at the "hottest place on the habitated world (Wikipedia)"

Schicht, Allendorf-Schicht, Dr. Fliß, Dr. Asemann
K-UTEC AG Salt Technologies

Gold Plata Project Peru

The presentation was not available at the time of publication, but can be found online at www.the-miningforum.com after the event.

Juilland
Goldplata Mining International Corporation

Development of a Greenfield Copper Open Pit Project in Turkey

In the north of Turkey close to the township Hanönü the Turkish company ASYA Madencilik AŞ (ASYA) is holding a license that is part of a copper bearing formation. The property is located in the metallogenic belt of the Central Pontides, which hosts numerous volcanogenic massive sulphide (VMS) deposits. The dominating mineral in the ore is pyrite. Chalcopyrite occurs in small layers. More seldom sphalerite is mineralized. The grain size is small and the mineralization takes place in-between small grain sized quartz and feldspar.

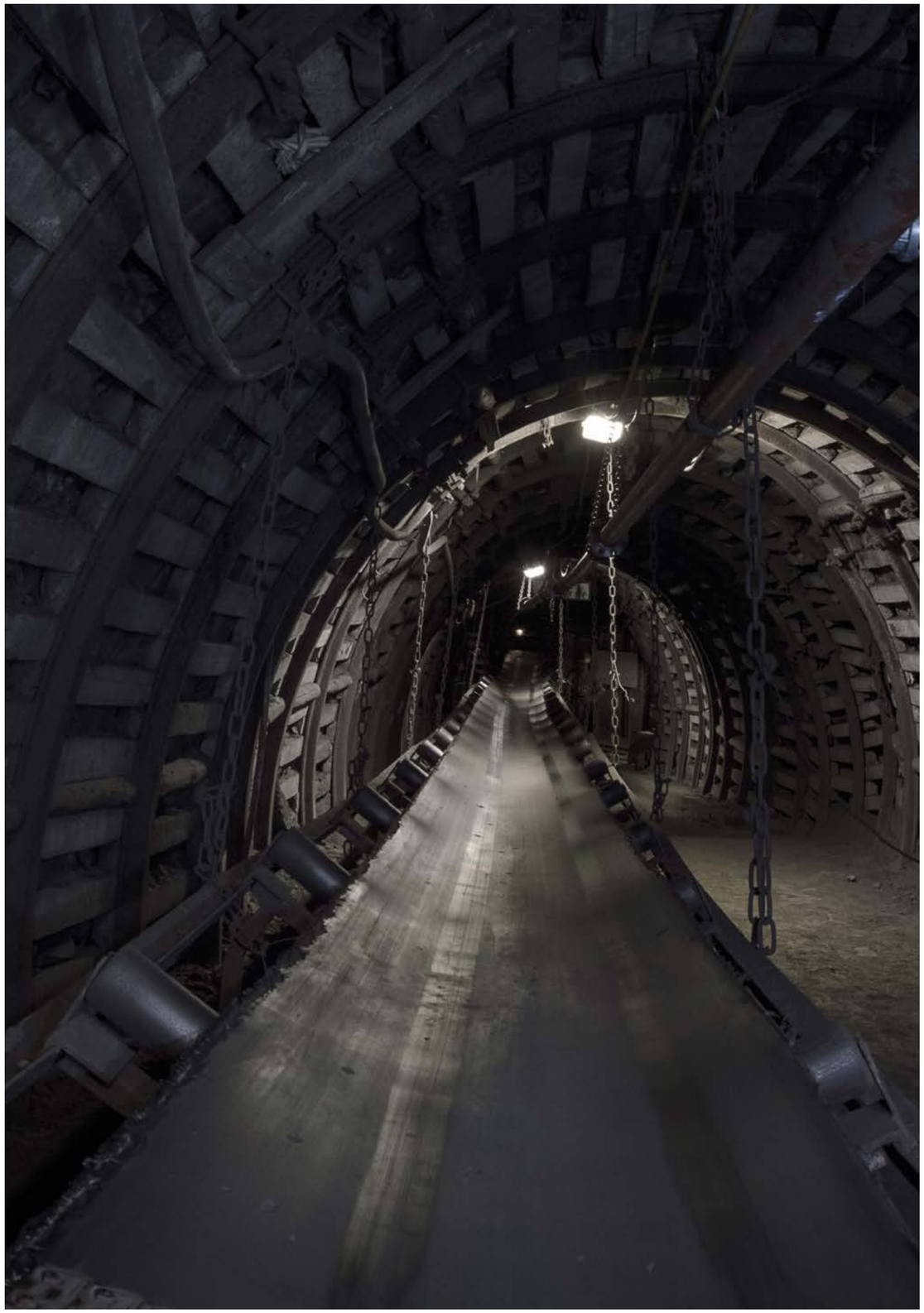
Extensive exploration has been conducted in different phases on the license area since 2007, and since 2012 it is carried out with assistance of DMT as consulting geologists. The exploration revealed substantial Cu-mineralization in the north-western part of the license area. The mineral exploration activities in the license area covered a broad spectrum of geologic, geochemical and geotechnical investigations. This included geological mapping, drilling of more than 180 boreholes, geophysical well logging and geochemical rock analyses. Based on the acquired data a 3D geological model was created that shows over 130 mineralized blocks. For the 3D block model a total of 128 drill holes (> 39.000 m drilled) located in the main mineralized sector in the north-west were used for resource estimation, which revealed substantial VMS-type copper mineralization within the meta-volcanic and meta-sedimentary basement rocks. Detailed inspection of these results yielded an average copper grade of 1.6 wt % in the ore bodies when no cut off is applied, and a total mineral resource of about 20 Mt ore.

Additionally to the resource definition program an intensive geotechnical investigation program was carried for the excavation planning. It included geotechnical core logging, surface mapping of joints and other discontinuities, interpretation of televiewer logs, sampling of rock and drill core and rock mechanical testing. Based on these data a detailed geotechnical characterization of the different main lithologies and a rock mass rating could be performed. The orientation data from core and well logging together with the rock mechanical laboratory results i.e. on the shear parameters were applied for a rock slope stability assessment, which included the calculation of the safety factor of the pit slopes and benches and the probability of failure.

In order to determine the ultimate pit (the most economical pit), a pit optimization was carried out by DMT, using NPV Scheduler software. Based on the optimization results an engineered pit was created, which served as basis for the further mine planning and scheduling. These results together with the studies on processing (carried out in South Africa and Turkey), infrastructure, marketing and economic feasibility will allow an estimate on the copper reserves.

An initial Feasibilty Study has been prepared and currently arranging of international project financing is underway which requires some updating of the initial Feasibility Study. Nevertheless Ilbak Holding, the owner of Asya Maden committed itself to the project by already starting construction work on the processing plant prior to finalization of the financing.

Sali
Asya Maden İşletmeleri A.Ş, Türkei;
Wagner
DMT GmbH & Co. KG



Hyperspectral and geochemical exploration at Tunnel Creek, Western Australia – results from the GMES4Mining project

GMES4Mining is a R&D project financed by the EU and Federal State of North Rhine Westphalia with the aim of developing multi-sensorial analytical methods to improve mining activities from early exploration stages through to mine closure and rehabilitation. In particular, the application of multi- and hyperspectral remote sensing techniques in combination with surface data are investigated.

A 52 km^2 area approximately 90 km south west of Newman, Western Australia, has been selected for an airborne hyper-spectral survey as well as soil geochemical investigations. The target area is located on the Ashburton structural corridor where several Pb/Zn/Au prospects and mines are under development or in operation, respectively. During 2013 a lithologic mapping and rock chip sampling campaign, performed by Force Consulting on behalf of Iron Bull Mining and Fortescue Metals Group in the target area identified several gossanous areas and alteration zones with elevated concentrations of base metals. Alterations seem to be linked to the calcareous-shaly Irregully Formation. In addition, vein zones associated with strong silica - clay alteration within fine grained clastic sediments of the Wyloo Group have been identified. These anomalous areas together with the structural setting confirm the high geologic potential for buried mineral deposits (Geerdts, 2013) within the target area.

In an attempt to refine the extent and type of alteration zones as well as to possibly identify additional target areas, an airborne hyperspectral survey, followed by a geochemical exploration campaign will be conducted during 2015. Hyperspectral data will be imaged by two Hyspex sensors in the range of 0.4 - 2.5 µm. The spatial resolution will reach approximately 1 m^2. The obtained hyperspectral data will be atmospherically and geometrically corrected using simultaneously acquired Lidar data. XRF-analysis of soil samples with a sample spacing of 500 m will provide geochemical information, which will enable comparison of soil geochemical anomalies with hyperspectral data.

Dr. Pakzad
EFTAS
Mittelstädt
DMT GmbH & Co. KG

Airborne Gravimetry in Germany and worldwide – current state and perspectives, technologically and economically

Gravimetric (and magnetic) data are highly beneficial for prospection, tectonics, geological mass balances and geodesy (e.g. geoid determination). The according measurement technologies can be utilized for airborne application. Compared to land and marine gravimetry the use of aircraft significantly increases the efficiency of investigating larger areas. In this presentation the current state and perspectives will be discussed regarding technological and economical aspects.

For most purposes measuring the magnitude of the gravitation vector is sufficient, as directional deviations in earth's gravitational field are very small. Vector gravimetry has been investigated, but is not operationally available. Detection of small-scale anomalies (approx. < 2km) is instead done using gravity gradiometers, whereas their suitability for the detection of large-scale variations is limited due to the drift of gravity-gradiometer sensors. Today (electro-) mechanical sensors are used but in near future quantum optical sensors will be feasible.

Cost per line kilometre of scalar airborne gravimetry is 10 times higher compared to airborne magnetics, and cost of airborne gravity gradiometry about 100 times. Therefore, method and extent must be attuned to the expected economical potential of the deposit expected.

The sole German manufacturer for gravimeters on moving platforms is Bodensee Gravitymeter Geosystem GmbH producing marine gravimeters. Worldwide, there are two Russian and two North American manufacturers of scalar gravimeters. Gravity gradiometers are individual items.

There is solely one commercial provider of airborne gravimetry in Germany (Gravionic GmbH, using an enhanced Russian system). Federal Institute for Geosciences and Natural Resources (BGR), Geoforschungszentrum Potsdam (GFZ) und Alfred-Wegener-Institut (AWI) conduct airborne gravimetry missions within their own scientific aims. Besides the European provider Compagnie Générale de Géophysique-Veritas (CGG, France), the worldwide market is dominated by few Canadian and US-American companies. Only a very little number of gravity gradiometers are in use.

An objective assessment of the usefulness and gains of airborne gravimetry is very difficult due to the lack of a common worldwide scientific community and the competitive situation of the involved parties. In the future manufacturer of gravimeter systems, flight operators, data evaluators and geological interpreters shall cooperate interdisciplinary for developing and utilizing new efficient and environmentally friendly approaches for prospection.

Pätzold
TU Braunschweig

Research@ZaB – research, training und education in the Zentrum am Berg

Austria has a lot of high mountains and due to increasing mobility also a lot of tunnels. It was Rabcewicz who presented a new tunnelling method at a congress in Salzburg in 1962, where he stated that rock surrounding an underground structure has a self carrying capacity and with the new proposed tunnelling method this capacity will be used. He named this method the New Austrian Tunnelling Method, which is nowadays well known as NATM worldwide. The high interest for seminars and even master courses in NATM tunnelling worldwide states the still high interest in this method.

But the development of a tunnelling method is just one piece of the puzzle in underground engineering. All at all we have to focus on underground constructions which can be operated safely – so safety and security are getting more and more priority. Latest with the catastrophies in the Gotthard- and also in the Tauerntunnel around the year of 2000 showed that underground engineering has to incooperate knowledge from many other fields to be able to handle such situations.

For the development of construction technologies, but also for doing research on new materials and equipment – starting from the ventilation ending up at the safety- and security installations like fire fighting systems in tunnels, realistic surrounding conditions where not available. Of course tests in large scale laboratories, like tests on tubbing elements are indispensable necessary. However, if we want to study the whole tunnel system behaviour these tests are not able to deliver all required information – and scenarios of real catastrophies cannot be studied in tunnels which are already under operation. Such tests are very costly, as the tunnels have to be closed during the testing period and the traffic has to be redirected during this time. Furthermore tests regarding fires have to be done with highly reduced fire loads compared to real situations; otherwise the tunnel structures would be severely damaged.

The underground research center ZaB – Zentrum am Berg, using old tunnel systems of an underground ire ore mine will close the gap between laboratory tests and real conditions. All at all 5 real scale infrastructure tunnels are foreseen to be available for research, rescue teams, fire brigades etc. and of course also for the industry. Two tunnel tubes are built with a cross section of motorway tunnels, two more are built with a cross section of high speed railway single track tunnels and one more tunnel will include an underground field of 200 m times 1000 m, which is available for any future underground tests. The overburden for the tunnel system consisting of about 3 km of tunnels will reach from 300 m to very shallow situations.

From the very beginning on it is intended that students are involved in all underground works, so that they get the possibility to fully understand all methods used in geotechnical engineering. Practical works at the ZaB – Zentrum am Berg is also incooperated in the curriculum of students of the Montanuniversitaet Leoben studying Mining and Tunnelling with a special focus in the field of geotechnics and tunnelling.

Scientists of other universities already show interest in using the test facility for their research fields, e.g. researchers of Graz University of Technology are intending to test existing and new ventilation concepts for underground structures. So for example the spreading of gases and the required equipment from the safety point of view will be studied in detail.

About 50 enterprises have already signed for projects to be done in the area of ZaB; the project ideas reach from the construction sector to the field of informatics.

The area of ZaB will also contain a safety and training center where disaster scenarios like tunnel fires can be trained so that the rescue teams are better prepared for such scenarios for the future. Futhermore, it is intended that all users of infrastructures are able to look for all the equipment in tunnels, so that in case of an emergency in an underground structure they are informed which installations to find where and for example how to open cross passage doors while ventilation is working. So the intention is to train people like in a civil building, where it also should be clear which installations for safety and security can be found where.

One further essential topic is the renovation of existing infrastructures. As the old tunnel system at Erzberg has quite small cross sections they have to be enlarged to fulfill the new safety regulations. So the ZaB will also be an ideal place for research and development regarding this technologies.

Prof. Dr. Galler
Montan Universität Leoben

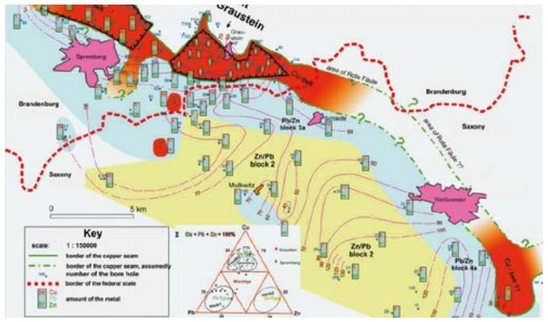
Exploration and mining of Kupferschiefer deposits

In South America, copper mining takes place on a vast scale on sulfidic "mass ores" of type "copper porphyries". These deposits provide the bulk of the world copper production. Also in Central Europe are enormous copper ore deposits exist, which are bound to the Zechstein base and the top layer sequences of Upper Permian and have become well known through the copper shale mining.

Kupferschiefer mining is almost exclusively known from Germany and Poland. Geologically, Kupferschiefer copper-silver deposits are located – similar to the European potash mining – and operated in the vicinity of saline horizons at the base of the Zechstein strata. Spatially, Kupferschiefer and potash mining are located near the sub-outcrops of the Zechstein salts, a zone in which the Zechstein salinars are subjected of significant subrosion processes. The hydrological potential of the hazards associated with this mining require special safety measures, which are not known nor applied in the standard underground hard rock mining operation. From the mining and regional geological point of view is the most important prerequisite for any exploration and mining campaign: to conduct a comprehensive study of the saline layer sequences. To assess the potential hydrological dangers to the mining operation, a comprehensive geological study is required that is based on a detailed knowledge of the stratigraphy and paleogeography and especially the tectonic style of the salt layers in the exploration area. Already in the exploration phase, both general and very specific premises of the deposit geology must be met:

- Selection and location of the drilling sites must be made on the basis of a modern exploration concept according to the Kupferschiefer-relevant professional and rational point of view.
- Probability of the expected exploration success must be reason able in relation to exploration expense, wherein coordinated exploration stages and exploration historical results are taken into account.
- The exploration professional must have the knowledge and experience to conduct a technically correct investigative process of this Kupferschiefer type of deposit – a type of sediment hosted, geochemically controlled deposit, bound to the Zechstein-salinar.

Past exploration and development efforts have failed because of the inexperience of the professionals in charge. And efforts lead to success where experience and knowledge is applied, e.g. in the Lubin district. To illustrate: One common fallacy of exploration campaigns is the plan to drill too dense a pattern to satisfy the requirements of international ore reserve classifications (NI 43-101 and JORC Code) and as such to disregard the Polish experience.From active Kupferschiefer mines we know that the safety pillar for exploration drill holes from the surface to the deposit usually requires a underground safety diameter of usually 100 meters. Disregarding this knowledge and placing drill holes too close to each other carries the risk of destroying the mineability of the reserves of the deposit. In order to conduct a successful Kupferschiefer copper-silver-gold exploration campaign the available modern and historic experience and expertise in East Germany and especially in Poland needs to be employed. The copper-silver deposit Spremberg (see figure), arrayed in the typical shape of consecutive metallic zones, shows how the international ore reserve standards can be met with a manageable number of exploration drilling holes.



The deposit that is covered by salt strata contains another danger to the mining operation: Areas with facies-changes in a small space, like for example of the Werra Anhydrite to the Werra Salt, may be dangerous. Here, the presence of water-filled cavities - the so-called „Schlotten" - can be expected. These can cause an abrupt water inflow that may represent an unsafe situation for the miners and the mine. The intersection by underground drilling or stoping of such areas should therefore be made only with the utmost security measures, but if possible completely avoided.

Exploration, mine development and underground mining have to interface from the beginning of the campaign in order to be successful and safe.

Kopp, Schleuter

Spieth
VS.GLOBALMETALL LLC.

International Project Work in Pakistan – The Barite Lead Zinc Project

In December 2012 IMC-Montan Consulting GmbH (IMC) now DMT Consulting GmbH (DMTC) has signed a contract with Bolan Mining Enterprises (BME), a joint venture between the Government of Balochistan (GoB) and Pakistan Petroleum Limited (PPL), for the execution of a pre feasibility (PFS) and feasibility study (FS) according to international standard on a Lead/Zinc/ Barite deposit in Balochistan region Pakistan.

The contract includes the supervision of at least 2,100 meter of drilling to prove the northward continuity of mineralization along strike and dip to establish a resource base with combined (barite)-lead-zinc. The first drilling program has been finished successfully and a second for infill drilling has been initiated. Samples have been prepared and were analyzed by SGS in Pakistan and Canada.

On the basis of available core samples a processing sample has been prepared and sent to a laboratory in Poland for bench scale tests. In May 2015 these tests have been finalized and lead, zinc and lead-zinc-bulk concentrates as well as barite concentrate according to API specifications were produced.

At the moment a PFS is under preparation in order to evaluate several alternatives of the project and conclude the economic feasibility to receive an initial planning with a +/- 25 % cost accuracy.

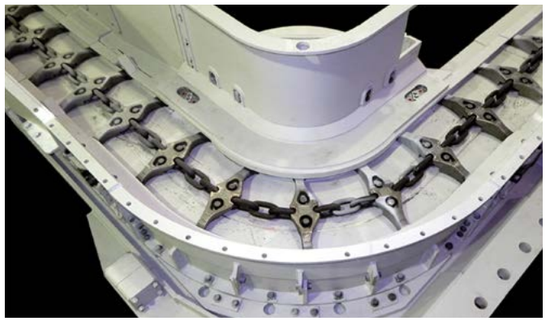
Beier
DMT GmbH & Co. KG

Updating Turkish Mining Plants

Mining is an important economic factor in Turkey and especially lignite plays a prominent role for the local energy supply with coal-fired power plants. In spite of this importance Turkish mining plants stayed beyond their means referring to mining methods. In many places conventional mining methods with manual operations are still carried out. In the hand-got faces a lot of miners are drilling and blasting manual and are shoveling the coal onto a small conveyor. The line pans are slim and lightweight, so that they can be moved over separately by hand. This applies also for the roof support.

Concerning this matter some mining plants, like Cairan for example, are an exception and be seen as pioneers of the updating in Turkish mining plants, which is in progress more and more. Adularia, Hema and Imbat can be mentioned as concrete examples. Adularia already uses modern conveyor technology partly, whereas other mining plants want to change their machinery stepwise and search for transitional solutions. Halbach & Braun finds an individual solution for every customer.

Halbach & Braun developed a special concept for this customer and carried it out in cooperation with a Chinese manufacturer of roof supports and a Polish manufacturer of conveyor and winning machines. The special characteristic of the project for the Imbat mining plant is the combination of two conveyors in the longwall face.



A classic armed face conveyor with a shearer loader as winning machine is positioned directly to the coal face. A second conveyor is positioned between the roof support and the waste area. Through opening a ceiling flap of the roof support the coal falls directly onto the conveyor and gets transported to the gate-road. The HB Rollercurve is the transition between longwall face and gate-road.

Braun
Halbach & Braun

Innovative approach for monitoring and inspection of deep mine shafts

Typically high-performance underground mining operations are producing closely to their capacity limits. Therefore undisturbed 24 hours operability of the shafts is essential for the success of the mining operation. Due to the permanent use of the shaft, the shaft installations are subject of wear. In addition commonly the shaft safety pillar is mined and this affects the shaft or parts of the shaft. Therefore it is important for mines to monitor the shaft carefully to avoid any damage and to start maintenance and repair before any safety risk can occur.

Within this paper a new approach for safe, fast and highly accurate monitoring of deep mine shafts will be presented. Two systems for the measurements inside the shafts are available for empty and equipped shafts in all phases, from sinking through equipping and operation to abandoning. All data registered by these systems will directly be evaluated and analyzed in an integrated informational support system.

At first the two surveying systems, one for shafts with hoist cage or skip installations and one for shafts without any installations, will be presented by examples from real projects. The achieved results will clearly illustrate how accurate, safe and effective the systems are working.

Within the second part of the presentation, the integration of the results from the shaft survey into an integrated informational support system will be presented. Even the system has the capability to support a shaft project during its entire life cycle; from planning phase, through shaft design, modelling of ground freezing-thawing scenarios, geotechnical monitoring and modelling of rock conditions and lining strength; the main focus within this presentation is on survey support from shaft sinking through shaft inspections during normal operations up to abandoning of shafts.

Bennecke, Weber
DMT GmbH & Co. KG
Reznichenko, Vorobyov
Sight Power Inc.

Integrated data management system with particular emphasis on potash mining

The integrated informational support system by Sight Power is focusing on development of enterprise-scale 3D spatial data systems for potash mining corporations including extended set of tools designed for intelligent geological modelling, mine design and mine planning, surveying (in particular with the use of laser scanners) and general mining operations support. The system shall provide secure fast and convenient access to the data and derivative data models for mining engineers, geologists, surveyors, mechanical and electrical engineers, geotechnical engineers, geophysicists, operational personnel and managers. The development of efficient and intelligent information workflows allows to effectively use versatile types of spatial data (geological, geophysical including seismic, hydro-geological, GIS etc.), engineering and surveying data (mining plans, mining equipment parameters, hoisting operational data, monitoring and dispatch data etc.), and geochemical data (ore samples and assay analysis). This results in better decision making by management, operational effectiveness and risk mitigation, clear reporting and simplified document flow and ultimately in safer in more profitable mining operations.

Monastyrov, Reznichenko, Vorobyov
Sight Power Inc.

The Vision of activated rock excavation machines – future or fiction?

Mechanical rock excavation processes ensure an almost continuous extraction process, due to the possible combination of extraction, loading and transport. Challenging, especially in hard rock or highly abrasive rock formations are high wear rates of tools, leading to high maintenance costs and long downtimes. As well the energy consumption is an expensive factor for mining operations.

During the last decades a lot of time and scientific effort was carried out to improve excavation technologies by a so-called activation of excavation processes e.g. by high pressure water jets or an activation of tools. The findings of the related researches have revealed a huge potential of those technologies.

Therefore, prototypes of rock excavation machines applying those technologies have been designed and manufactured by different global mining OEMs. Details on these rock excavation machines are mostly unpublished and often company secrets but first field tests under real conditions revealed promising results for those excavation machines.

This publication summarizes and explains the principles of current and also emerging technologies. Subsequently, the latest developments of activated technologies in mining industry are analyzed and their potential is evaluated. Finally an overview about actual and planned research projects of Department for Mining and Metallurgical Machinery (IMR), RWTH Aachen is given.

Philipp, Dr. Bartnitzki
RWTH Aachen

Redevelopment of the East Kemptville Tin-Zinc-Copper-Indium Mine, Nova Scotia, Canada

The East Kemptville property, a former tin-zinc-copper producer, is located in Nova Scotia, Canada. Tin mineralization was discovered in 1978 as a follow-up to regional geochemical till sampling. The mine was operated from 1985 to 1992 by Rio Algom Limited, when operations ceased largely due to low tin prices. At the time it was the only large tin producer in North America. Avalon Rare Metals Inc. acquired the mineral rights in 2006 and is advancing the project, including definition drilling, metallurgical test work and environmental baseline studies. Tin prices have been strong in the past few years due to imbalance between supply and demand, and it is generally predicted that prices will remain strong in the near future.

Avalon has published an estimated Indicated Mineral Resource of 18.47 million tonnes averaging 0.176 % tin, 0.173 % zinc and 0.064 % copper and with additional estimated Inferred Mineral Resource of 16.95 million tonnes averaging 0.148 % tin, 0.122% zinc and 0.062 % copper at a 0.10 % tin cutoff grade prepared under the Canadian National Instrument 43-101. These resources compare to the 18.8 million tonnes previously mined and processed prior to closure, thus at least 2/3rds of the original resource remains unmined with potential for expansion with further drilling. In addition, there are at least two other areas of mineralization that may increase the total resources on the property, the most significant one being the Duck Pond Zone.

The main known deposits, the Main and Baby Zones, are within the South Mountain Batholith (SMB), a large 370 million year old assemblage of granitic intrusives. The mineralization is part of the belt of Variscan / Hercynian-age tin deposits that stretch from Erzgebirge in Germany, through Cornwall and Spain, to the Canadian Appalachians. The deposits are hosted in a small body of leucocratic granite that is on the margin of the SMB. Cassiterite mineralization occurs in veins and adjacent zoned greisen on the centimetre scale, as well as massive greisen on the metre scale.The greisen alteration shows a sequence of progressive alteration from the fresh leucogranite with quartz, two feldspars, muscovite and topaz to a rock dominated by quartz, mica and topaz. Quartz-sulphide veins were emplaced later than the greisen and contain pyrite, sphalerite and chalcopyrite as well as cassiterite.

The Duck Pond Tin deposit, in contrast, is an array of veins hosted in deformed Paleozoic metasedimentary rocks of the Meguma Group. In contrast to the greisen deposits, at Duck Pond the cassiterite along with sphalerite and chalcopyrite mineralization is hosted in several cross cutting vein sets accompanied by chloritic alteration. There is no chlorite alteration in the Main and Baby Zones. It is possible that Duck Pond represents “leakage” above a granitic intrusive at depth, as indicated by a prominent airborne magnetic high coincident with the Duck Pond that is not explained by the known deposit.

As well as Sn, Zn and Cu, East Kemptville has potential for by-product indium, silver and gold. Indium was not analysed for historically however Avalon’s recent drilling has demonstrated significant indium enrichment in the greisen mineralization. Recent microprobe data indicates that most indium is hosted in sphalerite and will report to the zinc concentrate.

The company has completed an initial economic study on the potential for redevelopment of the deposit including preliminary mine design, metallurgical flow sheet development as well as capital and operating cost estimates. Long term average price assumptions of US$ 23,500 per tonne for tin, US$ 1.00/lb for zinc and US$ 3.00/lb for copper yielded positive economics and a recommendation for proceeding to a feasibility study.

There are unique challenges in exploration and development due to the former mining activities such as having to drill off deposits under flooded open pits. Also, the site is presently operated as a closed mine site, with water treatment facilities for acid rock drainage. This will have to be taken into account in future development plans.

Mercer
Avalon Rare Metals Inc.

Copernicus, Sentinel and post-mining – a contribution to a better understanding of modern monitoring systems

Germany is still a country with a strong mining sector. The current domestically sourced production of raw materials covers approximately 70 % of the total demand for resources in Germany. The mining process starts with the exploration of the deposit and ends with the proper safekeeping of the mine and the conversion of the influenced area. Due to centuries-old mining activities and very high production rates, it is not surprising that Germany is characterised by a large post-mining sector. The past 50 years have seen a significant reduction in the number of active mines so that in Germany more than 250 mines have been shut down. Approximately 20 % of this total relates to metal ore mines and more than 50 % to underground hard coal mines.

As it is not just Germany that is affected by mine closures, the subject is of global significance, posing a challenge for cities, regions and governments all over the world. The main reasons for this include reservoir conditions, production costs, popular resistance and environmental regulations. It is obvious that there is a big demand for environmentally compatible and efficient methods for the post-mining phase. The medium water is very important in this context. Nearly all mining plants have to deal with water, drainage and possibly with the clarification. In the active as well as in the post-mining phase it is important for the mining companies and the mining authorities to consider the EU Water Framework Directive.

The provision of the security of the surface in old mining areas yields a major challenge in this context. To establish a successful reuse of the influenced areas, it is necessary to avoid instabilities above shafts, adits and subsurface mine openings. According to court decisions of recent years the last mining operator is obliged to deal with the whole post mining process.

Against this background, the research activities of the Post-Mining Research Institute at the University of Applied Sciences TFH Georg Agricola Bochum focus on the flooding of underground openings, water bearing adits, subsurface mine openings and on international experiences with mine closure. Very important is an efficient monitoring of the post-mining processes. Besides local investigations, it is absolutely necessary to have spatial data.

At this point the space flight strategy of the German government of 2010 comes into focus. According to this, space flight is an important instrument for the economic system, the sciences, the politics and the society. Particular emphasis is given to the significance of space flight for innovations, growth, jobs, quality of living and environmental safety. In order to substantiate the strategy, the European Union and the European Space Agency established the satellite mission program "Copernicus". Copernicus builds up a modern and strong infrastructure for monitoring the earth and for geo-information services. The task of this project is to supply the experts with remote sensing data. Seven satellites will be developed especially for this mission. The name of the satellites is Sentinel. The earth observation satellite Sentinel-1 is in operation since April 2014. Sentinel-2 will be launched on schedule in June 2015.

In Cooperation with EFTAS, DMT and other partners the Post-Mining Research Institute is working on the application of satellite data for remote sensing and monitoring of concrete post-mining processes. Particular emphasis is placed on the hydrochemistry of water bodies, the soil water content, the land use and the land coverage. With respect to the potentials of the Copernicus-program and the reliability of the data provision, the connection between information provided by the satellites and terrestrial expertise will lead to an innovation of monitoring. As a consequence, we will be able to reduce post-mining risks and increase post-mining chances like the valorisation of mining infrastructures for the recovery of renewable energy.

Dr. Goerke-Mallet
TFH Georg Agricola

The Mining Rights Management (Bergrechteverwaltung) division of Immobilien Freistaat Bayern – Disused mines

How is the state-owned Immobilien Freistaat Bayern involved with mining and mining rights management?

The Free State of Bavaria was previously the owner of more than 500 publicly-owned mine fields, of which more than 60 remain in its hands today. The management of these fields and the mining work carried out in them was transferred from the Bavarian Ministry for Finance, State Development and Home to the Immobilien Freistaat Bayern in 2008. The project group established for this purpose – The Mining Rights Management (Bergrechteverwaltung) of the Immobilien Freistaat Bayern – is staffed by an interdisciplinary group of five members, which are divided into two specialised areas of responsibility. The main responsibilities of the Administration Section includes the assessment of mining property based on the information available from the records of former mine operators, archives and official departments such as mining authorities. It is also responsible for the administrative supervision of safeguarding measures and final documentation. The Mining Technology Section is responsible for assessing and evaluating the risk potential of disused mining property, stipulating the required safeguarding and sealing measures in co-ordination with relevant competent authorities (e.g. mining, bat conservation, monument protection authorities) and supervising the implementation of subcontracted work. The Mining Technology Section is also responsible for monitoring property and recording damage that may be attributable to mining.

The work of the Mining Rights Management is presented using the example of the long-term safeguarding measures undertaken on the sinkhole of 1940. The safeguarding measures are supervised by the Leipzig branch office of DMT GmbH & Co. KG and are carried out by Feldhaus Bergbau GmbH & Co. KG. The sinkhole of 1940 was filled with incidental materials in the 1940s without any knowledge of the underground conditions. A house was built within the area affected by the sinkhole in the 1950s. That house is still inhabited today. During the safeguarding work, an open shaft and open cavities were discovered under the neighbouring district road, which, as an approach road to the A8, is extremely busy. These will be made safe in stages after the completion of the safeguarding work on the sinkhole of 1940.

Lorenz
Immobilie Freistaat Bayern

Eliminating hazards at an industrial site in Zwickau by making two disused hard-coal shafts permanently safe

The English translation of the text was not available at the time of publication. The original text can be found in the German section under A63 Gefahrenbeseitigung auf einem Industriestandort in Zwickau durch die dauerstandsichere Verwahrung von zwei alten Steinkohlenschächten.

Kühn
Sächsisches Oberbergamt
Henkel
TABERG-Ost GmbH
Dr. Birndt, Kowarik
DMT GmbH & Co. KG

Synopsis – The Evolution of Large AC Mine Hoists Systems

This presentation examines the development of AC drive systems and the associated motor technologies. It discusses the various types of components and technologies including cyclo-convertors, voltage sourced inverters, synchronous motors and induction motors with a comparative review of the facilities and features provided.

The focus then moves to explore the major benefits available to hoist operators provided by GE Power Conversion's overhung High Performance Induction motor fed by a Medium Voltage PWM drive (MV7000) featuring Active Front end technology. By applying modern control techniques for the design of the complete drive system and coupling this with the inherently robust construction of the motors the end user is provided with:

- Increased system reliability
- Improved low speed capabilities
- Lower maintenance costs
- Improved power system harmonics
- Power factor compensation

The presentation then explores how the application of higher modulation frequencies of the PWM switching used for the line inverters made possible with IEGT technology can simplify the management of harmonic content seen at the Point of Common Coupling. Further consideration is then given to how the selection of multiple drive configurations can with the application of state of the art switching patterns can be used to further reduce the harmonic content seen at the PCC.

The presentation concludes with details of example systems implemented by GE Power Conversion in Canada and Southern Africa.

Noy, Castel
GE Power Conversion, Deutschland / UK

Shaft reclamation of old abandoned ore mines – development of an expert system and technical guideline

In the Ore Mountains in Saxony, mining activity started in the 12th century.

So this region has more than 800 years of mining tradition. Because of this a lot of knowledge and experience about underground mining was gained here. Also the Freiberg University for mining and technology as the leading university for mining in this area benefits from this.

But this long period of underground mining is also related to a lot of problems, especially with old mine openings and the rehabilitation of those.

In a joint Project of TU-Bergakademie Freiberg and WISMUT GmbH an appraisal of state of the art techniques for closing and sealing constructions and technologies especially for mine openings excavated during uranium mining between 1945 and 1962 has been elaborated

Normally the regarded abandoned mine sites were rehabilitated according to prior art, directly after mine closure. These safeguards were done around 50 years ago. Presently it has been shown, some of this abandoned and rehabilitated sites are not long-term stable according to current definition. For some of the sites it may be necessary to rehabilitate these once again according to the current state of the art.

The work is based on already (since 2003) second time long term stable rehabilitated mine sites. All work carried out as a part of this redevelopment is separately documented for each object. Around 100 documents of rehabilitation of these former mine sites are already available.

The aim of the project is to analyze the technology and materials used for already executed rehabilitations of the sites in the mentioned documents. Furthermore a decision guid-ance to design, creation and documentation further constructions of safety device for another abandoned mine sites should be developed. The ability to capture additional remediation projects with almost unknown properties to the database, as well as the provision of all collected data for further processing with a variety of existing remediation projects and their respective specific and partially unique properties (usage, function, geometry, location and inserted constructions and materials) is standing in the center of the project.

The ambition of the research project is to make it easier, faster and of course more eco-nomical to decide for construction materials and design for other security structures in rehabilitation of former uranium mines. As part of the joint research and development activities, the used technologies become continuously optimized and customized to the international state of the art.

Prof. Mischo, Schreiter
TU Bergakademie Freiberg
Speer
Wismut GmbH

Post Mining in Province Mpumalanga, Republic of South Africa, with support of German province NRW, first steps

Germany, especially NRW, has an excellence experience with the closing of coal mines for a long period. Coal mining was moving north in the Ruhr District which causes closings of coal mines over decades of years. In fact of the dense population in the Ruhr District it was not possible to leave the abandoned mining sites without responsibility. To protect the population it was necessary to secure the abandoned sites.

The moving north of coal mining from near surface mining above the groundwater table to extreme deep mining lead to the fact, that all kinds of mine openings are present from small open pits to extreme deep shafts.

Former prime minister of NRW, Johannes Rau, started a partnership with the province Mpumalanga in South Africa direct after the end of the apartheid system. In the frame of this cooperation some travelling politicians from NRW realized, that acid mine drainages from abandoned hard coal mines cause problems with the environment in that area. Mr. Roger Wolf from GIZ (company for international cooperation) and Professor Dr. Frank Otto from TFH Georg Agricola (University of Applied Sciences) prepared a first overview of the problems on demand of the state chancellery of NRW in autumn 2013. In the focus came two kinds of contaminations: First there are the near surface underground openings of abandoned coal mines which were flooded with rain water. Because of a great amount of Pyrite this water became extreme acid and mineralized. On the other hand there are mountains of fly ashes from burning hard coal deposits beside the power plants. These deposits are open and contaminate the groundwater by leakages as well as the air by dust.

The Council for Geoscience in South Africa has the idea to fill the openings of room-and-pillar mining with a suspension from the fly ashes. With this system the openings cannot collapse anymore and there will be less surface to contaminate rain and groundwater with Pyrite and heavy metals.

A second research trip was embedded in the student's excursion end of May, beginning of June 2014. In winter semester 2014 / 2015 first laboratory tests were done in Bochum with fly ashes from a German power plant to optimize the suspension and see the stability of the hardened material. With these results a next step for cooperation between Mpumalanga and NRW should be started in 2015.

Prof. Dr. Otto
Technische Fachhochschule Georg Agricola, Bochum

Seismological and geotechnical long-term monitoring of an abandoned potash mine

The application of geophysical and geotechnical methods for long-term monitoring in all kinds of mines underground and on the surface became more and more important throughout the last years. During the phases of mining as well as during the phases of back-filling, closing and post-mining the combination of geophysical methods and classical ge-otechnical measurements enable the prove of a long-term evidence in safety for the mine and the public.

Seismological monitoring offers the possibility for a reliable assess-ment of potentially hazard conditions of stability of galleries and voids of the mine or several working districts. Within the monitoring we are able to estimate states of destabilization as well as the hence resulting effects of stress and demands at the surface or the mine caverns. Monitoring can be applied over a very long period of time without entering or frequenting the relevant area. So the method is appro-priate to ensure or increase the safety of the staff, infrastructure and environment.

In the presentation an example of a former potash mine in the South Harz Mountains is shown. The technical possibilities are presented, how to monitor with ingenious methods over a very long period of time – also after closing and leaving the mine. The displayed potash mine was closed in 1993 and is actually in a state of abandonment and a non-guided, independent flooding, which is already finished in some parts of the mine. Here a measuring system is shown, which takes on geophysical monitoring of the seismicity caused by fractures as well as the observation and measurement of flood levels or the density of the dumped salt brines to prove the correct progress of the non-guided flooding. The monitoring can be also realized under hard conditions, e.g. in areas with potentially explosive atmosphere or influence of aggressive brines. This requires several technical conditions of both the transducers and seismometers and the transmission technologies for the signals.

Examples in the presentation show the technique for the measure-ments, the assembly in the mine and on the surface as well as the protection of the transducers and seismometers. Also first results of the measurements are displayed.

Gessert, Thiemann
K-UTEC AG Salt Technologies

Implementation possibilities of micro computers with related sensors for the documentation and evaluation of former mining activities within the scope of risk management at RAG Aktiengesellschaft

In previously active coal mining areas changes to the surface or even sinkholes can appear due to former mining activities. Aim of the monitoring activities within the risk management at RAG Aktien-gesellschaft is the early detection of changes of states in order to carry out required measures preventatively, if necessary.

RAG Aktiengesellschaft is currently developing new methods and systems to enable monitoring of the mining areas Ruhr, Ibbenbüren and Saar in order to optimize the effort.

Against this background, RAG Aktiengesellschaft is examining the use of micro computers and related sensors for the documentation and evaluation of possible changes to former mining activities.

For this reason the suitability of different micro computers and sensors was examined. A test system was developed based on a SWOT-analysis and a number of field trials.

The presented system for monitoring and alerting was tested on a mining shaft due to be renovated and provides the basis for a new, cost effective and innovative monitoring procedure in former mining areas.

Schnell, Koschare
RAG Aktiengesellschaft

Minimizing Impact While Maximizing Returns: Mine Fill Services and Tailings Disposal of High Concentrated Slurry

High concentration slurry in form of paste brings benefits by reducing operating costs and minimizing amount of water sent to the tailings facility for disposal. The decrease in the amount of waste reduces the environmental impact and offers significant environmental and cost benefits for mines. Paste backfill, or cemented paste backfill, is being increasingly used underground.

The composition is primarily mine rejects mixed with binders, which are typically cement and some form of supplementary cementing materials, and water. The role of the binding agents is to develop cohesion and strength within the paste backfill so that the exposed fill faces will be self-supporting and stable when adjacent stopes are extracted.

DMT has pioneered in developing high density backfill material, typically with more than 65-70% solids by weight which targets to produce a pumpable material that does not segregate when placed, and hence does not have fine materials runoff or require removal of significant quantities of bleed water.

In order to pump material at this density, the fines content, particles hydration, and more retained as interstitial water within the fill mass, thus significantly reducing or eliminating the need for drainage. Due to compaction, the constituent particles of a high density paste backfill do not settle out of suspension at zero flow rates. Mixture must be formulated for both placement (rheological properties) and in-situ performance (strength development) purposes. They must have good long-term durability to ensure stability in a given mine environment and meet the limiting strength and the pressures which will be devel-oped in the fill. These tasks successfully get accomplish in DMT's labs.

Lab samples are prepared by crushing coarse rejects to a top size of 08 mm - 05 mm and adding the rejects and tailings according to nominal feed of through put ratios which then gets summarized accounting pump ability and non-settling as two mains KPI's (Key performance indicators).

In this section of conference of mine closure, DMT delineates practical and productive advantages of paste backfilling over hydraulic and pneumatic by choosing some of its fresh ongoing activities in coal, ore and salt mines in domestic and international market.

The paper deals to define a methodological and strategical analysis and approach of paste picking up the pace, by quoting practical examples and case studies from its key projects / clients in Australia, Estonia, Vietnam, Laos, India and few others.

Danish
DMT GmbH & Co. KG

Storage power plant Nant de Drance, Switzerland – Construction of two 430 m pressure shafts

1. Introduction

In the midst of a colossal mountain landscape, between 1,000 m and 2,300 m above sea level, in the border region of French-speaking Switzerland to France, the Swiss companies Alpiq, SBB, IWB and FMV will build one of the currently most innovative power plant projects until 2018 – the 900 MW pumped-storage power plant Nant de Drance. The costs for the overall project are estimated at 1.8 billion CHF. Beside the impressive cavern with a length of 194 m, a width of 32 m, a height of 52 m and the 20 km long tunnel system, the two 430 m deep vertical pressure shafts are the main components of the construction project. "ARGE Schacht NdD", consisting of the companies MARTI Contractors and ÖSTU-STETTIN, was assigned with the construction of the shafts.

2. The pumped-storage power plant Nant de Drance at a glance

Following an approx. 500 m long, conventionally built access tunnel, the approx. 5,600 m long main access tunnel, which was advanced with a hard rock TBM, leads into the machine cavern. From there, an access tunnel with a length of 4,000 m and an inclination of 12 % leads to the shaft head caverns.

The intake waterway consists of two parallel strands. It connects the upper storage lake Vieux Emosson with the lower storage lake Emosson. An approx. 300 m long headrace tunnel (Ø 7.7 m) is followed by the 440 m deep pressure shaft, which leads via the distribution pipeline in the power cavern to respectively 3 pump turbines. The tailrace tunnel (Ø 7.7 m) has a length of 1,200 m. The rock in situ is predominantly granite, metagreywacke and orthogneiss in good to very good condition.

3. Construction of the vertical pressure shafts

ARGE Schacht NdD – MARTI Contractors and ÖSTU-STETTIN – was assigned with the execution of the pressure shafts, which were completed after two years of construction in March 2015. Pilot shafts were drilled with the raise boring method; this was followed by blast widening, the construction of the inner lining and the required injection work. The two shafts, which are identical in construction, consist of three sections: the approx. 23 m deep shaft-collar with approx. 4,100 m³ of volume, the standard cross-section area with an excavation diameter ≥ 8.0 m, and a 9 m deep shaft bottom expansion.

3.1. Raise Boring

The raise boring operations were performed by the ARGE partner MARTI Contractors with a machine of type RBR 600 VF of the company Herrenknecht. The machine has a torque of 600 kNm and a traction power of 10,000 kN. Drilling depths up to 1,000 m and expansion diameters up to 6.0 m can theoretically be achieved with this machine.

3.2 Blast widening

Blast widening was executed by ÖSTU-STETTIN. Furthermore, the hoisting equipment, like rope tower, shaft cover, working platform and winches, was planned, manufactured, delivered and assembled by ÖSTU-STETTIN. The basis for planning and permission were the regulations of the German mining authority (TAS and BVOS). For shaft widening, four winches (conveying winch, platform winch, control cable winch and emergency transport winch) were installed. In the shaft itself, a mobile suspended platform with three levels was used. Passenger, equipment and materials transport were undertaken with the conveying winch, which was designed for a load capacity of 11 t and a max. conveying speed of 130 m/min. Following construction of the shaft-collar and assembly of the complete shaft hoisting system, widening of the pilot shafts was predominantly executed in support class 1. Drilling of the blast-holes was done with a pneumatically operated shaft drilling rig with three carriages and pneumatic drilling hammers drills. The depth of advance was 2 to 2.5 m. As support means, 10 cm of shotcrete with single-layer mesh reinforcement were predominantly installed. Wet shotcrete was used. Concrete transport was undertaken via a free-fall line to a remixer on the platform, from where it was transferred into the concrete pump. Thus, a constant concrete quality could be achieved. The shotcrete was applicated with a manipulator. The average performance for the widening work was approx. 4 m/day.

3.3 Inner lining with sliding method and injections

The at least 40 cm thick, reinforced concrete inner lining was produced using the sliding method. The lowermost and the uppermost 30 m were double-layer reinforced, the remaining shaft section therebetween with a single layer. Together with the subcontractor Bitschnau Gleit & Schalungstechnik GmbH, at an average performance of approx. 7 m/day, a shaft was concreted without interruption in 58 days.

After reaching the required concrete stability of the inner lining, systematic contact injections and, upon geological requirement, consolidation injections with drillhole lengths between 5 and 12 m were executed over the entire depth.

Zmölnig
ÖSTU-STETTIN Hoch- und Tiefbau GmbH

Reflection of Modern Underground Drilling Equipment and Methods

The presentation was not available at the time of publication, but can be found online at www.the-miningforum.com after the event.

Baki
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Verband Bergbau, Geologie und Umwelt e.V

The Association of Mining, Geology and Environment eV (VBGU) is an Employers‘ Association and Trade(-Business) Association. It was established in 1990 in Berlin and is based in the capital. Currently, there are 36 VBGU members. The company with the most employees is the Wismut GmbH.

The association represents the interests of its members to ministries, agencies and authorities at federal level and at land level. The members regularly receive information about current documents of the Federal Republic of Germany and the EU in the departments of work law, waste law, mining law, environment law and water law. The VBGU supports its members in the areas of research and development as well as education and training. For this purpose there are annual colloquiums, field trips and workshops, nationally and inter-nationally. The VBGU is a member in governing bodies of the federal states Saxony, Thuringia and Mecklenburg-West Pomerania and is there partly represented in chairmanships.

The Association of Mining, Geology and Environment e.V. accompanies with its member companies, inter alia, the successful reclamation of mining legacies from the uranium mining in Saxony and Thuringia, formed by the Wismut GmbH. The key note of the VBGU is “Sustainably creating the future together.“

Verband Bergbau, Geologie und Umwelt e.V.
Poststraße 30
10178 Berlin
Germany

Phone: +49 (0)30/400542-70
Fax: +49 (0)30/400542-71
info@vbgu.de

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VDMA Mining
Lyoner Straße 18
60528 Frankfurt am Main
Germany

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Klaus Stöckmann
klaus.stoeckmann@vdma.org

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Germany

www.bartec-mining.com

Contact Persons:
Gerhard Meermann
Phone: +49 (0)2373/684-188
Fax: +49 (0)2373/684-182
gerhard.meermann@me.bartec.de

Ralf Neubert
Phone: +49 (0)2373/684-245
Fax: +49 (0)2373/684-232
ralf.neubert@me.bartec.de

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Germany

Phone: +49 (0)7834/86705-7
Fax: +49 (0)7834/86705-99
info@sachtleben-ms.de

www.sachtleben-ms.de

Contact Person:
Tanja Borho
Phone: +49 (0)7834/86705-82
t.borho@sachtleben-ms.de

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

TSU e.V.
Hersdorfstr.6
99867 Gotha
Germany

Phone: +49 (0)3621/30103-4
Fax: +49 (0)3621/30103-5
info@tsuev.de

www.tsuev.de

Contact Person:
Dipl.-Ing. Hans-Joachim Steinfeld
steinfeld@tsuev.de

Dr.rer.nat. Manfred Wohlrab
wohlrab@tsuev.de

Bentley Systems Germany GmbH

Carl-Zeiss-Ring 5
85737 Ismaning
Germany

Phone: +49 (0)89/962432-0
Fax: +49 (0)89/962432-20

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CFT GmbH Compact Filter Technic

Beisenstraße 39-41
45964 Gladbeck
Germany

Phone: +49 (0)2043/4811-0
Fax: +49 (0)2043/4811-20
mail@cft-gmbh.de

www.cft-gmbh.de

Contact Person:
Corinna Both
Phone: +49 (0)2043/4811-54
corinna.both@cft-gmbh.de

Korfmann Lufttechnik GmbH

Hörder Str. 286
58454 Witten
Germany

Phone: +49 (0)2302/1702-0
Fax: +49 (0)2302/1702-153
info@korfmann.com

www.korfmann.com

Contact Person:
Dipl.-Ing. Hanno Flick
Phone: +49 (0)2302/1702-152
hanno.flick@korfmann.com

PFEIFER DRAKO Drahtseilwerk GmbH & Co. KG.

Rheinstr. 19-23
45478 Muelheim
Germany

www.drako.de

Contact Person:
Jacqueline Müting
Phone: +49 (0)208/42901-39
Mobile: +49 (0)172/5202051
Fax: +49 (0)208/42901-54
mueting.jacqueline@drako.de

SCHACHTBAU NORDHAUSEN GmbH

Industrieweg 2a
99734 Nordhausen
Germany

www.schachtbau.de

Contact Person:
Dipl.-Ing. Ralph Haase
Head of technical office and distribution mining
Phone: +49 (0)3631/6325-32
Mobile: +49 (0)175/1820319
Fax: +49 (0)3631/6325-62
ralph.haase@schachtbau.de

Media Partner

IHU Gesellschaft für Ingenieur-, Hydro- und Umweltgeologie mbH

IHU Gesellschaft für Ingenieur-, Hydro- und Umweltgeologie mbH
Nordhausen am Harz
Am Sportplatz 1
99734 Nordhausen
Germany

Phone: +49 (0)3631/8906-0
Fax: +49 (0)3631/8906-29
info@ihu-gmbh.com

www.ihu-gmbh.com

Contact Person:
Dr. Andreas Schroeter

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Guido Albrecht-Eckhardt
SIEMAG TECBERG GmbH
Kalteiche-Ring 28-32, 35708 Haiger

Olaf Alisch
VBGU - Verband Bergbau, Geologie und Umwelt e.V.
Poststr. 30, 10178 Berlin

Anne Allendorf-Schicht
K-UTEC AG Salt Technologies
Am Petersenschacht 7, 99706 Sondershausen

Prof. Dr. Günther Apel
DMT GmbH & Co.KG
Am Technologiepark 1, 45307 Essen

Lothar Armbrust
K+S Aktiengesellschaft
Schachtstr. 1, 36414 Unterbreizbach

Dr. Volker Asemann
K-UTEC AG Salt Technologies
Am Petersenschacht 7, 99706 Sondershausen

Christian Augustin
Indurad GmbH
Belvedereallee 5, 52070 Aachen

Dr. Thomas Bartnitzki
RWTH Aachen
Wüllnerstr. 2, 52056, Aachen

Dr. Falk Bednorz
Fugro Consult GmbH
Wolfener Straße 36U, 12681 Berlin

Florian Beier
DMT GmbH & Co. KG
Am Technologiepark 1, 45307 Essen

Norbert Benecke
DMT GmbH & Co. KG
Am Technologiepark 1, 45307 Essen

Dr. Heinz Birndt
DMT GmbH & Co. KG
Am Technologiepark 1, 45307 Essen

Silke Bißmann
DMT GmbH & Co. KG
Am Technologiepark 1, 45307 Essen

Eberhard Braun
Halbach & Braun
Am Stahlwerk 11, 45527 Hattingen

Dirk Brinschwitz
Fugro Consult GmbH
Wolfener Straße 36U, 12681 Berlin

Bruno Castel
GE Power Conversion, Deutschland / UK
Boughton Road CV21, 1BU Rugby

Muhammed Danish
DMT GmbH & Co. KG
Am Technologiepark 1, 45307 Essen

Helmut Ehnes
ISSA Mining, BG RCI
Theodor-Heuss-Straße 160, 30853 Langenhagen

Yağız Engin
Fina Enerji Holding A.Ş., Türkei
No:4 Kat:1 A-Blok P.K.34662, Istanbul

Dr. Thomas Fliß
K-UTEC AG Salt Technologies
Am Petersenschacht 7, 99706 Sondershausen

Prof. Dr. Robert Galler
Montan Universität Leoben
Franz Josef Strasse 18, 8700 Leoben

Roland Gebhard
Siemens AG
Schuhstrasse 60, 91052 Erlangen

Prof. Dr. Alfred Gerlach
TSU e.V.
Hersdorfstr. 6, 99867 Gotha

Astrid Gessert
K-UTEC AG Salt Technologies
Am Petersenschacht 7, 99706 Sondershausen

Dr. Hartwig Gielisch
DMT GmbH & Co. KG
Am Technologiepark 1, 45307 Essen

Dr. Peter Goerke-Mallet
TFH Georg Agricola
Herner Strasse 45, 44787 Bochum

Henry Gräßel
DMT GmbH & Co. KG
Am Technologiepark 1, 45307 Essen

Jochen Greinacher
Deilmann-Haniel GmbH
Haustenbecke 1, 44319 Dortmund

Tina Haase
Fraunhofer Institut
Sandtorstr. 22, 39106 Magdeburg

Prof. Dr. Eduard Heindl
Heindl Energy GmbH
Rohrbacher Strasse, 78120 Furtwangen

Andreas Heinrich
BRIDON International GmbH
Magdeburger Str. 14 a, 45881 Gelsenkirchen

Dr. Torsten Hellmuth
Siemens AG
Schuhstrasse 60, 91052 Erlangen

Gerhard Henkel
Taberg-Ost GmbH
Limbacher Straße 63, 09113 Chemnitz

Dr. Marian Hertrich
NAGRA
Hardstrasse 73, Postfach 280, 5430 Wettingen

Holger Heymann
Sächsisches Staatsministerium für Wirtschaft, Arbeit und Verkehr
Wilhelm-Buck-Straße 2, 01097 Dresden

Knut Hirsch
DMT GmbH & Co. KG
Am Technologiepark 1, 45307 Essen

Klaus Hofmann
SIEMAG TECBERG GmbH
Kalteiche-Ring 28-32, 35708 Haiger

Frank Hunstock
K+S Aktiengesellschaft
Schachtstr. 1, 36414 Unterbreizbach

Michel Juilland
Goldplata Mining International Corporation
15 - 19 Rue des Mathurins, French Guiana 75009, Paris

Marcus Kampen
RAG Aktiengesellschaft
Shamrockring 1, 44623 Herne

Jens Köhler
ASSE GmbH
Am Walde 2, 38319 Remlingen

Jürgen Christian Kopp

Fenn 6A, 14554 Seddiner See

Andreas Koschare
RAG Aktiengesellschaft
Shamrockring 1, 44623 Herne

JoachimKowarik
DMT GmbH & Co. KG
Am Technologiepark 1, 45307 Essen

Christian Kropp
DMT GmbH & Co. KG
Am Technologiepark 1, 45307 Essen

Michael Kühn
Sächsisches Oberbergamt Freiberg
Kirchgasse 11, 09599 Freiberg

Prof. Dr. Hans-Joachim Kümpel
BGR – Bundesanstalt für Geowissenschaften und Rohstoffe
Stilleweg 2, 30655 Hannover

Oytun Kutay
Fina Enerji Holding A.Ş., Türkei
No:4 Kat:1 A-Blok P.K.34662, Istanbul

U. Larres
LBEG – Landesamt für Bergbau, Energie und Geologie
Stilleweg 2, 30655 Hannover

Prof. Dr. Bodo Lehmann
DMT GmbH & Co. KG
Am Technologiepark 1, 45307 Essen

Bodo Lorenz
Immobilie Freistaat Bayern
Lazarettstraße 67, 80636 München

Jens-Peter Lux
DMT GmbH & Co. KG
Am Technologiepark 1, 45307 Essen

Dr. Stefan Mann
Wismut GmbH
Jagdschänkenstraße 29, 09117 Chemnitz

Dr. Matthias Martin
Actemium BEA GmbH
An der Heide, 03130 Spremberg

Philipp Matthias
RWTH Aachen
Wüllnerstr. 2, 52056 Aachen

Dr. Günter Meier
TU Bergakademie Freiberg
Akademiestraße 6, 09599 Freiberg

Prof. Dr. Christian Melchers
TFH Georg Agricola
Herner Strasse 45, 44787 Bochum

Bill Mercer
Avalon Rare Metals Inc.
Suite 1901, 130 Adelaide Street West, M5H3P5 Toronto

Heiko Miller
DMT GmbH & Co. KG
Am Technologiepark 1, 45307 Essenl

Prof. Dr. Helmut Mischo
TU Bergakademie Freiberg
Akademiestraße 6, 09599 Freiberg

Philip Mittelstädt
DMT GmbH & Co. KG
Am Technologiepark 1, 45307 Essen

Jagan Mohanraj
BRIDON International GmbH
Magdeburger Str. 14 a, 45881 Gelsenkirchen

Vitaliy Monastryrov
Sight Power Inc.
3049 Apple Hill Dr, K1T3Y8 Ottawa

Prof. Dr. Peter Moser
Montan Universität Leoben
Franz Josef Strasse 18, 8700 Leoben

Dietmar Müller
MIBRAG mbH & Co. KG
Glück-Auf-Str. 1, 06711 Zeirt

Dr. Andreas Mütertheis
EFTAS
Oststraße 2-18, 48145 Münster

Paul Noy
GE Power Conversion, Deutschland / UK
Boughton Road CV21, 1BU Rugby

Frank Otten
Deilmann-Haniel GmbH
Haustenbecke 1, 44319 Dortmund

Prof. Dr. Frank Otto
TFH Bochum
Herner Strasse 45, 44787 Bochum

Kian Pakzad
EFTAS
Oststraße 2-18, 48145 Münstery

Falk Pätzold
TU Braunschweig
Hermann-Blenk-Str. 27, 38108 Braunschweig

Prof. Dr. Eiko Räkers
DMT GmbH & Co. KG
Am Technologiepark 1, 45307 Essen

Dr. Peter Reiser
TSU e.V.
Hersdorfstr. 6, 99867 Gotha

Sergey Reznichenko
Sight Power Inc.
3049 Apple Hill Dr, K1T3Y8 Ottawa

R. Rieche
LBEG – Landesamt für Bergbau, Energie und Geologie
Stilleweg 2, 30655 Hannover

Reinhard Rosga
OLKO-Maschinentechnik GmbH
Carl-Benz-Straße 4, 59399 Olfen

Ulrich Ruppel
DMT GmbH & Co. KG
Am Technologiepark 1, 45307 Essen

Naci Sali
Asya Maden İşletmeleri A.Ş, Türkei
Morbasan Sokak Koza İş Merkezi C Blok No:14 Giriş Kat Istanbul

Thomas Schicht
K-UTEC AG Salt Technologies
Am Petersenschacht 7, 99706 Sondershausen

Dieter Schleuter
Bohrtechnik-Geothermie-Brunnenbau-Bergbau-Beratung-Schulung-Consulting
Katzenbusch 2, 29565 Wriedel

Dr. J. Schneider
LBEG – Landesamt für Bergbau, Energie und Geologie
Stilleweg 2, 30655 Hannover

Stefan Schnell
RAG Aktiengesellschaft
Shamrockring 1, 44623 Herne

Jürgen Schnitzler
RWE Generation SE
Stüttgenweg 2, 50935 Köln

Peter Scholze
Vattenfall Europe Mining AG
An der Heide, 03130 Spremberg

Falk Schreiter
TU Bergakademie Freiberg
Akademiestraße 6, 09599 Freiberg

Wolfgang Schubert
SIEMAG TECBERG GmbH
Kalteiche-Ring 28-32, 35708 Haiger

Andreas Sikorski
LBEG – Landesamt für Bergbau, Energie und Geologie
Stilleweg 2, 30655 Hannover

Manfred Speer
Wismut GmbH
Jagdschänkenstraße 29, 09117 Chemnitz

Volker Spieth
VS.GLOBALMETAL LLC.
5425 E 10 Street, Tucson, AZ 85711

Hans-Joachim Steinfeld
TSU e.V.
Hersdorfstr. 6, 99867 Gotha

Wilhelm Stock
RWE Generation SE
Stüttgenweg 2, 50935 Köln

Lutz Teichmann
ASSE GmbH
Am Walde 2, 38319 Remlingen

Katja Thiemann
K-UTEC AG Salt Technologies
Am Petersenschacht 7, 99706 Sondershausen

Frank Topp
RWE Power
Stüttgenweg 2, 50935 Köln

Dr. Borys Vorobyov
Sight Power Inc.
3049 Apple Hill Dr, K1T3Y8 Ottawa

AD Friedrich Wilhelm Wagner
Bezirksregierung Arnsberg
Goebenstraße 25, 44135 Dortmund

Dirk Wagner
DMT GmbH & Co. KG
Am Technologiepark 1, 45307 Essen

Thomas Walther
Siemens AG
Schuhstrasse 60, 91052 Erlangen

Martin Weber
DMT GmbH & Co. KG
Am Technologiepark 1, 45307 Essen

Dr. Stefan Weber
K+S Aktiengesellschaft
Schachtstr. 1, 36414 Unterbreizbach

Axel Weißenborn
Thyssen Schachtbau GmbH
Sandstraße 107 - 135, 45473 Mülheim an der Ruhr

M. Wiedicke
BGR – Bundesanstalt für Geowissenschaften und Rohstoffe
Stilleweg 2, 30655 Hannover

Andreas Wilde
SANDVIK Mining Systems
Hafenstrasse 280, 45356 Essen

Jason Wilkinson
Allana Potash Corp
65 Queen Streest West, M5H 2M5, Toronto

Dr. Reik Winkel
Indurad GmbH
Belvedereallee 5, 52070 Aachen

Martin Zmölnig
ÖSTU-STETTIN Hoch- und Tiefbau GmbH
Münzenbergstraße 38, 8700 Leoben

Organizer:	DMT GmbH & Co. KG Am Technologiepark 1, 45307 Essen, Germany
Support by	K+S Aktiengesellschaft Bertha-von-Suttner Str. 7, 34131 Kassel
and	TSU e.V. Vereins für Technische Sicherheit und Umweltschutz e.V. Hersdorfstraße 6, 99867 Gotha
Organization:	Jörn Philipp Jordan, Carolyn Tepel
General Management:	Prof. Dr. Günther Apel / Jens-Peter Lux
Photography:	DMT GmbH & Co. KG, Kassel Marketing GmbH, Fotolia, iStockphoto

DMT GmbH & Co. KG

Am Technologiepark 1
45307 Essen
Germany

Phone +49 (0)201 172-1284
Fax +49 (0)201 172-1880

info@dmt-group.com
www.dmt-group.com

TÜV NORD GROUP

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