ABSTRACTVOLUME

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PRACTICING SUSTAINABILITY - ENGINEERING SOLUTIONS FOR A SUSTAINABLE DEVELOPMENT

The effect of mine reclamation implementation on sustainability of Bibishahrbanoo Limestone Mine (Region)

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Some believes that "Sustainable Mining" due to impermanence of mining operation and adverse environmental impacts of mining, is an oxymoron. Truly, no one can overlook these environmental impacts; however, a sustainable development is based on three elements: Environmental, economical and social sustainability. Thus, the effect of mining operations on society and economy must be considered. Thanks to mine reclamation the adverse impact of mining on the environment can be reduced, moreover it will improve the social and economical conditions after the mine-closure. To ensure that a mining operation is toward sustainable development goals, specific criteria and indicator frameworks have been established. By applying these criteria and indicators, sustainable development can be measured in mining industry.

In this study, a plan for Bibishahrbanoo mine reclamation is suggested. Bibishahrbanoo limestone mine is located in the southeast Tehran, Iran. It is one the major raw material producer of Tehran Cement Factory. Using criteria and indicators frameworks established by Global Reporting Initiative (GRI), indicated that the implementation of reclamation plan will increase the sustainability of Bibishahrbanoo region.

Sustainable mining with Atlas Copco products

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Sustainable mining is a big issue, and in this presentation we want to change the focus from single operations towards total operational solutions. Once we understand how all of the parameters involved are linked together and how they interact, we can begin to optimize and improve the production chain. This presentation will show how Atlas Copco can help to improve the production chain and reduce the cost by using the options that are available with Atlas Copco´s intelligent products.

Mine ventilation is often the highest single cost factor in deep, complex mines - in some cases it is responsible for up to 40% of the underground mines´ total electrical consumption. By reducing the ventilation requirement for individual vehicles the total consumption can be reduced. Ventilation on demand can give a substantial cost reduction as it is only necessary to provide air flow in the area where the air consumer is operating.

The total cost for water systems includes water intake (flow and pressure), dewatering (length and lift height) and also pump cost and maintenance. All drilling equipment underground needs water to perform and also to bind dust in the underground environment. Reducing the consumption for every single vehicle in operation and thereby reducing the total consumption will not only affect the cost for water intake but also reduce the cost for dewatering. Pumping water out of deep mines requires large energy consuming pumps, and on the surface, water needs purification before it can be released into the surrounding environment.

Compressed air systems are often used underground. Large, complex tube systems always have a certain percentage of leakage; in some old mines, compressed air systems can leak up to 70% of the total consumption volume. Short tube systems and portable compressors can reduce the leakage. By reducing single operational consumption, the total cost can be reduced.

Utilizing drill holes when installing electrical cable, instead of installing them in ramps and drifts, can reduce cable length by up to 90%. The benefits will be reduced cost for the cable, safe and protected installation and thereby less risk of damage from mobile equipment.

By optimizing the parameters described above you will be able to reduce energy consumption and thereby achieve a better and more environmentally friendly operation. This is what Atlas Copco calls sustainable productivity.

Integrated sustainability approach to mining, mineral processing and recycling of aggregates

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As an application of the Sustainable Development principles to the production and use of aggregates for the construction industry, the sustainable supply mix (SSM) can be defined as a procurement from multiple sources according to criteria of economic, environmental and social efficiency. SSM can therefore be regarded as a blend of conventional natural aggregates, quarry by-products and residues from extractive activities, and recycled waste (construction and demolition waste, excavated soils/rock from civil works, etc.), which together maximize net benefits of aggregates supply across generations.

SSM would benefit from an increased recycling rate and an integrated sustainability approach to mining, mineral processing and recycling of aggregates. However, recycling rates are still lower in several EU member states and there is still scepticism among conventional natural aggregate producers about the opportunity to extend their business by integrating recycling aggregates production.

According to the UEPG (European Aggregates Association) even in those countries where recycling has nearly achieved the maximum, the contribution of recycled aggregates is below 20%, thus recycled and natural aggregates are not competitors, but rather they joint use is the key issue towards sustainability. On the contrary, conventional natural aggregate producers and recyclers tend to act as competitors and sometimes negatively distort local markets. At the same time, planning public authorities seems not to be able to organise and optimise mining, mineral processing and recycling activities in order to minimise transportation and increase eco-efficiency of resource use.

The promotion of recycling and the encouragement of the SSM policies is one of the main challenges of the EU SARMa Project "Sustainable Aggregates Resource Management". In such a context, the paper analyses the production of natural and recycled aggregates, which are regulated by the mining EU Directive on the management of waste from extractive industries, by the EU Directives and Communications on waste (relevant to the waste management, the interpretation on waste and by-products, the strategy on the prevention and recycling of waste, the end-of-waste criteria) and by the European Directive on Construction Materials. Starting from the definition of a common glossary, the paper will discuss on the removal of obstacles to the use of recycled aggregates as construction products for several end-uses and outline the potential benefits of an integrated sustainability approach.

Possibilities of utilizing mineral wastes in Hungary

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In Europe, and therefore in Hungary opening a new mine is harder and harder. Depletion of mines, unfavorable legal and economic changes, and growing public concerns are the main

reasons. Social and economic interests require total utilization of mineral raw materials of the operating mines, and furthermore utilization of waste heaps of the former mines. There are 5-6000 waste heaps of the operating and the closed mines in Hungary. 2000 of these waste heaps have already been estimated, and researches show that total amount of waste heaps can be calculated to 1 billion tones. These researches left out of consideration waste heaps exploited and placed in deep lignite mining.

In several projects and researches we analyzed processing of waste heap and possibilities to use its components. A processing technology for utilizing waste heaps has been developed based on laboratory and pilot plant tests. Great amount of useful materials of quarrying waste heaps can be utilized with this technology.

Tests were also done for processing waste heap of a former ferrous metals mining. The developed processing technology contributes to use these waste heaps as aggregate for cement industry, as dielectric and aggregate for construction.

The essay presents in details main characteristics of waste heaps, technologies already used for processing waste heaps of quarrying and ferrous metals mining, mass balances and qualitative parameters of the end products.

Sustainability at Bucyrus

H. Bussmann (Managing Director, Bucyrus HEX GmbH, Germany), U. Paschedag (Managing Director, Bucyrus Europe GmbH, Germany)

Bucyrus is today´s largest mining machinery manufacturer worldwide. Its mission is to have a positive, lasting effect on our world. Bucyrus makes sustainable devel-opment a fundamental way of doing business through economic, environmental and social initiatives that support, educate and benefit our employees, customers, shareholders and other stakeholders.

Our participation in GRI, a network-based organization that has pioneered the most popular sustainability reporting framework will be discussed as well as examples will be given on each major field of engagement.

However there is also "the other side of sustainability" for an OEM like Bucyrus. This being its machinery that helps its customers mine minerals from surface and under-ground mines with less rock content, less fines, less electrical power being used just to name a few.

Two examples from surface machinery are most fuel efficient haul trucks as well as the Highwall mining system which allows access to coal reserves which are lost not making use of this kind of system.

The product range of MT 3300 - 6300 offers trucks with payloads of 150, 190, 240, 340 and 400 sht, all of equipped with AC drive systems, being more fuel efficient as well as offering higher torque as both DC and mechanically driven trucks. On top of that our standard diesel engines consume less fuel than other competitive models. This totals up in fuel savings of 15 - 40%, which is significant saving considering a fuel consumption of 70 gallons per hour (MT 5500).

The Highwall Mining System is a compact tool which, from an abandoned surface coal mine, an open highwall or a purpose built trench allows mining of coal sitting in the interface between surface and underground coal mining. A continuous miner cutter head is pushed into the seam mining approx 3,5 m width up to 300 m deep, an automation system making sure that no rock is being cut at the roof and floor. After pulling out the system moves some 3 - 5 m, depending on the pillar width determined by geological conditions, allowing for a reasonable recovery rate of coal which is not minable with any other system. On top of this being operated from a control panel in the main machine this system brings best possible safety.

Two examples from underground machinery are Bucyrus´ automated plow systems for medium and thin seams and Bucyrus´ intelligent CST drive system for high-powered armored face conveyors (AFCs).

Automated plow systems by Bucyrus are today successfully used in many parts of the mining world. Our customers can mine down to 0,8 m seam thickness of coal without having to mine adjacent rock. This is due to the systems automation, which doesn´t require an operator on the face. The cutting depth is electronically pre-set and controlled, the shields advance automatically. Such automated plow systems also produce fewer fines, requiring less water in the preparation plant during later processing of the raw coal if that is needed. With up to 2 x 800 kW of cutting power available this system is more productive than other shearer face at least up to 1,8 m seam height.

The intelligent CST drive system for armored chain conveyors includes features such as no-load motor-start, AFC soft start, heavy-load startup using full breakdown torque of all motors if needed, accurate load sharing and rapid overload protection in case of chain jams. These features are all possible due to the multi-disc CST clutch in combination with Bucyrus´ own hardware and software to control the slip of the clutch extremely accurately. This in turn allows a running slip of typically 0,2 % or in other words an efficiency of 99,8 %. If compared to the often used fluid coupling or similar systems, a customer will save lots of money per year in energy less consumed through this reduced slip. It goes without saying that availability and productivity of longwalls are greatly increased by this intelligent drive system.

Developing a practical mechanism for incorporating sustainability principles into mineral processing plant design and operation

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Many organisations, including those in the resources industry have Board-level endorsed principles on sustainability. A key challenge, however, is how to systematically integrate these high-level principles into the design and operation of mineral processing plants. Current project management systems do not readily deliver the innovative solutions that are needed to address key sustainability issues, such as minimal impacts on the environment, significantly lower carbon emissions, and maintaining the societal "licence to operate".

In an effort to meet this challenge the Sustainable Operations framework, called SUSOP®, was conceived and developed through the Co-operative Research Centre for Sustainable Resource Processing (CSRP) in Australia. Somewhat analogous to HAZOP (Hazard and Operability Studies) which is well entrenched in the resources industry, the key aim of SUSOP® is to produce a holistic, systematic and rigorous set of processes for identifying and assessing sustainability opportunities and risks within the organising architecture of a sustainability framework.

A multi-faceted approach has been taken in the development of SUSOP®. Utilising the expertise of research and industry collaborators, drawing on the substantial body of published work on sustainable development, and most importantly undertaking "live" case studies with the minerals industry have been critical features in enhancing SUSOP®´s development. In particular, the "live" case studies have provided significant insights into the process of identifying and evaluating opportunities for improving an operation´s contribution to sustainability and its long-term business case. Such insights have emphasised that the outcomes from a mechanism such as SUSOP® need to be integrated into current project management systems to ensure its acceptance and potential to deliver value.

This paper argues the important need for a systematic and rigorous approach for embedding sustainability principles into mineral processing plant design and operation, presents the key

elements of SUSOP®, and highlights both the value that SUSOP® delivered to the case studies and how the case studies enhanced its development. In addition, the long-term aspiration for SUSOP® to become an industry standard and the reasons why such a framework will have growing importance into the future will be articulated.

Optimizing coal mine design for sustainable development at a large surface coal mining operation in Appalachia

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Traditional coal mining planning seldom considers key "sustainability factors" such as: societal impacts in the area; jobs (both created and lost); dislocation of towns and residences; impact on neighboring communities and individuals; infrastructure concerns; post-mining land use (except when limited by law or other factors); habitat disruption and reconstruction; long-term economic impacts in the community; and, net long-term community benefit. Previous papers by the authors have presented a systems engineering approach based on the premise that systems can only be optimized if all factors are considered and integrated into mine planning..

This paper discusses a specific case study for a large-scale surface coal mining operation in Appalachia, utilizing geographic information system (GIS) tools to incorporate ecological and other sustainable development concerns into models of coal mine sustainability performance. GIS data on environmental and social resources were considered along with coal production cost and value information obtained from past and present coal mining operations to develop mathematical cost equations and models. By analysis of the on-the-ground data, the parameters to be included in these models were identified, the relationships between these parameters quantified, and the models developed. For most of the parameters, index variables, such as habitat quality and quality of life factors, were used to represent more complex individual sustainability considerations.

The paper discusses the adjustment and validation of the models. The paper also presents a comparison of site-specific information on the mining plan and the profit, costs, and other desired outcomes that were realized at that property with the optimized values obtained from modeling. Finally, the paper examines how the mining plan at the operation which could have been derived from this methodology to develop an optimized mine plan for the specific mining property which would have theoretically improved profitability and assisted in meeting other sustainability goals.

The introduction of UK rock bolting technology into coal mines around the world

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Many mines around the world have been seeking ways to achieve sustainable developments and reduce operating costs. Rockbolting is a technology that needs to be considered as it provides a means of reducing operating costs and improving safety whilst allowing improved production to be achieved. The problem is how to introduce this technology in the knowledge that a successful outcome will be achieved. The authors have considerable experience in the introduction of UK rock bolting technology in many large underground coal mines around the world. Rockbolting is a complete package and not only includes the consumable materials but also training, production of Codes of Practice, Monitoring Schemes, Refinement of Design and long term management of the systems. This paper explains the methods that have been applied for its successful

introduction and discusses several case studies. It does not give fine detail but is intended to allow decision makers to gain a basic understanding of the method used to successfully introduce rockbolting to a mine.

Wind power as an alternative post-mining land use in surface coal mines in West Virginia, U.S.

A. Duerksen (Graduate Student, Department of Mining and Mineral Engineering, Virginia Tech, USA), E. Westman (Associate Professor, Department of Mining and Mineral Engineering, Virginia Tech, USA)

Surface coal mining in West Virginia has supplied energy to the eastern coast of the United States for over a century. Over the years, the coal mining industry has been forced to adapt as societal demands regarding health, safety, and environmental impacts have changed. Recent pressure has called for another iteration of change: long-term post-mining sustainability. The research discussed in this paper investigates one potential solution - or component of a solution - to achieving sustainable surface coal mining in West Virginia: post-mining wind power.

The paper begins with an introduction to the Appalachian region of the U.S. and the role that mining has played in its history, followed by a discussion of the need for sustainable mining and how post-mining wind power may fulfill it. Next, the GIS-based process by which the three monitoring locations were selected is explained. Justification for field monitoring equipment selection follows. Data processing methodology is also discussed, including statistical analysis of the raw field data. The results of the preceding section are then used to estimate the electrical output of various wind turbine models.

The results of comprehensive economic analyses of each site are then presented. Individual site geography will dictate the maximum post-mining wind farm size, so each of the three sites has a unique wind viability profile. The power generation simulations presented in previous sections form the basis of a cash flow analysis, which includes multiple wind farm construction and operation scenarios. These scenarios encompass combinations of different construction timelines, power distribution options, and degrees of government-based incentives and restrictions. The paper concludes with a discussion of these analyses and quantifies the specific economic and sustainability-related benefits of constructing wind farms on reclaimed mine land.

Assessing the contribution of underground In-situ Coal Gasification (UICG) within a sustainable development framework

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Underground In-situ Coal Gasification (UICG), although not a new concept, is now attracting considerable global attention as a viable process to provide a "clean" and economic fuel from coal. Climate change legislation and the declining position of coal reserves (i.e., deeper and thinner seams) in many parts of the world are promoting and fueling the UICG renaissance.

Applying improved UICG technology to gasify deep, thin, and low-grade coal seams could vastly increase the amount of exploitable reserves. The coal could be converted to gas for a variety of uses, and emissions of sulfur, nitrous oxides, and mercury could be dramatically reduced. The economics of UICG can be promising. The capital plant expenses appear to be substantially less than the equivalent plant fed by surface gasifiers because purchase of a gasifier is not required. Similarly, operating expenses are likely to be much lower because of the savings in the traditional mining cost, coal transportation, and significantly reduced operations for ash management facilities. Even for configurations requiring a substantial environmental monitoring program and additional swing facilities, UICG plants retain many economic advantages. In addition, UICG

maybe the only feasible technology to harness energy from deep unminable coal seams, in an economical and environmentally clean way.

UICG however, has the potential to create significant environmental hazards if operations are not optimally managed, including ground-water contamination, surface subsidence, extensive distribution of reactants in the gasification zone and unrestrained cavity growth rate. These hazards appear avoidable through careful site selection and adoption of best management practices for operations. The challenge of managing CO2 emissions creates a strong drive towards pairing UICG with carbon capture and sequestration (CCS). It is imperative, therefore, that further development of this technology is based on integrating UICG practices and potential environmental impacts to accepted sustainability frameworks and processes.

This paper evaluates the potential of UICG to conform to different frameworks defined to assess the capability and potential of any project to be termed as "sustainable" such as Natural Step, MMSD (Mining, Minerals and Sustainable Development), etc. It also assesses the potential contributions that UICG can make to sustainability during its design, operation, closure, and post-closure phases. Finally, the paper attempts to show how UICG can integrate economic activity with the ecosystem integrity, respect for the rights of future generation to the sustainable use of resources and the attainment of sustainable and equitable social and economic benefits.

The Assessment of noise from block cutting machines using the P-wave velocity

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Millions of employees in Europe are exposed to noise at work. Noise affects humans both physically and psychologically, whose impacts vary from person to person. Block cutting machine is one of the most important noise sources in the stone processing factories. The objective of this research is to asses the noise from block cutting machines in the stone processing factories using the P-wave velocity. Since the limited types of rocks were cut in the factories, to assess the site noise is very difficult. For this reason, the methodology explained following was applied:

In the first step of the research, the noise levels of some block cutting machines were measured during the cutting of the three different rocks in the stone processing factories. Then, core samples of the same rocks were cut by an automatic cutting machine in the laboratory and noise levels were measured. The site noise levels were divided into the laboratory noise levels and the results were averaged. The average value of 1.16 was described as conversion factor. This means that the site noise level is 16 % higher than the laboratory noise level. At the second stage, thirty three different rocks such as igneous, sedimentary, metamorphic, and pyroclastic rocks were cut by an automatic cutting machine in the laboratory and noise levels were measured. The P-wave velocity of rock samples were also measured in the laboratory. The laboratory noise levels were correlated with the P-wave velocity values and regression analysis was performed. A strong power relation ($r = 0.84$) between the laboratory noise levels and the P-wave velocity was found. The laboratory noise level for a new rock type to be cut can be estimated using the derived relation. Then, the laboratory noise level can be converted to the site noise level using the derived conversion factor.

Sustainable development in Vietnam mining industry - Challenges in occupational health and safety

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Vietnam is a country with a very fast growing economy. The average economic growth amounted to 7% per year during the period 1995 - 2005 and it was still 5.5% in 2009, after the recession in

the global economy. This boom leads to an enormous demand for raw materials. To meet this demand, the capacity of Vietnamese coal mining has been greatly expanded since the turn of the century. According to the master plans of the Vietnamese government, this trend should continue so that the Vietnamese coal industry is in a phase of ongoing expansion. The big challenge in the coming decades will be to make this process as sustainable as possible when it comes to economic, environmental and social objectives. One of the most important tools to achieve this aim is risk management in enterprises.

Occupational health and safety is one of core importance for a company´s risk management. Risks could occur when companies solely focus on production growth targets and lose sight of the health of their employees. That could lead to a damage of companies not only in financial aspects - as they must pay for fines, compensation, reconstruction etc. - but also in their prestige - as the media and the public will communicate about risks and hazards. To strive for the promotion of health and safety and an adequate protection work as a fundamental objective of social sustainability, should therefore be a core element of business strategy.

Up till now, risks prevention is not taken into priority by Vietnamese coal mining enterprises. Consequently, when incidents and accidents occur, not only do serious damages happen - but - as mentioned above - also plenty of costs for compensation or for reconstruction are incurred as well. Main reasons for this weak risk prevention can be found in deficient legislative conditions and non-synchronized systems of risk management in Vietnam nowadays.

In contrast, Germany has implemented an adequate legal system and the German mining industry has gained lots of experiences in risk management, especially in occupational health and safety, so that fatalities and other accidents could be reduced to the minimum level by means of prevention and so-called "First protection": actively protect coal production from risks which can likely occur.

This paper seeks to point out the specific challenges of how to improve occupational health and safety in Vietnam by applying and transferring German methods and standards.

A vision on Indian coal mining strategy - Engineering solutions for sustainable development for future

B. Kumar (Chief General Manager, The Singareni Collieries Company Limited, India)

Coal is the most abundant fossil fuel resource contributing to energy generation to the tune of 60% all around the world and rest is from gas, diesel, nuclear, wind and hydel. Global coal market is large and sundry with many different producers and consumers from every continent. The international thermal coal trade has steeply increased in the last 20 years. The diversity and abundance of global coal deposits would meet the strategic challenge and energy security. India stands eighth in total world coal reserves, forth in proved reserves and third in coal production after China and USA. Coal has been traditionally a vital source to the industrial growth in the country. Commercial coal mining was started during 18th century with an annual production of 0.9MT. The coal production reached to 6MT in the year 1900, 30MT by 1946, 290MT by 1995-96 and continues to increase. The projected coal demand, at the end of 11th five year plan (2011-12) is 731.10MT as estimated by the Working Group on Coal and Lignite. At present, 75% of coal production in the country is being consumed by power sectors. The coal demand has been rising steadily and outstripped domestic production. The power sectors continue to report generation losses from coal shortages. The pace of power capacity additions has hardly been commensurate with the need. Less than 30 GW of the planned 40 GW for 2002-07 could have been materialized as reported by The Energy and Research Institute of India (TERI). The Government´s recent effort to build several 4000 MW power plants under ultra mega power schemes would require coal blocks with reserves of 600-700MT. The projected coal demand at the end of 15th five year plan (2031-32) is 1900MT which is three times of existing coal production. The present 6-8% growth in coal production would not be sufficient to meet this

demand. Hence Government of India (GoI) is looking at various alternatives such as FDI, acquisition of overseas coal blocks, captive mining, faster project approvals and advanced technology for bulk production from underground mines.

The coal production in India is being administered by Ministry of Coal (MoC) which regulates coal industries such as Coal India Limited (CIL) with eight subsidiaries, Singareni Collieries Company Ltd (SCCL) and few captive mines. The CIL and SCCL are accounting for a production share of 81% and 9.5% respectively. As per the coal mines amendment bill, GoI has brought reforms in the coal industry in the recent years by permitting private sectors to participate in coal mining for captive use. GoI has identified more than 300 coal blocks so far and allotted 214 blocks having proved reserves of 50889.5 MT to private and public sectors to augment the coal production. But this is only transitory solution for the deficit. Because, the coal production in the country predominantly comes from open pit mining which is contributing nearly 89% of absolute production. The coal deposits exist at shallow depth and in thick seams particularly in the north eastern part of the country which is compensating the country´s need at present. The coal from these shallow deposits had started depleting and will be exhausted rapidly in the coming years. As the mining depth increases year by year, the excavation of overlying rocks, refilling and land reclamation becomes tedious and uneconomical. In addition to this, the open pit mining has its own implications due to land acquisition and environmental impact issues. The Environmental and Forestry clearances become crucial and getting delayed in the changed global warming scenario.

The underground coal mining in India mainly of room and pillar method with manual and semi-mechanised mining methods accounts for less than 15% of total coal production with low production rate. The mechanised longwall faces produces hardly 4 % of total underground coal production in 2009-10. Besides, billion tonnes of coal is locked up in underground standing pillars and in thick seams requiring suitable technology. Further, the country has huge underground coal mining potential upto the depth of 600m. The Geological Survey of India (GSI) has estimated the coal reserves upto the depth of 1200m are 276.8BT (as on April 2010) of which 109.8BT are proved, 166BT exist upto the depth of 300m and 76.267BT exist between 300m-600m depth. This needs a viable technogical adoption and proper engineering solutions to meet the demand-supply gap from deep shaft underground mines with thick, deep, and steep coal seams of complex geo-mining nature.

Bulk production of coal at faster rate from underground, particularly from deeper reserves is possible from Long wall which is proven technology worldwide. Though the technology did record only moderate success in the past thirty years due to geological, operational and economical reasons, it developed enormous of experienced engineers and R&D scope in the country. The world scenario of longwall technology has been vastly modernised with most sophisticated and reliable equipment with wider and longer faces in the countries like USA, China and Australia. The world trend shows an incremental achievement in longwall production from 1000TPD to 35000TPD over the years. Longwall technology can be introduced with proved reserves of 100MT deploying faster development system using bolter miners. Besides, about 40% of the proved reserves are in thick seams posing technological challenge for long time where Longwall Top Coal Caving (LTCC) can be considered. The coal seams where the mining geology is not suiting to longwall mechanisation, the continuous miners can be introduced in more numbers. Detailed exploration with boreholes atleast 20/sq Km and intense geo-technical studies are mandatory in the deep and uncertain mining conditions. A paradigm shift is required to adopt the world class standards in ventilation, strata control and sophisticated infrastructures for underground mines. In addition to traditional mining, Coal Bed Methane (CBM) extraction and Underground Coal Gasification (UCG) are the state of art of mining which are cleaner, cheaper and eco-friendly mining processes and are alternate for unmineable, deep and complex coal seams. A MoU has been signed by Indo-British coal forum (Jan1997), Indo-German working group (Nov2008), Indo-Australia collaboration on coal sectors (Nov2008) and India-EU energy

panel (Nov2004) for CBM/CMM/AMM technology transfer and assistance. CIL has identified few blocks to introduce underground coal gasification.

This paper deals with the present status of Indian coal mining and its future application in the deep & complex geo-mining conditions and explores engineering solutions for challenges to make coal mining in the country more viable and sustainable for the future energy needs.

"SAFETY FIRST" in the development of underground mining machines

E. Lammer (Sandvik Mining and Construction G.m.b.H., Austria)

Underground mining processes are dangerous.

The underground environment is hostile: Rock stress and potential rock fall have to be controlled; the influx of water, poisonous gasses or combustible gasses is possible. Darkness and the non-existence of natural fresh air supply create additional hazards.

In addition the operation of a high density of machinery within a production process at confined space increases safety and health risks for the operators. Dust and noise also have to be controlled.

The design of mining equipment, which is able to cope with this environment, is a challenge for the machinery manufacturers.

The EHS (Environment, Health & Safety) vision of SANDVIK calls for zero harm whenever working with SANDVIK mining equipment.

Prerequisite for realizing this vision is the installation of appropriate processes:

a specific "Product Safety Process" has been integrated into the product engineering and product development processes of Sandvik Mining and Construction, where all safety related activities like identification of all life cycle hazards, risk management and safety verification / validation are planned, performed and documented.

Product safety shall be "designed into" the products: Therefore specific research activities have been started, to address the safety and health related topics for the development and for the engineering of SANDVIK mining machines.

These research projects include:

- Improvements in the design, focusing on ergonomics of the operation of SANDVIK Bolter Miners.
- Mechanization and automation of roof bolting
- Improved dust suppression and Methane dilution by use of a specific CFT (Computational Fluid Dynamic) software. Simulations of the machine system and the interaction to the mine are used for optimized, customer tailored solutions.
- Systems verification / validation by the use of in house test facilities. (E.g. Cutting test rig, "Burning Coalface" test rig.
- Independent wheel suspension for SANDVIK shuttle cars for optimal drivers comfort at difficult floor conditions.
- Investigations on the integration of proximity detection systems

The aim of these activities is to minimize the risk of harming the operators of SANDVIK equipment to the lowest possible level.

Sustainable underground mining operations at MOIL Limited

G. Manekar (Chief Mines, MOIL Limited, India), G.P. Kundargi (Director Prod. & Planning, MOIL Limited, India)

MOIL limited is engaged in producing manganese ore since middle of 19th century. It operates 7 underground & 3 opencast mines in India. The underground mines are operated at shallow to moderate depths. Asia´s deepest underground manganese mine is situated at Balaghat, Madhya Pradesh. In tune with present market scenario, the company is augmenting the production from the underground workings by adopting rock mechanics studies & instrumentation for strata control. Horizontal Cut & Fill (HCF) mining with passive timber support now has been replaced with advanced techniques of pre-mining support for reinforcement underground structures. This has changed the total underground mining operations and has improved the safety, productivity and sustanabilty considerably.

To have the sustainable underground operations, various mechanizations programmes are taken, these are, introduction of Side Discharge Loaders for mechanical handling of ROM in the stope. Increase in level interval from 30 mtrs to 45 mtrs. It is very difficult to make a higer degree of mechanization programme in the underground mines of narrow ore bodies as the width of the orebody is in the range from 8 to 12 mtrs.

To overcome this situation, institutional programme for research is undertaken by the company and formed a group of academicians, machine manufactures and the company´s engineers. Hope, this may generate a good machines and will certainly improve the suitable underground mining operations. It will fulfill the demand of future manganese ore demand in the country.

This paper deals with satisfactory result of technological upgradation in weak rock mass condition that could change the future underground method of mining in manganese ore.

Contribution to sustainable development through alternative dumping concepts for coal mine waste dumps in Vietnam

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Quang Ninh province is located in the north east of Vietnam and the coal mining in the province generates two thirds of the province´s GDP. The coal is extracted from both open pit and underground mines for the country´s complete coal export and by a share of 95% for domestic coal usage. Overburden generated through open pit mines is piled up nearby in the form of large waste rock dumps. The sidehill fill dumping near open pit mines is the source of environmental degradation in the region. Among the current problems at solid waste rock dump sites are dust emissions during and after dumping as well as Acid Rock Drainage (ARD). One of the major existing problems at waste rock dumps is stabilisation issues of erosion, sliding and subsidence.

The RAME R&D project (Research Association Mining and Environment in Vietnam) is - among other activities - actively involved in the research for stabilisation and rehabilitation of mine waste rock dumps in Vietnam in the form of several sub-projects. The Institute of Mining Engineering I of RWTH Aachen University is leading the sub-project of mine waste dump stabilisation in co-operation with Chair of Geotechnical Engineering and Brenk Systemplanung GmbH. Mine waste dumping in the form of layers as an alternative to the sidehill fill dumping is expected to bring up environmental and economical benefits by minimising problems of the dump sites with a contribution to a sustainable development. Reduction of the post construction settlements, long term stable dump profile with minimum erosion, improvement of material parameters for geotechnical slope stability of the dump through compaction of hauling trucks as

well as economical evaluation of new dumping concepts, are the areas of the current research. The project has been financed by German Federal Ministry for Research and Education (BMBF) from German side. The ultimate aim of the sub-project is the compilation of the project results in the form of a "Best Practice Guide" and software based "Decision Support System" for planning and management of solid mine waste dumps.

The applications of phosphogypsum in environmental remediation

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Phosphogypsum is an industrial by product of phosphoric acid manufacture using a single (dihydrate) or two-step (hemihydrate-dihydrate) process. Phosphogypsum contains impurities of free phosphoric acid, phosphates, fluorides and organic matter that adhere to the surface of gypsum crystals and also substituted in the crystal lattice of gypsum. Phosphogypsum also contains radioactive elements such as U 238, U234, Ra226, Pb210 and Po210, which are derived from the phosphate rocks. The contents of radioactive elements vary in a wide range, depending on the composition of rock phosphate.

Worldwide, large amounts of phosphogypsum have been produced up to now and it is estimated that if historic trends continue, production will increase to several hundred million metric tonnes annually. Phosphogypsum poses various environmental and storage problems and produced in the technology of a wet-process phosphoric acid production is still a problem to be resolved. Although, the best option for dealing with the phosphogypsum problem appears to be the commercial use of this material in the agriculture (e.g. amelioration of acid soils) and construction industry (building/road construction), only a relative small portion of the phosphogypsum produced (14%) is reprocessed, a significant part is dumped into water bodies (28%) and the main part of thematerial is accumulated in large sludge ponds and retaining stockpiles.

Some beneficiation processes comprising washing with water, thermal as well as chemical treatments have been applied to gypsum sludge but these treatments are not enough to solve this problem. However, because of economic restraints (e.g. the price of the land) and pressing environmental issues the development of a safe disposal procedure is necessary.

The purpose of this study is to provide a broad overview of recent patterns and trends of applications of phosphogypsium. Also, the environmental problems related to phosphogypsium are outlined.

Utilization of lignite fly ash as hydraulic binder and backfill material

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In 2004, the experts of the Department of Process Engineering at the University of Miskolc, the Institute for Transport Sciences Non-profit Ltd. and H-TPA Co. Ltd. elaborated a project to improve the condition of unpaved, damaged roads in Hungary, especially in rural areas. The aim was to build local roads at low cost and to reduce the considerable amount of unpaved roads using brown coal fly ash as binder for in capping and base layers and wastes from the construction industry. The main aim of the research work was to examine fly ash mechanical activation by grinding in ball and vibration mill during different grinding time, furthermore to produce an individual binder as a mixture of ground fly ash and lime (or hydrated lime) in various ratios as a function of the strength value to be achieved. Present paper summaries briefly the main achievements of the above mentioned project as preliminaries.

Furhermore, this study deals with the laboratory experience of lignite fly ash utilization for two different reasons. On the one hand the secondary raw material was tested as a binder, on the other hand it was investigated as a backfill material. About 1.2 million m3 fly ash is generated by the Visonta lignite fired power plant yearly and this by-product is utilized just in small amount.

Considering the first goal, in this paper utilization of a mixture of mechanically activated fly ash and lime for producing an independent binding composition has been assessed involving determination of interrelationship(s) between the degree of activation of fly ash and the resultant breaking strength of the obtained concrete. The results confirmed that the obtained hydraulic binder is suitable for construction of road (stabilisation and capping layers or base layer).

Regarding the backfilling application possibility, this paper is presenting laboratory experiments, their results including settling tests, hydraulic permeability and strength measurements and dense slurry technology related results and difficulties. The Gyöngyösoroszi lead-zinc mine was once a combined historic production of 3.6 M tonnes of low grade vein type Pb-Zn ores. Its production stopped in 1986. Due to environmental risk, mine cavities has to be backfilled for reducing ARD potential of the cavities. As a potential backfilling material, fly ash generated by Mátra Power plant has chosen. Fly ash material can be found close to the mine area, therefore it is cheap to purchase and transport. Not to mention that using fly ash material means reduced environmental risk of the power plant operation and other properties of fly ash might has other advantage for backfilling. Best available technique is high concentration technology for underground backfilling.

Waste management in Estonian oil shale industry

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The most important mineral resource in Estonia is a special kind of oil shale. Currently Estonia is independent energy producer thanks to existing of oil shale deposit and favourable mining and processing conditions. About 85 % of oil shale is consumed by power plants which produce 98% of Estonian electricity and great part of thermal power. Oil shale industry provides a significant contribution to the country´s economy, but causes a large number of different problems. As a result every oil-shale producer and consumer should think today how to be successful in the future.

Underground oil shale production is obtained by room-and-pillar technology with blasting. This method is cheap, highly productive and easily mechanizing. Investigations showed that if the depth of excavation increases over 60 m (mine Estonia), the current underground mining technology is not effective. The loss in pillars increases up to 40% and the efficiency of mining works decreases. In these conditions the room-and-pillar technology is not applicable. New flexible and powerful mining technology will guarantee securing independence of Estonian energy sector. Backfill technology will be applicable in conditions of Estonian oil shale mines.

On the other hand, appears the problems of landfill of waste. Strong environmental impacts are caused by disposal sites of waste generated by oil shale combustion. Use of combustion and mining by-products in mining industry is treated as a part of mining technology (Directive 2006/21/EC), not as a waste disposal. Underground utilization of oil shale combustion and mining by-products reduces the volume and area required for surface disposal and consequently the environmental taxes.

In Estonia there are CO2 emissions per capita one of the highest in Europe. Reduction of the flue gases could be reached using different measures. Mineral sequestration of CO2 and SO2 is possible. Unfortunately, it is still in the development stage and is not yet ready for implementation.

Complex approach is needed for solving above mentioned problems. It will have great impact on mining practice in Estonian oil shale industry.

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Sustainable bioremediation and industrial ecology model: A sustainable management alternative for mining industry

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Developing countries must face environmental crisis such as adaptation to global warming. Latin-American and the Caribbean are highly vulnerable to effects of global warming and must understand that facing these environmental issues require multidisciplinary approaches, with a strong focus on best technology available, science and public policies to preserve its pristine areas. Our main challenge is to achieve a sustainable development but without compromising our development too.

Relationships among mining industry, society and environment have been historically complex due to its environmental impacts. Today, the mining sectors are in a tipping point to achieve equilibrium between a sustainable productions avoiding increasing levels of pollutant toward environment. A feasible and novel approach to solve this need is the incorporation of concepts from the Industrial Ecology and Sustainable Bioremediation to mining processes such as integrated management of materials available as well as inside mine plants or derived from other industrial and depurative activities.

In the Chilean mining industry, placed at Atacama Desert, repetitive and small spills of fuel as diesel and lubricant oil during reparation and maintenance of machinery have been routinely adsorbed by desert soils and sawdust to control environmental pollution. Both contaminated materials are considered as hazardous waste by the Chilean legislation, and necessarily must be contained and cleaned up. Our objective was to investigate the feasibility of applying bioremediation as a cost-effective alternative technology to physical and chemical treatments. Our results indicated that the bioremediation is feasible and that the autochthonous microbial communities adapted to fuel contaminated soils are capable of removing it although at a low rate.

The froth flotation is the main technology to recover specific mineralogical species from sulphide ores. Commercial collector and frother reagents have been used at large-scale. These flotation reagents are expensive and representing an environmental risks due to its physics properties such as: low flash point temperature, high vaporization rate and residual waste chemistry that produces an unpleasant odor in warmer climates. The aim of this present study was to evaluate the efficacy of biosolids (BS) from municipal wastewater treatment systems as foaming agents in froth flotation by quantification of tensoactive capabilities, foam-forming potential and stability of formed foam. The results show the feasibility for BS to be used as new environmental-friendly organic reagents that previously were considered as wastes. In this research, a sustainable bioremediation process and industrial ecology model based on these two successful cases is presented.

A new proposal for reutilization of bauxite red mud: Exploring its use in isolation technologies for hazardous substances

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Within a global frame the searching for alternatives of reutilisation of mining residues is a priority if we want to approach to a sustainable development concept. Red mud (RM) is an industrial waste arising from the production of alumina generated in enormous quantities worldwide and which is currently stored in extensive dumps. The recent catastrophic event occurred in western Hungary, where 600-700 thousand m3 of RM sludge were spilled from the MAL Zrt sludge reservoir and inundated the settlements of Kolontar and Devencser, showed the dramatic consequences of an uncontrolled and infinite storage of this residue, including the loss of human lives and the extreme devastation of the local environment. Therefore, the searching for options of massive reuse of RM must be seriously considered with the objective of reducing its accumulated volumes. In this direction, the present work explores the reutilization of RM as a component of isolation technologies for hazardous substances. The RM used was obtained from the ALCOA-San Cibrao factory (northwest Spain). Its main components are Fe (37%), Ti (20%) and Al (12%) oxides, containing also traces of heavy metals (<1%). The work involved the study and optimisation of the geotechnical properties of RM in conjunction with extensive adsorption experiments of arsenic and mercury. The results from both type of experiments were integrated in a dispersion-diffusion model to calculate migration curves and minimum thickness of the RM compacted layer. The geotechnical studies showed that compaction increased the dry density (up to 1.67 Mg/m3 at 28% water content) and shear strength (c = 0.81 kg/cm2) of RM, increasing its stability, whereas decreased its hydraulic conductivity below 10-9 m/s and settlement (total settlement = 7.5%). RM sorbed high amounts of As (up to 44 mmmol/kg) and Hg (up to 9.2 mmol/kg). The calculated minimum thickness of the RM barrier was 1-10 cm for As and 2-19 cm for Hg, for an initial concentration range of 0.02-2 mmol/l and for an operation period of 35 years, whereas for an operation period of 100 years the minimum thickness required was 3-28 cm and 6-52 cm for As and Hg, respectively. These values mean the potential reutilization of 16-800 x 10^3 tons RM per km^2 of compacted RM barrier. The results obtained let to conclude that the reuse of RM as a component of isolation systems of hazardous substances represents an alternative use of this residue.

Study on acid mine drainage control by mixing non acid forming and potentially acid forming waste rock in opencut coal mine

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Acid mine drainage (AMD) has become a serious environment problem in mine industry in the last decade. Many efforts have been conducted in order to get better method to manage this problem in proper manner, both on prevention and mitigation. One of the methods to prevent AMD generation is a dry dump cover system that had been proposed to minimize oxidation of sulphide waste rock in dumping site. The performance of this system depends on the physical and geochemical stability of a barrier layer to minimize water and oxygen influx. In mining industry, this barrier layer was formed by using Inert/Non Acid Forming (NAF) waste rocks to cover Potentially Acid Forming (PAF) underneath. However, the amount of NAF waste rocks is very limited in some mines. Therefore, instead of conventional cover system, the mixing of NAF and PAF with blending method is proposed as the new system for preventing AMD generation.

A field column leaching test was conducted under local climate condition in order to evaluate the per-formance of geochemical stability of mixed waste rocks with different geochemical compositions. Compositions of NAF and PAF waste rocks were determined by the results of

Net Acid Generation test and Acid Base Accounting Method. Fresh blasted waste rock with controlled size distribution was used for this field column leaching test. This experiment was conducted for one year to cover the wet season and dry season period. Water quality measurement to monitor pH, EC and sulphate concentra-tion of leachate water was carried out weekly as well as the measurement of oxygen concentration in the column. At the end of this experiment, column leach test was dismantled and further analysis was conducted to investigate the changes of geochemical composition of rock samples.

The results of field column test showed that both physical and geochemical conditions of material on the column changed by the time of experiment, influenced by the climatic condition, and control quality of leachate water and oxygen diffusion. Leachate water from each leaching column was in circum neutral pH and has low dissolved metal content and oxygen diffusion were lower due to increasing of bulk density of material in the columns.

The SARMa Project: Enhancing sustainable aggregates resource management and supply in Southeast Europe

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A country´s level of aggregates production is closely tied to its GDP and rate of economic growth. Thus, it was not surprising to find that aggregates production fell in many parts of the world after the onset of the recession. Aggregates industry representatives and some authors have suggested that the major issue facing the aggregates sector is recovery from the recession. But longer term, more fundamental concerns are at stake that will need to be dealt with. For aggregates to be produced from new resources (or new areas associated with existing operations), certain conditions will need to be met. These include the well-recognized issues of deposit quantity and quality, location, permitting, environmental protection, etc. In addition, firms must be able to demonstrate that they can be profitable even when all costs are taken into consideration, including exploration, acquisition, permitting, operation, environmental controls, regulatory compliance, transport to market, and reclamation. Moreover, they will need a social license to operate, which typically requires more of the firm than profitability and following the letter of the law. Social license is the support of the people living near and potentially affected by the quarry, and in its absence firms may not be allowed to mine or may face extra costs.

The countries of Southeast Europe are rich in aggregates, but neither management nor supply are coordinated within or across this area. The Sustainable Aggregates Resource Management project (SARMa), an EU Southeast Europe (SEE) activity, has as its objectives the development of common approaches to sustainable aggregate resource management (SARM) and sustainable supply mix (SSM) planning in SEE.

There are open issues in SEE on the local scale as well as on regional/national and transnational scales that will need to be addressed in order to meet societal expectations related not only to the security of aggregates supply for economy, but also those linked to environmental concerns and social issues. SARMa partners have identified salient issues at all three scales and are gathering information, performing analyses, and synthesizing results. The goal is to develop both overarching and scale specific recommendations, as well as results targeted at various groups of stakeholders (local community, industry, regional / national authorities). In the paper some of the issues from the local scale (high environmental impacts of primary aggregates extraction, illegal quarrying, limited recycling, need for stakeholder consultation) will be discussed more in detail. Since the regional / national and transnational parts of the project will not have ended have by the paper deadline or the conference itself, those activities will be addressed in more general terms.

Sustainability and resource efficiency in potash and rock salt mining

F. Spachtholz (Head of General Mining Division, K+S Aktiengesellschaft, Germany)

Raw materials industry is crucial for the national economy. German mining companies are known for their high degree of resource efficiency based on modern technology and know how. K+S is one of the world´s leading suppliers of standard and speciality fertilizers. In the salt business, K+S, with sites in Europe as well as North and South America, is the world´s leading producer.

The mine sites of K+S are distributed all over the world producing mainly potash and magnesium salts and rock salt. Focus is on the sustainable use of the natural deposits in order to stay competitive. For this reason a raw material policy, both national and international, is necessary to get access to new mineable deposits which are still available in Germany. Further on, knowing the market conditions is a must for sustainable development. At least sustainability and resource efficiency in potash and rock salt mining are achieved by constantly developing new technologies as well as optimizing the organization and improving the qualification of the workers.

Effect of mine water on the stability of underground coal mine roadways

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The basic objectives of mine roadways are to provide sufficient cross sections in order to meet the needs of accommodation of equipment, transport, personnel travel and ventilation. However, many roadways become damaged to the extent of needing maintenance, generally dinting, and in some cases requiring re-ripping. The damaging of a roadway is a result of several factors including geological properties of surrounding strata, method of roadway formation, support systems and so on. Among these factors, strata conditions play important effects on the stability of roadways and other mining activities. Weak rocks cause excessive roadway closures, and water softens some rocks and worsens the closure problem.

In Indonesia, over 200 Mt of clean coal is produced from almost surface mines. In the near future, some coal must be mined from underground. Unfortunately, the mechanical properties of coal measures rocks are not so good to open an underground mine.

In this paper, a scientific discussion on the effect of water on the stability of roadways is given on the basis of results obtained by means of in-situ investigation and laboratory tests both in Japan and Indonesia.

A practical and rigorous approach for the integration of sustainability principles into the decision-making processes at minerals processing operations

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The traditional method for making decisions with respect to mining projects is to evaluate and compare the financial aspects and benefits across different options. However, it is widely recognised that there is an imperative to move away from financial indicators being the primary driver in decision-making. Instead, the drivers for decision-making processes should represent the wider arena of project impacts that are embodied by the holistic concept of sustainability. In the mining industry, high-level commitments to adopt sustainability have been made at the

corporate levels of mining companies, but there continue to be problems when attempts are made to translate these high-level sustainability aspirations into appropriate targets and methods at the more-specific operational level. In order to advance the global aspiration towards sustainable minerals processing operations in earnest, it is necessary to achieve integration of the principles of sustainability at all levels in mining companies.

The integration of sustainability principles into day-to-day decision-making processes at mineral processing operations has particular challenges that are not addressed adequately by current tools and methodologies, such as GRI reporting, life cycle assessment and footprinting. Decisions at the operational level are more imperative and the tools need to be directed and usable by operational personnel (e.g. mining engineers and metallurgists), who have a different focus to personnel at higher company levels.

A methodology for achieving integration of sustainability at the operational level is being developed. This methodology uses a systematic and rigorous mechanism to identify and characterise sustainability issues at an operation. Identified issues are characterised according to the sustainability indicators that they impact upon, the size of the scope of impact, as well as whether the extent of an issue can be measured using current processes. When an issue is fully qualified and able to be monitored, the problem to be solved becomes clearer and real solutions can be then more effectively generated to address the issue and its root causes, rather than reactive solutions which tend to treat impacts.

The methodology has been successfully tested and refined at an operating mine. It was able to guide operational personnel in the identification of sustainability issues that embodied notable sustainability and business risks related to water, energy and dust. More importantly, the case study was able to proactively identify issues and possible opportunities that would not be normally identified through traditional analysis processes and had the potential to deliver feasible business benefits.

Development of a new method for quality control in the quarry industry for practicing sustainability

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The large extent of global production and consumption of natural stone and mainly quarries, grabs one´s attention and makes its substantial and essential standpoint in the world today pretty clear. A great amount of this natural stone is utilized in civil engineering applications such as road construction, railway industry, concrete production, etc. Considering this fact that igneous rocks display a higher strength and abrasion resistance, this type of rock is preferred in the field of civil engineering. For all these applications, rock quality assurance is a key factor and certainly unavoidable, and it has great influence on the quality of constructions in civil engineering. One of the major problems encountered by both the producers and users of igneous rock is the fact that, with the passage of time, some specific rocks loose their strength, up to a complete loss of structure or in other words, their disintegration and degradation.

In the last decades, different methods and procedures such as Glycol test, methylene blue dye test, as well as the Los Angeles test have been introduced to distinguish these rock properties, and to identify these problems. However, as these methods are time consuming, hard to perform, only to be applied to hand-piece samples, requiring special laboratory equipments, and only possible to be accomplished under laboratory conditions, their application has always been limited to some specific cases, and they are neither recommendable nor advantageous. To address this widespread quality management problem of the quarry industry, a relatively quick, easy and user-friendly approach is necessary. It calls for a systematic solution with a device that can simply be used day to day in a mine for quality control of the quarry´s daily production.

This scientific research is concentrated on developing a systematic method for early recognition and diagnosis of rock quality, in order to control and manage the quality of the quarry production in advance. This method was developed, based on the procedure of the magnetic susceptibility measurement. The obtained values can lead to valuable information regarding the quality of the rock and allows the quality control process to be accomplished and performed at the borehole location.

This approach has been assessed through extensive field and laboratory studies. A detailed and comprehensive discussion will be made on the results of the experiments. The advantages and impacts of the application of this method, on increasing the reserves and environmental protection are also discussed.

Contribution of engineering methods to sustainable development of mining systems

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Mining systems are designed, manufactured and used worldwide. Thus, they have decisive impact on a sustainable development of mining industry and minerals industry. Due to this, they require sustainable development themselves. Orientation of sustainable development onto human beings, by development of knowledge and skills of worldwide users of mining systems, is one of its aspects. Engineering methods, which were already used in the early stages of development of mining systems, and which aid assessment of design solutions in the light of broad and sustainable spectrum of criteria, are used for that purpose. Sustainability of criteria manifests in appearance of human factor: health protection and safety criteria apart from technical criteria.

Engineering methods aiding sustainable development of mining systems, including:

- virtual prototyping of designs of mining systems, including health protection and safety criteria,
- modelling and assessment of technical and health risk, which appear during operation of mining systems,
- creation of knowledge repositories disseminating safe work methods, considering existing language and cultural barriers,
- dissemination of the methods integrating world community of users of mining systems,

will be presented in the paper.

to be announced

M. Wittig (Chief Executive Officer, Roland Berger Strategy Consultants, Switzerland)

to be announced

F. Wodopia (Managing Director, Gesamtverband Steinkohle (GVSt), Germany)

Mineral processing - Challenges for the future: Water, Energy and Masses

H. Wotruba (Head of Mineral Processing Unit, RWTH Aachen University, Germany)

Deposits of metals and industrial minerals are decreasing in quality. Ores getting more complex and grades are decreasing. For one unit of product, more material has to be mined and processed. To liberate finely interlocked ores, grinding has to be finer. As a result, more energy is used to produce one unit of product. As most concentration processes are wet, water consumption per

unit of product is also increasing, as well as the amount of waste, which has to be deposited in a safe way. A number of new technologies have been developed in mineral processing to counter this trend, like waste elimination by sensor based sorting, new grinding and dry concentration technologies. The article presents challenges, new strategies and solutions in this field

SUSTAINABLE SUPPLY CHAINS

Acquisition and assessment of non-intended outputs in the lignite mining and power generation industry

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For the activities of the lignite mining and the power generation from lignite land is occupied and equipment and energy are used. During operation various material and energy flows are released. The released material and energy flows are nearly always without value in the raw material supply chain and in the electric power supply chain. They are not the production targets of the mining industry and the power generation industry. Instead, they usually have negative effects on the economy and ecology and are, therefore, referred to as non-intended. The knowledge of the quantities and qualities of these non-intended outputs as a function of the individual processes and their parameters is the basis for technical and economical measures to affect them.

The methodology for the acquisition and assessment of the material and energy flows in the lignite mining and the power generation from lignite is based on an integrated approach due to the comprehensive technical and economic analysis of material and energy flow systems. A hierarchical system structure allows the precise assignment of the material and energy flows to the individual processes. Mathematical process models were deduced to characterise the chemical change of materials and the conversion of energy during processes. For modelling the overall system as a material and energy flow network the software Umberto is used.

The system analysis and the investigation of the general conditions for the lignite mining and the power generation in lignite-fired power plants in Germany show a complex overall system with many influencing factors. Using the example of mining in an opencast mine with conveyor bridge technology and mine water treatment together with the example of power generation in a conventional steam plant with the option of post combustion carbon dioxide capture and compression all the relevant non-intended outputs are determined and aggregated to characteristical indicators.

If the necessary data is available for several systems the calculated indicators can be used for the purpose of a benchmarking to compare individual processes of the lignite industry or complete systems from mining to power generation to each other. Then appropriate measures can be derived for the choice of techniques and for operational practice to contribute to a sustainable development in the lignite mining and power generation industry.

Importance of mineral secondary and waste raw materials in the minerals' management - Poland's case

K. Galos (Head of Department, Polish Academy of Sciences, Mineral & Energy Economy Research Institute, Poland)

The paper will present increasing importance of mineral secondary and waste raw materials in the management of mineral raw materials in Poland. In the beginning, the definition of mineral secondary and waste raw materials will be proposed, according to current law. On this basis, sources of various types of mineral waste raw materials will be analysed. The special attention will be paid to the wastes from mining and processing, wastes from power plants, and wastes from steelworks and other smelters. Other types of waste and secondary materials, such as metallic containers, glass containers, batteries, metallic wastes and scraps, will also be taken into account. After analysis of sources of such materials, the main directions of their economic use will be given. Available sources of information on manufacture and use of the mentioned secondary and

waste raw materials will also be analysed. Finally, for a wide range of materials, current and expected significance of secondary and waste materials in the domestic management of mineral raw materials will be evaluated. These will relate e.g. to metals, aggregates, gypsum and other raw materials for cement production.

Removal of Cd 2+ from mining industry wastewater using Montmorillonite

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Heavy metal is one of important pollutants in water and especially in wastewater, and it has become a public health concern because of its non-biodegradable and persistent nature. The toxicity of these metals is enhanced through accumulation in living tissues and consequent biomagnifications in the food chain. Cadmium is a heavy and toxic metal and has been placed in the category of non-essential substances. It is generally released into natural water from metal plating, mining, pigments and alloy industries. It can spread into the environment through soils and water streams, and bring a chief threat to human health. Cd(II) is known to cause lung insufficiency, bone lesions, and hypertension. Several technologies such as chemical precipitation, ion exchange, membrane filtration, carbon adsorption and coprecipitation/adsorption are employed for Cd removal from wastewaters. However, these techniques have inherent limitations in application (such as complicated treatment process, high cost and energy requirement) or have a danger of secondary pollution. New practices have been focused on the study of processes based on sorption approaches using low-cost adsorbents. Clay minerals have great potential as inexpensive and efficient sorbents which can be used as alternative adsorbents to replace the costly activated carbon. That is why there is an upsurge of interest in recent years to utilize clay minerals to remedy heavy metal cadmium contaminated environments in environmental studies.

The aim of the present study is to investigate removal of Cd 2+ ions from mining industry wastewater using montmorillonit. Among the parameters studied are the adsorption isotherms, solution pH and adsorption contact time.

The CTC (certified trading chains) mineral certification system: a contribution to good governance in the mining sector of Rwanda

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Mineral certification serves to transitionally fill governance gaps in the mining sector of development countries until national institutional capacities and law enforcement in a given country have been strengthened sufficiently. In this context, mineral certification may address different corporate social responsibility standards as defined in multinational guidelines, and may also include traceability and transparency aspects of mineral trade serving to link a specific mineral product to the conditions of mining prevailing at a given production site. The latter has become particularly important as a due diligence measure for responsible mineral producers operating in conflict-affected or high-risk areas. Increasing international awareness of the risks of human rights violations associated with mining activities in the eastern provinces of the Democratic Republic of the Congo have created pressure for actors involved in the production and trade of tin, tungsten, and tantalum (coltan) ore to demonstrate upstream supply chain due diligence, or risk facing trade sanctions. In this context, mineral certification systems may serve as platforms for responsible mineral producers and metal processors to independently verify their due diligence measures and, in case of positive verification, to showcase their efforts on a credible base at the international level.

The Certified Trading Chains (CTC) scheme represents a mineral certification system implemented in Rwanda since late 2008 as a joint German-Rwandese technical cooperation pilot project. Implementing the CTC system in Rwanda also paves the way for subsequent establishment of a regional certification mechanism as defined by the International Conference on the Great Lakes Region. A further aim of the cooperation project is to contribute to building best practice in the Rwandan mineral industry, in particular, as it relates to the artisanal mining sector.

The core element of the CTC system is a set of country-specific standards developed in an international consultation process and organized in five CTC principles referring to traceability and transparency, labor and working conditions, security, community development, and environmental aspects in mineral production and trade. Five Rwandan tin, tungsten, and tantalum ore producers, mainly relying on artisanal labor, and their trading partners are participating in the project on a voluntary base and have been supported in improving their performance with respect to CTC standards by several consulting interventions. Producer performance with respect to the CTC standard set will be assessed by an independent third-party audit scheduled for autumn 2010. Coordination and consultations with other relevant certification schemes in the region are currently underway.

Mine tailings used as alternative materials for asphalt pavement

Z. Song (Researcher, Laboratory of Rock Engineering, Aalto University, Finland), M. Rinne (Professor, Laboratory of Rock Engineering, Aalto University, Finland), L. Korkiala-Tanttu (Professor, Aalto University, Finland)

Along with the development of mineral industry, the disposal of mine tailings has been recognized as an unavoidable burden of mining companies and local authorities. Conventional methods, e.g. impoundment, backfilling, phytoremediation, normally dispose mine tailings in a passive manner which hardly generates more value from these by-products. On the other hand, as mining activities booming nearby, adjacent local communities need more infrastructures which require great amounts of raw materials. In view of the above mentioned situation, a novel utilization of mine tailings is explored as alternative materials for asphalt pavement, in order to solve the disposal of mine tailings and the shortage of pavement material. Inherent physical properties of the mine tailings are first investigated through the research, and then pavement specimen made from the mine tailings are tested by laboratory experiment, e.g. softening, specific gravity, stability, deformation, density and air voids, according to related industrial norms. The mine tailings have presented considerable potential as pavement filler for low categorized road with low-volume traffic. Furthermore, the limitation of the use of mine tailings and the future work are also discussed in the end of this article.

Infrastructure in mining industries: A geopolitical and investment challenge

M. Taghizadeh Ansari (MD, Niitco GmbH, Germany)

This article explains the ways in which investment on mining infrastructure is a geopolitical issue. It discusses the effect of installing sufficient infrastructure to get the product to the world market, and argues that there is a risk involved in depending on traditional suppliers who wish to invest in the infrastructure. It explains how to make a distinction between dedicated purpose infrastructure and general use infrastructure by examining the positions of the main actors in mining projects. It argues that these positions can not be understood as analogous to projects in developed countries.

To conclude, infrastructure is a crucial link in the supply chain to market but the relative size of such projects in relation to the economy means that investors decisions in developing countries have quite different implications from those in developed countries.

Does sustainable mining have any meaning?

D.J. Williams (Golder Professor of Geomechanics, School of Civil Engineering, The University of Queensland, Australia)

Sustainable development is at odds with reality in the minerals industry due to: (i) diminishing and lower grade resources, (ii) "peak oil" and "peak metals" production, (iii) as little as 50 years of economic oil, 100 years of gas, 150 years of coal, etc. remaining, (iv) gold nuggets now rarely being found, and mining ores with as little as 1 part in 1 million gold, and (v) many rarer metals being depleted. And yet, mining continues, with a long-term downtrend in commodity prices, matched by more efficient mining and processing. Will prices come to better reflect full cost of mineral production? Will we turn to a low carbon economy before resources are depleted? What will drive this? Increasing world populations and aspirations is leading to increased energy consumption and increased carbon emissions. World oil production has peaked due to a lack of large new oil reservoirs being found to support new refineries, but this is not well reflected in the price of oil over time. Gold production and price are poorly related. Copper price is approximately inversely proportional to copper stocks; that is, supply and demand governs price, not the cost of production. While the production of some metals appears to have peaked, coal, iron ore and copper production are all increasing, driven largely by the excess demand from China. And yet, the World simply does not have enough copper reserves to bring developing nations up to same standard of living as West. The mining cycle is governed by boom and bust. Drivers continue to be population and economics: (i) increasing population and aspirations, (ii) supply versus demand for most metals, and (iii) economic uncertainty; with gold a safe haven. Relative non-drivers (to date) include: (i) production costs, (ii) diminishing recoverable resources, and (iii) environmental factors. Does Sustainable Mining Have Any Meaning? Yes: so far, mining remains sustainable due to market pressures, rather than resource depletion, cost of production or impacts, and there is potential for far more recycling and substitution of metals. And, no: "peak metals" is a fact for an increasing range of metals particularly rare ones, and metal production is dependent on oil, which has peaked in production. Price volatility contributes to both!

MINERAL RESOURCES POLICIES AND GOVERNANCE

Zonal land use planning and the mineral industry: The need for a new approach to finding sustainability underground

S. Addie (Graduate Student, University of Victoria, Canada)

The mineral industry is fundamentally different than other extractive industries; it forms a unique link to the social and environmental landscape it interacts with. Despite this particularity, the industry frequently finds itself confined within the same sustainability-seeking land use planning processes that apply to forestry, fisheries and outdoor recreation. This paper addresses the problems with such inclusion, and through an historical analysis of events dating between 1992 and 2010 articulates the need for a non-zonal approach to assuring sustainable mineral resource use.

Between 1992 and 1996 the Commission on Resources and Environment (CORE) was tasked with creating a land use plan for the Canadian province of British Columbia. Rich in resources, and approximately the size of France and Italy combined, this was an immense undertaking. While the mineral industry at first expressed a degree of excitement over the prospect of being involved in the process, the reality of mining´s incompatibility quickly dawned on participants. The consensus based multi-stakeholder process was ill suited to account for the mineral industry´s susceptibility to global demand and its secretive exploratory nature.

The outcome of the process greatly limited the area which could be explored or developed, but did so without account of the mineral industry´s likely effect on the environment or social well being of the region. In the end the process limited extraction, but did not promote sustainability. Additionally, this land use planning process has shown itself vulnerable to sudden and drastic policy shifts. In 2010 a major mineral development in an "intensive use area" was successfully defeated by a small local preservationist movement. This confounds the problems of inclusionary land use planning processes by removing the economic value supposedly provided through stability to access.

From this historical analysis it is clear that zonal land use planning of the mineral industry does not promote sustainable development, nor has it provided any value, in the form of stability of access, to the participating mineral interests. Instead it is apparent that the route to sustainability is through an ad hoc approach to mineral development. This paper stops short of describing the exact process that ought to be developed, and instead discusses the general mechanisms needed to create a sustainable mineral lands development review device outside of the land use planning process. In short, to find sustainability underground we must rely upon our humanity; the convictions of good people interested in a good future.

Effect on best practices by the lack of mineral policy

Z. Agioutantis (Director, Department of Mineral Resources Engineering, Technical University of Crete, Greece)

Nowadays, stakeholders have a strong say to the enforcement of best practices by mining and quarrying companies. In most cases, following the concept of best practices ensures that the mining will be in line with sustainable development guidelines for the region and the stakeholders. On the other hand, companies try to apply best practices in order to sustain their operation without lost time and effort to litigation, and other obstacles. However, when and where there is a lack of state or regional mineral policy, mining operations may be subject to additional administrative hassles, they feel threatened and tend to apply best practices loosely. This paper will discuss the above issue and give examples of how the lack of mineral policy undermines sustainable development.

Promoting sustainable development in the minerals industry: The phosphate project in Saudi Arabia

M. Aldagheiri (Department of Geography, Qassim University, Saudi Arabia)

The Kingdom of Saudi Arabia is largely considered to be a single-commodity economy, in that the oil sector is the most important pillar of the national economy, while the non-oil sectors play a relatively weak role. National economic diversification is considered a strategic goal for the Saudi Arabian government. The minerals sector in Saudi Arabia is one of the economic activities which has already started to achieve this strategic goal of diversification away from oil-related activities as the main source of national income. Saudi Arabia has strategic industrial minerals such as phosphate, bauxite, high-grade silica and gypsum as well as industrial raw materials that can be used in the domestic, regional and overseas markets. The industrial minerals sector in Saudi Arabia recognises sustainable development as a vital objective for society and readily acknowledges its responsibility for helping to achieve this critical aim. This paper examines the phosphate project which is considering one of the industrial minerals important to the economy of the Kingdom of Saudi Arabia, focusing on its production, the structure of its industry and the effects of government policies and planning efforts.

The role of coal in energy policy and sustainable development of Turkey: Is it compatible to the EU energy policy?

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This paper aims to assess the current and future role of coal in energy strategy of Turkey and evaluates the compatibility of the policies to the EU energy policy and strategy. Coal is regarded as the most important indigenous energy source in Turkey together with hydropower to strengthen supply security of the country. Turkish government set targets to fully utilize coal reserves of the country in next decades. However, the country is also in the process of becoming an EU Member State, hence, it is expected that the energy policies have to comply with the EU. Moreover, Turkey ratified Kyoto Protocol, thus the country should limit CO2 emission together with other greenhouse gases. The probable obstacles that Turkey may face due to the utilization of coal were determined as CO2 emissions, lack of technology in Carbon Capture and Storage (CCS) and health and safety issues. CCS is expected to become an important instrument for the mid-term reduction of CO2 emissions. An alternative technique to the CCS methods is CO2 sequestration by mineral carbonation in which CO2 can be stored in a safe and permanent way. Turkey has significant resources of magnesium silicate minerals (olivine, serpentine) and trona deposits which can be utilised in CO2 sequestration by mineral carbonation method. It is concluded that coal is a very important domestic energy source for Turkey but new policies have to be developed and more realistic targets for the country should be set for reduction of CO2 emissions and applying CCS methods.

Uranium as nuclear fuel - Scarce resource or sufficient available?

F. Charlier (Chief Engineer, Institute of Nuclear Fuel Cycle (INBK), RWTH Aachen University, Germany)

The International Atomic Energy Agency (IAEA) estimates that within the next 40 years 17% of the global power production could be covered by nuclear power plants. In doing so, it reckons that the global primary energy demands will have doubled until the year 2050. In 2009, nuclear energy made up 13.8% of the worldwide power production. Almost two-thirds of the electricity were produced by conventional-thermal power plants (coal, gas, etc.) the IAEA says, as well as 18% by hydropower stations, and 1.4% by renewable energy sources.

The IAEA's estimations assume that in 2050 about 55% of the world's primary energy will be used for power production only. Nowadays barely 37% are used. Furthermore, the IAEA expects an increase in the global electricity demands from 18.558 terawatt hours (TWh) in 2009 to 61.500 TWh in 2050. Within the same time, the entire energy demands would rise from 142.000 TWh to 300.000 TWh.

Against this background, the presentation will discuss the national and international supply situation with nuclear fuel from a current and future perspective.

Die Internationale Atomenergie-Organisation (IAEO) schätzt, dass in 40 Jahren bis zu 17% des weltweit produzierten Stroms aus Kernkraftwerken stammen könnten. Dabei rechnet sie mit einer guten Verdoppelung des weltweiten Primärenergiebedarfs bis ins Jahr 2050. Ende 2009 betrug der Anteil der Kernenergie an der globalen Stromproduktion knapp 13,8%. Fast zwei Drittel der Elektrizität stammten laut IAEO aus konventionell-thermischen Kraftwerken (Kohle, Gas, usw.) sowie gut 18% aus Wasserkraft, und die neuen erneuerbaren Energiequellen trugen 1,4% bei.

Bei den Schätzungen geht die IAEO davon aus, dass 2050 rund 55% der Primärenergie der ganzen Welt für die Stromproduktion verwendet werden. Heutzutage sind dies knapp 37%. Die IAEO rechnet mit einer Zunahme des globalen Strombedarfs von 18'558 Terawattstunden (TWh) 2009 auf rund 61'500 TWh bis ins Jahr 2050. Der Gesamtenergiebedarf werde bis 2050 von heute rund 142'000 TWh auf 300'000 TWh steigen.

Vor diesem Hintergrund wird in dem Vortrag die nationale und internationale Versorgungslage mit Kernbrennstoffen - aktuell und zukünftig - diskutiert.

to be announced

P. Chevalier (Director Strategic Outreach and Partnerships, Natural Resources of Canada - Minerals and Metals Sector (MMS), Canada)

Underground extraction of aggregate - Barriers and opportunities

J. Cowley (Director, Mineral & Resource Planning Associates Ltd, Great Britain)

Underground extraction of aggregate seems to offer substantial advantages in sustainable development terms. It dramatically minimises surface impacts on landscape, habitat and adjacent land uses, although transportation impacts still need to be taken into account, and it can appear to dramatically increase the resource base by turning non-resources, due to depth of overburden or limiting surface land uses, into resources.

The space created has a potential for various after uses such as for utilities, storage, factories and recreation and this prospect for a new subterranean world, where perhaps "difficult" activities can be located has been widely discussed by urban designers, engineers and economists.

Underground extraction of aggregates, and subsequent use of the void, has been undertaken in parts of the US since the 1920s. The continuation of that industry has raised the prospect of the adoption of undergrounding in the UK, and other European countries, as a significant supply solution for the future.

But, to date, there seems only limited take up of the concept in Europe and there are no operations in the UK. This seems strange given the pressures on UK and European land and that resources are more constrained physically and in total. Why has underground extraction not taken off? Are there unique opportunities or conditions in the US enabling undergrounding? Or are there barriers in the UK and Europe inhibiting undergrounding? If there are such barriers, are these capable of being overcome now or in future? John is leading a small team reviewing the concept in England as part of the Aggregates Strategic Research Programme. The paper will draw on the review and underground extraction elsewhere.

Curse or blessing? The sustainable development dilemma of the mining regions in Brazil

M.A. Enríquez (Professor, Ministry of Mines and Energy, Brazil)

Is large-scale mining a curse or a blessing for the development of mining communities in Brazil? What are the effects of mining royalties (CFEM)? The article examines the 15 largest Brazilian mining communities, besides four Canadian municipalities, seeking a comparative analyses, using environmental, economic, social and governance indicators. Results shows that the international markets pressure and the environmental regulation frameworks have contributed to the emergence of a more environmentally responsible mining. Mining is an important factor for economic growth and for human capital formation in the affected communities, but by on its own, mining does not solve automatically two serious challenges - jobs creation and equitable distribution of benefits. The CFEM is an important economic instrument for Brazilian mining municipalities, but its adequate use demands certain favorable institutional conditions that allow municipalities to escape the "single treasury pitfall" that leads to the impossibility of productive diversification and of inter-generational equity.

China: friend or foe - On the brink of a new mining paradigm?

M. Ericsson (Board of Directors, Raw Materials Group, Sweden)

Financing of mining projects - Can banks drive sustainability?

P. Eysel (Vice President, KfW IPEX-Bank GmbH, Germany), M. Götze (Vice President, KfW Entwicklungsbank, Germany)

For many years, KfW has successfully financed mining projects, supporting German and/or European companies in exporting mining equipment or in securing raw materials supply. In doing so, KfW has followed mining projects in many parts of the world (e. g. Chile, Zambia, Laos, Finland) and for various raw materials (e. g. copper, iron ore, gold, coal).

For the financing of mining projects, so-called project financing by banks with its various instruments often is a central element of the overall financing structure. Nevertheless, there are other means of financing for mining projects, especially for larger mining companies, causing a competitive environment.

Over the last years, the importance of the assessment of environmental and social aspects as well as issues of good governance has increased significantly in mining finance. This includes the compliance with international standards (e. g. IFC Performance Standards, Equator Principles, EITI) as well as with internal policies of the banks or other involved institutions. The reasons for this development include a generally higher importance of these aspects in all parts of the economy and the society, possible reputational consequences and pure credit risk considerations. The widely accepted international standards ensure that most banks have similar requirements and that there is no “standards dumping”. Obviously, if other means of financing are utilised, there is a risk that less challenging standards are applied.

By implementing certain provisions and covenants in the loan documentation, the banks can have some influence on the project company´s obligations concerning sustainability aspects. This covers the whole life cycle of the project from construction to operation and mine closure and thus even the time after the repayment of the financing. The tailored definition of these provisions and covenants requires a thorough understanding of the project and its possible impacts. Later on, the ongoing monitoring is very important and requires constant supervision even of already well-established projects.

KfW plays an active role in this whole process, having dedicated internal policies and taking advantage of own in-house expertise for sustainability assessments. In some cases, KfW assumes

the coordination of environmental and social aspects for all the banks involved in the financing. In fact, sustainability is a strategic focus for KfW in all its financings.

Finally, it can be concluded that in fact the banks can influence the design and the structure of mining projects - and that they have done so in the past. However, there are limits due to the competitive environment and other available means of financing. Clearly, it has to be avoided that unreasonable provisions and covenants jeopardise the overall economic viability of the project.

to be announced

K. Freytag (President, Landesamt für Bergbau, Geologie und Rohstoffe Brandenburg (LBGR), Germany)

Regional development planning in Western Australia´s Pilbara Region - Facilitating growth and building a positive social legacy

J. Gawler (General Manager Communities, Rio Tinto Iron Ore, Australia), B. Harvey (Global Practice Leader Communities, Rio Tinto, Australia), S. Nish (Principal Advisor, Rio Tinto, Australia)

The Pilbara Region of Western Australia, 1500 km north of Perth, is a major mineral (iron ore) and energy (natural gas) exporting region. Major resource companies operating in the region include Rio Tinto Iron Ore (RTIO), BHP Billiton Iron Ore, Chevron Australia, Fortescue Metals Group, North West Shelf venture, and Woodside Petroleum. By the mid 2000s, it was clear that the Pilbara region was on the cusp of the biggest expansion of iron ore mining and oil and gas development activity in Australian history. In the context of this resources boom, Rio Tinto and other mining companies cannot by themselves ensure sustainability in the Pilbara. One of the key challenges for RTIO in forming its vision and strategy for working in the Pilbara is that a range of stakeholders - local, state and federal government as well as private sector interests - have competing agendas. Regional development policy and practice in remote Western Australia is inconsistent and incomplete because government development plans do not necessarily align with our business interests, nor do they take a long term approach to investment beyond the political cycle. There are a saturation of plans and strategies addressing regional challenges and many groups have individually developed visioning strategies and detailed plans to address key regional issues and challenges. There are varying views as to how the region should be developed into the future which are captured in an array of documents often developed in isolation. Of the numerous initiatives, committees or strategy documents currently in circulation, their commonality is a regionalised Pilbara-focus and a claim to support regional sustainability. It is inevitable that the towns and Indigenous communities will continue to undergo substantial change. Decisions, particularly in relation to towns´ management and investment have in the past been made in isolation of a full understanding of the regional context for RTIO´s impact on the region. This paper will explore how RTIO´s "social licence to operate" requirement is best served by a Pilbara community investment strategy based on its ongoing contribution to developing local economies through sustainable towns development and building socially inclusive communities. In addition to charitable giving and sponsorship, RTIO´s long term community partnerships are addressing the more ambitious and useful objective of improving the livelihoods of our community hosts and making them active participants in the economic activity engendered by our businesses.

Heimische Rohstoffe: Versorgungssicherheit, Nachhaltigkeit und Rohstoffeffizienz

J. Geisler (Chairman of the Board of German Raw Material and Mining Association, VRB e.V. , Germany)

Die Versorgung Deutschlands mit mineralischen Rohstoffen basiert auf zwei Pfeilern: Industrieminerale, Baurohstoffe und - bis zu einem gewissen Grad - Energierohstoffe. Sie

werden aus heimischen Lagerstätten gewonnen, während fast alle Metallrohstoffe, Edelsteine und Erdöl importiert werden müssen. Die importierten Rohstoffe werden hauptsächlich in der verarbeitenden Industrie eingesetzt, während die Produktion aus heimischen Lagerstätten überwiegend den Infrastrukturbereich, den Baubereich, und weite Teile der Wirtschaft insgesamt versorgt. Heimische Energierohstoffe sind Braunkohle und Steinkohle sowie Erdgas. Der Gesamtbedarf an mineralischen Rohstoffen in Deutschland beträgt jährlich annähernd eine Milliarde Tonnen Material.

Deutschland ist ein bevölkerungsreiches Land mit entsprechend dichter Besiedlung und somit relativ vielen konkurrierenden Ansprüchen an die Raumordnung und Landesplanung. Zusätzlich sind weite Bereiches des Landes unter verschiedenste Arten von Naturschutzräumen gestellt.

Im Gegensatz zu einigen energetischen Rohstoffen (Erdöl, Erdgas) und den metallischen Rohstoffen bleibt die Bedeutung der heimischen Rohstoffe bezogen auf ihre gegenwärtige und zukünftige Rolle im Bewusstsein der Bevölkerung, aber auch der Politik, auf kommunaler, Landes- und Bundesebene deutlich zurück. Die Bundesrepublik benötigt gegenwärtig und für die Zukunft eine eigenständige Rohstoffgewinnung. Die Sicherung des langfristig möglichen Zugangs zu Rohstofflagerstätten ist als eine hoheitliche Daueraufgabe des Staates unverzichtbar; sie ist Bundesländerübergreifend zu betreiben.

Das Bundesraumordnungsgesetz sieht grundsätzlich eine herausgehobene Stellung der Rohstoffgewinnung in der Planung vor, allerdings räumt es dem Bund keine Durchgriffsmöglichkeiten gegenüber der durch die Länder zu vertretenden Raumplanung ein. Der Zugriff auf Lagerstätten wird überwiegend durch fachgesetzlich geregelte Raumnutzungsansprüche oder durch Überplanung stark eingeschränkt.

Fallen Gebiete unter Naturschutzrechte in irgendeiner Form, so wird dies in Deutschland häufig als unvereinbar mit der Gewinnung mineralischer Rohstoffe betrachtet, obwohl die rechtliche Grundlage dafür gegeben wäre.

Im Herbst 2010 hat die Europäische Kommission neue Leitlinien veröffentlicht, mit denen die Regelungen für die nicht-energetische Rohstoffgewinnung in Naturschutzgebieten präzisiert werden. Es wird ausdrücklich festgestellt, dass das Natura 2000-Netz ein flexibles Programm sei, in dessen Rahmen Bergbau und Gewinnung von Steinen und Erden zugelassen werden können. Einzuhalten seien Aspekte der Nachhaltigkeit und die Integrität des Natura 2000 Netzwerkes.

Rohstoffe aus heimischen Lagerstätten sind aktuell und langfristig unverzichtbar für die Versorgung der Bevölkerung und der heimischen Industrie. Die rechtlichen Rahmensetzungen dafür sind im Grundsatz vorhanden. Es bedarf eines gesellschaftlichen Konsenses, diese auch auf der Ebene des Vollzuges anzuwenden.

Long term demand for construction raw materials and the implications for mineral provision; the case of sand and gravel in the Netherlands

P.J.M. Groot (Programme Manager Infrastructure, Economic Institute for Construction and Housing (EIB), Netherlands), M. van Elp (Researcher, Economic Institute for Construction and Housing (EIB), Netherlands), R. Saitua Nistal (Senior Researcher, Economic Institute for Construction and Housing (EIB), Netherlands)

In the Netherlands about 60 million tons of concrete and mortar sand and gravel is used per year. The need for construction raw materials arises from investment in housing, non-residential buildings and infrastructure. Demand is mainly met with inland production and import of primary materials. Currently a minor part of mineral use is met with secondary materials from recycling of construction and demolition waste.

For mineral provision, knowledge of long term demand for minerals and hence developments in construction investment is essential on different levels. Firstly, national government policy seeks to implement sustainable development in construction and material use. Secondly, regional government is involved in spatial planning that combines quarrying activities with projects like nature preservation and flood management . Thirdly, the quarrying industry has to invest in new projects like the purchase of land and equipment. Fourthly, the recycling industry seeks to increase the recycling of construction materials.

Long term demand for construction raw materials depends on a large number of factors like demographic, economic and technological trends. Key factors are the role of the government versus the private sector and the international economic orientation. Over the next 30 years the probable directions of these trends will diverge strongly. By using scenarios the main trends that influence construction and the need for minerals can be defined and coupled consistently.

The Dutch Economic Institute for Construction and Housing (EIB) has recently accomplished a number of studies into structural trends in construction, material demand and the implementation of sustainable development policy. We found a number of opportunities and threats for future mineral provision that might be incorporated in policy strategies of government and industry.

Common developments in the scenarios are decreasing population growth and a smaller share of the labour force in total population. These trends have strong effects on investment in housing and offices within the next 30 years. Only in an optimistic scenario the demand for construction raw materials in 2040 will be at the current levels. Furthermore, material use is influenced by technological development and demand for quality improvement. We expect supply of secondary materials to increase strongly in the next decades. Sustainability policy of the government and economic factors determine the chances for recycling. Without additional policy measures the share of substitutes for sand and gravel in concrete will only increase slowly.

to be announced

D. Mager (Ministerial Councillor, Federal Ministry of Economics and Labour (BMWA), Germany)

Risks and opportunities of using social media in the mining industry

Z. Mullard (Graduate Student, Department of Mining Engineering, University of British Columbia, Canada), D. van Zyl (Professor, Department of Mining Engineering, University of British Columbia, Canada)

Mining is an important industry, yet it is mired by negative perceptions and is constantly under scrutiny. Transparent communication with stakeholders is an important aspect of successful business, and mining companies take a cautious approach to control flows of information. The introduction of Web 2.0 platforms, with their architectures of participation and extensive social networks, has ushered in a new era of interaction and information exchange, which impacts

business and governance. This paper explores the risks and opportunities of using social media in the mining industry, based on a qualitative mixed methods investigation that included 41 interviews with respondents representing the public, private, academic and civil sectors, primarily based in Canada. The research found that 62% of respondents were using social media; blogs and social network services are gaining popularity in the mining industry as vehicles for raising awareness about projects.

Mining companies have harnessed social networking tools to extend marketing campaigns, for recruitment purposes and to target niche audiences, such as investors. Free from strict regulatory guidelines about information dissemination, civil society groups are able to host dialogue about community concerns, and build allegiances on social networking platforms. Canadian government departments are slowly starting to adopt social media tools, which have been useful for monitoring stakeholder groups and to gauge public perception about mining projects.

There are significant challenges to implementing social media platforms at an organizational level, particularly as the mining industry faces age, language and cultural barriers. Determining the extent of human and financial resources needed to maintain social media activity is difficult, as there is no control over the extent of participation. Measuring the return on investment for increased transparency cannot be clearly calculated, so indicators must be closely monitored. Currently, online dialogue is not recognized as part of formal consultation processes, therefore there is limited motivation to open these communication channels. Many believe that face-to-face interactions cannot be replaced by online dialogue and information presented online is at risk of being manipulated. Respondents from the study indicated that using social media tools might put a company at risk of increased exposure to critics and potential legal ramifications.

Despite the challenges and risks, the study found that many mining stakeholders are incorporating social media tools into their communication channels. Strategies, policies and flexible approaches to transparent communication and public engagement are creating new opportunities for information exchange.

Tailings disposal options study for Sangan Iron Mine Project, Iran

S. Naraghi (MSc. Student, Science and Research Branch (SRB), Islamic Azad University, Iran), F. Rashidinejad (Assistant Professor, Science and Research Branch (SRB), Islamic Azad University, Iran)

The Sangan Iron Mine Project (SIMP) is located in the province of Khorasan in Northeast Iran, approximately 20 km east-northeast of the village of Sangan. Total mineral resource of the area which has been divided into three regions (Western, central and eastern) is estimated to be 1.2 bt. The western regions consist of four orebodies (A, B, CN and CS) of which the orebodies B and CN with total minable reserve of 160 Mt have been considered for the first phase of the project. The concentrator plant with capacity of 2.6 Mtpa will be commissioned in the end of 2010. A total of 73 Mt, or roughly 45 Mm3, of tailings over a projected 34 year mine life will be produced. Approximately 77% of the tailings will originate from orebody B and the remaining 23% will come from orebody CN. The main criteria for the tailings disposal options study was the need to provide enough capacity to contain the tailings produced through the mine life. In this study other technical criteria such as topography, water reclaiming capability and expansion projects as well as economical and environmental criteria have been considered. Due to complexity of optimum selection of the tailing disposal system, fuzzy multiple attribute decision making process utilized in this study.

Can community-based mining support rural sustainable development objectives in Nigeria?

I.T. Oramah (PhD Candidate, Department of Earth & Atmospheric Sciences, University of Alberta, Canada), J.P. Richards (Professor, Department of Earth & Atmospheric Sciences, University of Alberta, Canada)

Despite the abundance of solid mineral deposits, Nigeria only earns about 0.5-1% of its current Gross Domestic Product (GDP) from the solid minerals sector. This is as a result of the dominance of the oil and gas industry, which has negatively affected the competitiveness of other sectors of Nigeria´s economy. The dominance of this industry has resulted in unemployment, poverty, hunger, domestic price inflation, corruption, unstable government, and higher exchange rates. These impacts are typical for economies suffering from the effects of "Dutch Disease" and the "Resource Curse".

Community-based small-scale mining offers hope as an economic activity that can create wealth, employment, reduce hunger and poverty, and provide basic amenities for rural communities with solid minerals endowment.

This study presents preliminary results of ongoing research into the prospects of using community-based small-scale mining in a developing country like Nigeria to move towards rural sustainable development.

Analysis of data obtained from field visits has identified several economic, social, and environmental advantages from adopting a community-based approach to mining, including: job creation, collective sharing of profits, collective environmental responsibility and monitoring, culture preservation, and protection of important cultural areas. Thus, encouraging this practice could lead to improved socio-economic and environmental conditions in Nigeria´s rural communities, through provision of community-based healthcare, better education, social services, and reduction of poverty and hunger.

Sustaining resource communities: A case for collaboration, coexistence and community considerations in mining-affected regions of Australia

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Recent developments in Australian mining regions are seeking to govern the industry in a more holistic way that contributes to sustainable futures for affected communities. Depending on the context, this produces different governance responses. In some areas of the State of Queensland apparent land use conflicts between mining and agriculture have come to the fore as has consideration of cumulative impacts of multiple projects and activities across time and space. In more isolated regions of Western Australia the dominant issues relate to overstretching employees, residents, infrastructure and services in predominantly mining towns. In both cases, there is an ambition for regional towns with a strong extractive industry presence to transition into desirable, liveable and affordable cities with a diversified economy.

The need to consider the viability, self-reliance and resilience of small communities is a perennial challenge in regional Australia. Recently, the concept of "multifunctionality" has been applied to understand such situations and more adequately guide decision-making and planning. This concept conveys the multiple impacts that mining and other rural industries can have on economies, environmental management, and the viability of regional communities by producing environmental, aesthetic, cultural and recreation "goods" as well as primary products. Multifunctional strategies might offer new possibilities for repositioning both agricultural and mining sectors within regional economic development by endorsing the significance of territorial

assets in building long-term, sustainable futures for regional communities. These assets include human, social, built, natural, economic and cultural capital. For them to be enhanced in the development process, and not just harnessed, requires sound governance strategies. The paper analyses the role of two such strategies - Pilbara Cities and the Pilbara Plan in Western Australia, and the Sustainable Resource Communities Policy in Queensland - to identify how these governance instruments are involving and affecting resource extraction companies and other stakeholders and contributing to sustainable development.

Benchmarking political risk abatement strategies of coal companies in developed countries through data mining

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Political risk is a strategic issue for U.S. based coal companies, largely due to the varying environmental/energy regulation proposals, social concerns over climate change, land use, employment, and mine safety. In order to foster the continued use of coal as an energy source and to protect investments in the developed countries consuming the energy (Australia, U.S., and Canada), mining companies have developed long term strategies to abate political/social risk. These strategies assist in striking the balance between governance and economics, and include investments in large clean-coal demonstration plants, lobbying groups, trade associations, international diversification, investment in clean-coal technology, mine safety, and public education. Executives and other strategic planners intuitively understand that these investments reduce political risk and promote sustainable development. The information age and the subsequent availability of information allows for the development of quantitative models and other analytics to establish relationships between scale and type of investment with company size, regional presence, and other important industry variables. These analytics provide strategic planners valuable benchmarks, increase effectiveness of future investment and assist in meeting the International Council on Mining and Mineral´s sustainable development principles. Data warehousing allows for linking the disparate data sources that list fiscal, social, mine safety, and other measurable factors into an easily accessible single data structure. This paper reviews the results of the development of such a data warehouse and applied analytics comprising the companies accounting for 80% of the U.S. coal production. The applicability of such an approach to other commodities and role in quantification of sustainable development approaches and its abatement of political risk are discussed. Mineral economics originally evolved in an information-starved era, where many assumptions or data-limited models were developed. Considering the information age´s data availability, new information-based mineral economic models may be developed, largely from sustainability reporting information.

Mining and tribal displacement in India: Critical rehabilitation and resettlement issues

M. Sahu (Academic Research Fellow, Indian Institute of Management, India)

Development-induced displacement is one of the major social processes in contemporary India. Its scale and complexity is going to expand in the context of globalization. In India development projects have displaced roughly 60 million people, most of whom have never been properly resettled. After independence, the Indian state assumed the responsibility for economic growth and national progress via adoption of the dominant development ideology. In India, a mining-induced displacement is being increasingly during the last 10-20 years and adversely affected the marginalized sections and drastically altered the relationship of tribes with their natural environment and its resources, which led to disempowerment of the tribes. The issues, debates and conflicts over the natural resources and model of development aimed at benefiting the

private sectors and privileged since then have changed very little. The heighten conflict over the natural resources between the people who own it and then the private corporations and the state which uses the principle of eminent domain to claim everything in the name of public purpose or national interest. The fact is that for those affected development has been too often experienced not as an opportunity of development but as disruption and impoverishment. This paper is an ambitious attempt at trying to delineate the patterns of displacement, resettlement, and rehabilitation since independence till date and traces the evolution of national rehabilitation policy. It seeks to study and present handling of displacement due to man made disasters through development of mining projects in pre independence era, and show the colonial attitude to development, which unfortunately continues till today, after 60 years of independence. The paper tries to portray how case after case in each decade since independence promises of development, dignity and livelihood to those affected has been betrayed. It concludes that compensation is not enough to provide sufficient safeguards against impoverishment. The state has obligation to search for alternative development strategies that are non-displacing or least displacing and to provide adequate resettlement and rehabilitation where displacement is inevitable. The sustainable tribal resettlement programme must centre on enhancing human capabilities and expanding social opportunities by addressing the social and personal constraints that restrict people´s choices.

How the past ceases to be a burden for future sustainable development

A. Shtiza (Researcher, Katholieke Universitetit Leuven, Belgium)

Albania is a rich country in natural raw materials, such as chromium, copper, ferro-nickel, coal, bitumen as well as crude oil. Although there are no records for the entire exploitation period, only in the period 1986-1996 were exploited: 25 million tones of limestone; 7.1 million tones of chrome ore (i.e. 1989 third place in world scale); 6.8 million tons of copper ore; 5 million tons iron-nickel ore; 12.5 million tons of coal; 100 000 tones of natural bitumen; 500 000 tons of bituminous sands. Its communist legacy, which dictated the development of various industrial sectors, followed by a political transitional period characterized by apathetic institutions, aggravated land contamination and additional negative environmental impacts for Albania during the period 1950-2009.

This literature review discusses the role of the Albanian institutions, the natural resources industry, potential investors and stakeholders in order to provide a set of indicators that can help to monitor amelioration within sustainable development principles. A map with the potential prospects of the natural resources will be a first step in identifying the further potential for exploitation. Mineral resource policies and governance, sustainable processing and supply chain as well as environmental management information system are some of the crucial tools identified, that will help to set up the indicators and quantify the achievements in environmental management in Albania. Moreover, the integration of practices that will support institutional capacity building; follow-up practices; the mainstreaming of global environment into planning; and the compliance monitoring process will additionally improve the environmental situation in Albania. Aligning business strategy with environmental policy, socio-economic analysis, environmental auditing are decisive tools in order to provide the Albanian authorities with a clear overview of the economic costs and the social benefits for sustainable development.

Mining is a part of the environment: Towards an sustainable health paradigm for managing toxic pollution from small-scale metals mining and refining

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This paper explores the historical causes of the environmental community´s antagonism towards mining and miners, and proposes governance strategies for strengthening sustainable development in the minerals mining and refining industries by steering policy towards collaborations with the environmental health and public health sectors, and thus away from conservation-oriented environmentalism. We trace the historical vilification of mining from its roots in the Roman writer, Pliny the Elder, through the early Renaissance treatise - and defense of mining - by the German writer, Georgius Agricola, and finally to the modern conservation movement' s aesthetic objections to mining. In the course of this historical treatment we contend that environmentalists ´resistance to mining as a legitimate economic activity has resulted in the exclusion of miners from prominent international negotiations over chemicals management, biodiversity planning, and climate change regimes, and retarded the evolution of sustainable development policies in the mining sector. Meanwhile, this resistance to mining is exclusively concentrated on large-scale mining, and fails to account for the small-scale mining economy - driven by extreme poverty in the developing world - which is at once a greater source of toxic pollution than large-scale mining, and an essential economic activity among the world´s poor. Even as the small-scale mining economy supports tens-of-millions of people, its toxic emissions of bioavailable mercury and complex cyanide compounds are the cause of public and environmental health emergencies. The paper introduces findings from ongoing fieldwork by the authors in Colombia - where atmospheric concentrations of mercury in densely populated urban areas are 1000 times higher than WHO guidelines - and Ecuador, where 150,000 tonnes per annum of potent mercury-cyanide laden tailings are released into central waterways. Without urgent attention to establish public health institutions for mitigation, monitoring, and technical assistance in these - and similar - small-scale mining areas, ecological and human health will be threatened for generations to come. There is immediate need is for coordinated and resourced international intervention from environmental health advocates who are not aesthetically predisposed toward antagonism with miners. Finally, we examine philosophical and strategic rationalities for collaboration between miners and environmental health advocates, a collaboration aimed at reducing toxic pathways through the combination of public health awareness and technical assistance.

Mineral resources policies and governance in Indonesia

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Indonesia is a fast growing developing country, one of the emerging economies in the world (GDP in 2009: US$ 514.931 billion (2009 est.); GDP per capita in 2009: US$ 4149.38, growth rate 4.26 %). Indonesia is also one of the most highly mineralised countries in the world, i.e. an important coal exporter, second biggest tin producer of the world, third biggest copper producer, one of the biggest producers of nickel and gold. GDP contribution of the mining sector is about 4, 4%; there has been an increase of employees from 47.000 employees in 2005 to 120.639 in 2008. Indonesia has expressed a desire to increase investment in the sector in the coming years.

However, sustainable mineral resource management has been difficult in the last years because of the country´s structure. Indonesia is an archipelago country comprising 5 main islands out of 17.508 islands (1.860.359 km2 area). There are 33 provinces including 440 regencies (at least 220.953.634 people). Due to the fast development, there has been an increasing unbalance

between central, regional and local governments which caused serious tensions (which also affected the mining investment business). Primarily, the central government was responsible for developing mineral policies, regulations, issuing mining permits, controlling minerals development and monitoring in the former years. Thus, discussion in terms of decentralization has taken place, due to the fact (amongst other causes) that mineral resources are spread over the country.

In 2001, the Decentralization Law No. 22/1999 came into force. It assigns broader authority to the regional governments and has influenced the discussion of a new mining law. After more than 2,5 years of discussion within the parliament, Indonesia promulgated the Mineral and Coal Mining Law No. 4/2009 (which replaced the former Mining Law 1969). The government argues that this new law will reinvigorate mining investment in the country.

This paper analyses the new Indonesian minerals policy, the new mining law and its regulations compared with the former law against the background of change, i.e. Indonesia moving towards an emerging economy.

The paper also discusses the different challenges in terms of finding the right balance between central and regional governments, between local and foreign investors. Moreover, it underlines the requirement of increasing the effectiveness of permitting procedures and human resource capability. Finally, the paper gives recommendations for a clearly written minerals policy, aiming at the creation of a favourable legal and administrative framework in terms of sustainable development in the minerals industry.

Methods of geological-mining assets valuation based on results of geological works

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Two main phases i.e. exploration and minerals extraction may be marked out in the development of geological-mining projects. Concessions for exploration are valuated as geological assets, using methods based on probability of deposit finding on the concession area. Concessions for extraction of already discovered deposits, are valuated in relation with capital value of deposit calculated according to the procedures used during investment project evaluation.

The geological and mining assets are defined as information, including geological study of deposits their reserves and associated rights, and especially concessions for exploration and extraction of deposits. Value of geological and mining assets should be related with probability of finding, exploration and operation of deposits as well as value of mineral at each stage of geological and mining activity. The probability of finding the deposit during prospecting works is defined basing on geological criteria and usually it has very small value which is calculated using simple method upon boundary industrial criteria, which must meet such deposit. During the deposit exploration, depending on category, the probability of accurate evaluation of deposit parameters and value increases. Then the most detailed calculation methods are used. As a standard, the deposit value is identified with the effectiveness of its development plan, measured by net present value of cash flow during the extraction phase. Value of assets related with deposit value and probability of its finding should be sharply distinguished from the price.

Market value of geological-mining assets, called also fair market value, is defined as sum of money which willing buyer is going to pay the willing seller, provided their independent operation and that any side is forced to make the deal as well as that both sides are acquainted with all essential facts concerning the deal and market situation. Therefore the real concession value may be established only under conditions of free and open market. Evaluation of concession values is made by independent experts, which do not have any connection with the concession owner.

In the paper authors define the concept of value of geological information and concession for deposit exploration and operation values, describing them by mathematical formulas. Special attention was paid to results of the deposit prospecting works and exploration, and consequently their characteristics and geology. The relations between geological information and market of geological-mining projects were pointed out.

CRITICAL PRIMARY RESOURCES AND NATURAL RESOURCES MANAGEMENT IN EUROPE AND WORLDWIDE

Trends of exergy costs and ore grade in global mining

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Mining is a high-priority issue in the world economy, nevertheless it requires significant energy to extract and to refine minerals, besides the associated environmental impacts. Assessment of the energy consumption for these commodities, put forward an overview of the implications needed to achieve sustainability. This paper apprises the energy requirements for minerals production through an exergy approach taking into account the long-term decline in ore grades.

In this context, the exergy required for restoring resources from the dispersed state of the reference environment into the physical and chemical conditions in which it was delivered by the ecosystems in light of the available technology, is known as exergy cost. Accordingly, exergy cost is the point of reference in order to evaluate in a single variable, characteristics such as composition, concentration (ore grade) and the state of technology.

Otherwise, the ore grade is one of the main issues which affects directly the costs associated with mining the ore. Hence, the exergy costs to produce minerals from progressively lower ores grades by the current technology is analyzed. The exergy costs curves are presented for the main minerals such as aluminum, copper, gold, iron, lead, nickel, silver and zinc, in order to know the trend when the ore grade decreases.

to be announced

J. Geimer (Manager Purchasing Raw Materials, ThyssenKrupp Steel Europe AG, Germany)

Evaluation of multilayer deposit layers using a profitability index

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Electrical power in Greece is mainly generated by lignite steam power plants. Lignite deposits in Greece are usually multilayered, which requires that exploitation plans account for the spatial distribution of lignite. As a result, the profitability evaluation of each individual layer as well as the total reserves estimation is inherently complicated

The purpose of this work is to present a profitability index that facilitates the evaluation of individual lignite layers and the estimation of reserves. A lignite layer may be unprofitable to exploit depending on technical equipment, economic conditions or quality considerations. Therefore, a flexible profitability index that incorporates such parameters is an essential estimation tool for mining engineers. The proposed index can be easily generalized for application to any kind of multilayer deposit.

Critical minerals to the EU economy on the national member level - Case study - Poland

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The assurance of future raw materials supply to the EU mineral industry has become, in recent years, one of the most important tasks of the EU Commission. After many years of negligence,

the problem of developing supply risk of many raw materials in Europe has been perceived, along with the menace to the EU economy competitiveness coming from dynamically developing countries such as China, India and others - basically of Asian origin. This has initiated a new mineral policy within the EU zone, referring mainly to non-fuels. One of the starting points for this activity has become the assessment of the EU mineral resources potential and identification of the raw materials that are critical for the harmonious and sustainable development and technological progress.

The paper presents the glance to this problem from the National Member level in a form of a specific case study.

The Polish mineral reserve base and its potential as a possible source of critical raw materials for the European Union was shown. Taking into account the raw materials that are critical for the European Union economy, Poland cannot be considered as its resource base. The source of these raw materials are not only scarce in Poland, but also they are not produced, and their demand is now - and according to forecasts is going to be in the future - met by imports. However, the role of our country as a manufacturer of finished products from components of foreign origin is anticipated to increase. The raw materials in question are not considered exactly critical for Polish economy, as any industrial branch based upon their utilization has emerged so far. Therefore, they are of limited economic importance. On the other hand, their growth is a best opportunity and at once the need to the future sustainable development of our country and a proper management of rich human resources.

Presumable utilization of limited sources of above-mentioned critical raw materials in Poland could be anticipated in a perspective of at least 20 years. The most probable in this respect are the following: opening out the new Mo-W-Cu ore deposit "Myszków", and the development of exploration works for similar deposits

Critical raw materials and the EU

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A reliable supply of non-energy raw materials is a precondition for the functioning of the European economy. In line with its importance, the issue of raw materials supply has become more prominent in the past years, especially owing to turbulent raw material markets. However, these turbulences are not due to depletion of the geological resources but to a missmatch of supply and demand, with several interacting factors influencing the markets both from the supply as well as from the demand side.

On the supply side, an important role is played by the uneven distribution of mineral deposits on the earth´s crust. This can lead to a relatively high concentration of known reserves. However, this concentration does not necessarily have to match the concentration in production at any time, because the latter is also influenced by political and economic factors.

On the demand side, both global economic growth and new technological developments influence the trends for the different raw materials. As a results, the large scale adoption of emerging technologies may lead to significant changes in demand for mineral raw materials, which require an adjustment in supply.

A recent evaluation, published in June 2010 within the framework of the EU Raw Materials Initiative, sought to bring together these two sides of raw material markets and asked the question "which raw materials are critical for the EU?" The report, prepared by the Ad-hoc Working Group on Defining Critical Raw Materials with the support of Fraunhofer ISI, defines critical raw materials as those exhibiting comparatively high supply risks and at the same time

being of compartively high economic importance. Furthermore, the report presents a transparent methodology for assessing the criticality of raw materials along these two dimensions (supply risk and economic importance). This methodology was then applied to 41 selected raw materials.

This contribution will present the methodology used by the working group and the results obtained. Furthermore, these results will be complemented by examples from the study "Raw Materials for Emerging Technologies" and current case studies in the field of electric mobility.

The yearly exergy decrease in the mineral endowment of the planet

Al. Valero (Project Manager, CIRCE, Universidad de Zaragoza, Spain), A. Valero (Director, CIRCE, Universidad de Zaragoza, Spain)

As man extracts minerals, the natural deposits become depleted in quantity and ore grade, and hence the mineral wealth of the Earth decreases. Exergy can be a useful measure for quantifying that mineral depletion caused by man, as it takes into account the main physical features that make minerals valuable: composition and concentration. Exergy measures the minimum (reversible) work required to extract and concentrate the materials from a Reference Environment (RE) to the conditions found in Nature. Furthermore, through exergy costs, we can account for the actual exergy required for accomplishing the same process with available technologies. Conventional economics only accounts for the energy required in the extraction and refining processes of minerals. Nature exists only to service man and no price is put to the depletion of mineral resources. Nevertheless a fair accountability of resources should also take into account the use and the decrease of the non-fuel mineral capital endowment. This means that the true yearly balance of the exergy decrease in the mineral endowment of the planet should account for at least, the exergy of fossil fuels world production plus the loss of the mineral exergy bonus of the non-fuel minerals. Taking into account the world production and recycling figures of the most important extracted non-fuel minerals, this paper quantifies in universal units (energy units), the annual exergy decrease in the mineral endowment of the planet. The results of this study reveal that the decrease of the global non-fuel mineral exergy bonus provided by Nature each year is in the order of magnitude of the exergy loss associated to fossil fuels. This analysis enhances and puts numbers to the importance and necessity of material reuse and recycling.

Consequences of the RMI and the EU report on critical metals

P. Weihed (Director CAMM - Centre of Advanced Mining and Metallurgy, Technical University of Lulea, Sweden)

The European commission, in autumn 2008, published the report the raw materials initiative - meeting our critical needs for growth and jobs in Europe (RMI). This report highlighted the EU dependence on raw materials for growth and competitiveness of European industry. The report defined 3 pillars:

(1) To ensure access to raw materials from international markets under the same conditions as other industrial competitors.

(2) To set the right framework conditions within the EU in order to foster sustainable supply of raw materials from European sources.

(3) To boost overall resource efficiency and promote recycling to reduce the EU´s consumption of primary raw materials and decrease the relative import dependence.

As a consequence of the RMI, two ad hoc groups of the Raw Materials Supply Group were tasked to advise the European Commission on critical raw materials and sustainable supply in EU. Reports from both groups were published during summer 2010. In the report on critical raw materials a list of 14 raw materials were listed as critical based on: 1) their significant economic importance for key sectors, 2) high supply risks, and 3) lack of substitutes. The report on

sustainable supply concluded that efforts are required to improve the EU´s knowledge base of mineral deposits through better networking and making optimal use of the satellite-based information system GMES and especially highlighted the importance of understanding the subsurface geology of Europe in 3D. In October 2010 the communication on Europe 2020: Flagship Initiative Innovation Union was published by the Commission, which in order to enhance EU competitiveness, with focus on innovation, suggests seven areas where European Innovation Partnerships should be established. One of these areas is defined as Ensuring a secure supply chain and achieve efficient and sustainable management and use of non-energy raw materials along the entire value chain.

Collectively this means that Europe for the first time, at least since the early 1980´ies, again has defined a platform for how to sustainably use its own non-energy raw materials, how a better framework for utilizing new Pan-European in situ resources can be achieved by improved RDI, legislation and cross-border cooperation using best practice. This paper will address the possibilities and challenges this new political awareness can have in a globalized economy and the question how Europe can contribute to a sustainable development by fostering a sustainable supply of raw materials from European sources.

Is a road to sustainable use of non-renewable mineral raw materials possible?

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The principle of inter-generational fairness is generally accepted as a base for achieving a sustainable development: a path allowing every future generation the option of being as well off as its predecessors. We have to look far into the future when investigating a road to sustainable use of non-renewable mineral raw materials.

Concerning non-agricultural resources we can distinguish two systems on Earth: an open system, our energy system, and a closed system of all other non-renewable resources. We receive continuously solar energy input which is the base of all renewable energies except geothermal energy. Solar insolation is 3 to 4 orders of magnitude larger than terrestrial heat flow. In addition there is geothermal energy which practically is limitless.

Thus it is reasonable to use an unlimited source to help to reach the path of sustainability for other non-renewable resources. How can energy help to achieve the goal of sustainability? Fossil energy resources are totally consumed and cannot be recycled. However all other non-renewable resources are only transferred from the geosphere to the technosphere in one form or the other and are available for recycling. This is especially true for metals which are used and not consumed. Recycling requires energy. Although a 100% recycling efficiency is thermodynamically impossible, a stage can be envisioned when most of the material for our industrial requirements can be secured from the technosphere. Curves of consumption over time are learning curves with a sigmoidal shape. When the growth in consumption levels off, there is a chance to create a stage of equilibrium in which major proportions of resources can be recovered from the technosphere and only the excess demand needs to be produced from the geosphere. For the remaining portion which we would require from the geosphere the principle has to be applied that we do not need a raw material as such but only its intrinsic property to fulfil a function. Thus with man's creativity solutions of functions have to be found with all the available resources in the geosphere and the technosphere. The concept of finding different solutions for functions does not work for the essential agricultural fertilizers nitrogen, potassium, and phosphate. There is no replacement for them. The plants need them as such. For nitrogen and potassium this is not a problem because the atmosphere is an inexhaustible source of nitrogen and oceans are full of potassium, meaning with enough energy these elements can always be produced. However, phosphate is different since there is no unlimited reservoir. Fortunately the (reserve + resources

+ geopotential)/consumption ratio is very high, thus giving mankind a time buffer and hereby the chance to develop a complete and practically closed cycle system by e.g. improving more and more fertilizing and recovery techniques.

SUSTAINABILITY REPORTING, ADVANCES IN LCA & SDI

Environmental impact assessment framework of Ali-Abad copper mine

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One of the principal tasks of any EIA is to ensure that the environmental, social and health costs are adequately considered during the selection process of the optimum method of development. The EIA provides a tool to be used to help in determining the economic viability and acceptability of the various project scenarios.

Taft Copper Complex is located in Yazd province, central IRAN. Plants feed will be supplied from Ali-Abad and Darreh-Zereshk deposits. In vicinity of Ali-Abad deposit, Ali-Abad village and its agricultural lands are situated. Because of dry weather of the region, water is very vital for agriculture and it is conducted to the lands by underground water ducts called Qanat, Opening of Ali-Abad open pit will destroy the main Qanat and will change the underground water flows toward the open pit and most of the agricultural lands will be covered by mine stockpiles during pre-stripping.

In these discussions, the most significant environmental aspects that are identified in the Ali-Abad Copper Mine are the quality and quantity of water, pollution of the existing watercourses and post-mining land use, matters such as air and noise pollution are deemed to be of less significance. Analysis has been performed for Do Nothing Alternative, Pre-stripping Phase, Mining Phase, Closure and After-use Phases.

Analysis of the environmental assessment of Ali-Abad Copper Mine was carried out in three stages. In the first stage, the general negative and positive aspects of the project were identified. In the second stage the intensity, magnitude and significance of the environmental impacts of the project were identified. The third stage related to the final conclusions of the assessment team and the relevant reasoning. A modified Leopold Matrix was adopted for evaluating the significance and magnitude of the environmental impacts. For this project, the matrix was modified to allow the assessor to take account of negative and positive numbers

The study has shown that the local community suffers from low incomes, poor housing conditions, and low standards of living and there is an increasing migration away from the area. It, as the one positive development, can improve their quality of life. The EIA has demonstrated that the pre-stripping and mining phases of the project potentially may cause significant adverse environmental impacts. Adverse impacts at these stages in the project are almost inevitable and have been assessed in this study. Effective measures can be taken to avoid or reduce these impacts and these are set out in the Environmental Management Plan.

Life cycle assessment as decision tool for sustainable choices in mineral materials field: environmental declarations of Belgian products and their foreign equivalents

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Introduction

As well known, construction is a very important economical sector, including roads, buildings, houses, terraces, etc. A lot of materials can be used and to help choice, comparison between all products is often made based on durability, reliability and aesthetics. Another important point to consider is environment. Construction field also uses environmental tools as environmental product declaration (EPD) based on a life cycle assessment to classify and inform architects or customers about the different materials.

Pierres et Marbres de Wallonie, association of mineral materials producers, and University of Liège realized environmental declarations of three different mineral products (Belgian bluestone internal and outside paving and Belgian sandstone outside pavement) based on ISO standards 14025, 21930 and French standard NF P 01-010.

Materials and Methods

The goal of the studies was to obtain environmental product declarations (EPD) usable to make comparisons, comprising environmental point of view, between Belgian products or between Belgian and foreign products. Indeed, competition with China (for bluestone) and with India (for sandstone) is very important and environmental impacts can help in deciding. An environmental declaration for foreign products was realized, using only environmental impacts due to transport from production site to Belgium.

The functional unit is one thousand square meters of paving. The boundaries of the systems are the production (extraction and shaping), transportation from production site and implementation in Brussels (Belgium). End of life was neglected due to the inert nature of the paving. Data were provided by producers and a national average of production types was calculated.

Impacts were obtained using CML 2001 methodology as required by French standard NF P 01-010.

Results and Discussion

Impacts on climate change, acidification and resources consumption were calculated based on the life cycle assessment methodology (ISO standards 14040 and 14044) for each scenario. Results show a more important impact in these three categories for the transport of Chinese paving compared to the whole life cycle of bluestone paving. Similar results were obtained with sandstone pavement and transport of Indian products.

Conclusions

CML 2001 methodology was successfully applied to these five studies (three about Belgian products and others studying transport of foreign products) and permits to obtain main environmental impacts as climate change, acidification and resources consumption. Comparison from environmental declarations of Belgian products and only transport for foreign equivalents permits to highlight the importance of this transport on environment and to promote, supposing equal performance, Belgian products.

Tools for assessing and reporting mining sustainability: Challenging the oxymoron?

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Recent years have seen a proliferation of tools for assessing and reporting mining sustainability. While these tools vary substantially in scope and approach, they all seem to share the goal of better informing decision-makers about the future implications of mining to the environment and society. Whether they do so, however, remains an open question. The purpose of this paper is to describe, compare, and critically analyze five sustainability assessment and reporting tools used in recent years by mining companies, governments, and industry associations. Based on 23 interviews and extensive literature reviews, the paper highlights the underlying assumptions of

those tools and presents a diagram that helps to clarify aspects such as temporal orientation, geographical scope, and quantity and types of indicators. Four out of the five tools analyzed were found to follow a silos approach to assessing mining sustainability, while overlooking trade-offs and synergies among sustainability dimensions. None of the tools seemed fully capable to shed light on the problem of mineral scarcity and the effective legacy of mineral operations. The paper concludes by emphasizing the need to carefully consider the information generated by those tools. Future research needs are finally recommended.

Development of a holistic tool for assessing the environmental sustainability of mining facilities

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The dynamic nature of the environment, the constant modifications of the industrial systems and the pressure from the society have forced mining industries to develop and apply efficient tools in order to analyze and assess their environmental performance and sustainability. In that aspect the development of a tool for assessing the environmental sustainability of mining facilities is described in this study. The development of the tool is influenced by the principles of Industrial Ecology. Industrial Ecology consists of various holistic and systemic concepts and tools that try to simulate the way that nature works by eliminating material and energy losses thus leading to sustainability. Thus, notions such as recycling, life cycle thinking, renewable energy utilization, dematerialization and so forth are incorporated into the proposed methodology as far as possible. The tool is based on the analysis of basic components of the examined system, i..e, the quantities of the incoming materials and outgoing wastes, their hazardousness and scarcity, the utilization of water and energy resources, and the biodiversity. The developed tool provides both qualitative and quantitative assessment of the environmental performance of a facility in a broad time scales (past-present-future) and is easily applicable from non environmental experts. Moreover, a relative software is developed to further support the application of the methodology. The implementation of the tool is expected to lead to an improved understanding of the environmental performance of a facility and more importantly identify the areas of significant environmental concern. However, based on feedback from industries, a number of shortcomings of the approach have been identified so far and are presented, indicating further actions for the advancement of the proposed tool.

The evidence theory in the construction of linguistic variables for mineral industry

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Among other types of sustainability indicators, linguistic variables have been proposed. During the past few years considerable effort for using the fuzzy logic and linguistic variables in environmental decision-making for the mineral industry has been made. The linguistic variables defined could, among others properties, describe the property of acceptability for environment for various environmental indicators. Some proposals for construction of such variables are based on administrative decisions from environmental impact assessment procedures for mining, which provide information for acceptability of quality kind for environment (e.g. obtained from public participation, experts, environmental administration).

The measures of evidence for construction have to be based on sets (not only on the members of sets). The administrative decisions with their statements and explanations could be considered as such sets. The measures of evidence appropriate are plausibility and belief measures. Using the

more elaborated methods from the theory of evidence, the better estimation of those measures could be achieved.

The methods of constructing the linguistic variables, previously suggested and based on obtained measures, are also discussed.

to be announced

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Serving information requirements on environmental and social dimensions of mineral extraction by earth observation methods: First results from EO-MINERS

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The extraction of mineral resources (aggregates, minerals, metals and fuels) is prerequisite for deriving benefits and services from them for a sustainable development. In spite of extensive scientific discoveries and technological advancements, the enormous increase in production volumes within the last decades has induced sizeable environmental pressures at different stages of the life cycle of products. A significant part of these pressures takes place due to the extraction and processing of these mineral resources. Beside environmental pressures, social issues associated with mining are to be considered, as the social acceptability of the mining activities has become for mining companies one of the key issues to be dealt with.

The Framework Programme 7 project - Earth Observation for Monitoring and Observing Environmental and Societal Impacts of Mineral Resources Extraction and Exploitation (acronym: EO-MINERS) - aims at integrating Earth Observation (EO) tools to improve best practice in mining activities and thus to assist the global mineral resources industries in their transition to sustainable development (http://www.eo-miners.eu). EO-MINERS will develop such earth observation products and services; and test their applicability on three mining sites. As part of this project, EO techniques are assessed with regard to their capacity to support monitoring systems with help of a global review of former and ongoing achievements in the development of earth observation techniques including their degree of success.

The information requirements to be served by the EO products are divided into requirements at site/regional and at the global level. Accordingly, the analysis of information requirements is based on (a) interviews with stakeholders, (b) site conceptual models, and (b) a review on corporate and public policies. These elucidated requirements form an input to an indicator development process that will potentially result in a set of environmental and social indicators at different levels. The development is supported by a SWOT analysis on existing "footprinting methods" and an examination of already existing indicators. The indicators to be derived are envisaged to reflect main information requirements at the different levels. EO-MINERS will develop procedures and methods for the application of EO techniques to meet stakeholders´ information requirements based on stakeholder elucidation procedures and will develop protocols for such undertakings. By doing so, it will show the viability to populate indicators by specific EO products.

SOCIAL SUSTAINABILITY

Corporate social responsibility within the mining industry: Case studies from across Europe and Russia

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Responsible mining requires a company to engage with local communities throughout all stages of their operations, from exploration phases through to post mining planning. Assessment of current and potential future social impacts allows a company to maximize the positive impacts they can have on a community, whilst minimizing negative social impacts from mining. Initiating and upholding effective stakeholder relations are key to a company´s ability to obtain and maintain their "social license" to operate.

The level of interaction between mining companies and stakeholders, including local communities, varies substantially between and within countries. As part of the EU funded Framework 7 "ImpactMin" Project (Impact Monitoring of Mineral Resources Exploitation), we have examined the level of community engagement in mining and related processing industries at sites across Europe, including Romania (Rosia Montana), Sweden (Kristineberg), the UK (Cornwall), Bosnia Herzegovina (Vihovici) and Russia (Karabash, Gay and Mednogorsk). These sites reflect different stages in mining and therefore reveal a diverse range of issues and differing levels of community engagement. Our aim has been to focus not only on how practice varies, but also to try to explain the complex reasons behind the relationships that exist between mining companies and different stakeholders. Findings of questionnaires undertaken across the sites (between June - October 2010), and results of interviews and focus groups of different people linked to the mining industry, will also be discussed.

The expectations that "mining" communities have of their local mining company vary substantially, directly relating to what the community believes the mine company owes them. These examples highlight that the notion of corporate social responsibility in the mining sector in Europe and Russia is fluid and changes according to the differing expectations and goals of stakeholders. We will present highlights of initial results. For example, Rosia Montana Gold Corporation, in Romania, is trying to reopen closed state gold mines. They have seen international media attention relating to campaigns by NGOs to oppose the mines reopening. Our results will help reveal what samples of different stakeholder groups really think of the mines reopening. This example contrasts distinctly with a mine in Kristineberg, Sweden, where Kristineberg village was built alongside the mine. There are now distinct issues felt within the community due to the decline in the number of people employed at the mine.

Culture, a pillar in your sustainability initiatives

M. Arias (President, Mafalda Arias and Associates, Canada)

Most mining and mineral exploration companies operate in remote locations, either locally or internationally. To be aware of the culture of the country where we operate is one of the pillars of

our sustainability initiatives; it will increase productivity, benefit the communities and become a bridge to built trust.

The role of our industry is essential to future societal needs and to set the foundation for a better world, it is important to built trust and relationships inside your global team, within communities and together with stakeholders. Building the "invisible asset" and developing intercultural awareness is an important part of leadership programs for geologists and engineers on your team, and should be a key component of your sustainability initiatives.

Why is culture important for mining and mineral corporations in their sustainability initiatives? Because culture is the foundation of your organizational identity. Understanding the impact of identity, for an organization and for each individual, will provide a description of the experiences and values that affect every work placed interaction, with your clients, with colleagues, with suppliers, with the community of the host country. Each one of us sees and evaluates the world through our perceptions. Through these perceptions we give meaning; how we view and understand our reality which sets the tone for how relationships are built. This is what I call building the "invisible asset".

Identity, experiences, values and beliefs are invisible commodities, locating them can be as difficult as finding a mine. But if they are not located, the commodity does not have value, and consequently there is no contribution to society. Just like in the work we do in our industry. For example when you are working in an underground gold mine and the vein is lost, you keep on working and trying to find the vein; time passes, money is being used and no results. After a few attempts, you bring an expert on this type of deposits who gave you directions that allowed you to find the vein. This expertise, in intercultural terms is called intercultural competence, one of the qualities of a global leader.

To set the foundation for a sustainable world, it is imperative to go as deep as your next drilling program or the next level in the mine, because only there and then, that can you develop the cultural sensitivity and the ability to become an agent of change for responsible, sustainable and profitable businesses.

Overcoming local conflicts and production needs related to mining. Social impact assessment and local participation

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Mineral raw materials industry is a key-component of the Gross Domestic Product of industrialized economies, e.g. providing a total value added of #1300 billion in European Union (2005), closely related to both the building sector (construction minerals) and the industrial sector (industrial minerals).

Although securing an adequate supply of building materials is a strategic aim of industrialized countries, availability of aggregates is affected by their geographic distribution and some environmental restrictions. Despite the increasing reduction of available areas on behalf of other land uses, e.g. urban sprawl and nature protection areas, a continuous growth of the global demand for aggregates it is expected.

While the need for resources is a widely recognized issue, at local level mining and quarrying are associated with both an irreversible environmental damage and several visual alterations affecting the natural landscape. As local communities mainly see their need of natural environment preservation, they give rise to strong conflicts exacerbating the access to aggregates resources. These problematic issues started to require particular attention by mining companies, who ought to be able to handle the growing social implications.

In this sense, the SIA (Social Impact Assessment, as US National Environmental Policy Act, 1969 and the Mackenzie Valley gas pipeline inquiry in Alberta, 1974-8, have defined) has become a strategic tool that can not only improve the prediction but also the assessment of the social impact by involving the local communities into a participatory process. SIA can also provide a data collection regarding the needs and attitudes of the involved communities, outlining a community profile which proves to be really useful at the end of the life cycle of the quarry, assisting the decision-makers in their research for redevelopment measures.

Taking into account the SIA experience, together with the examination of some relevant international case studies, it is possible to draw up a list of good practices for the redevelopment of aggregates quarries. Such good practices will complement the existing studies, focused on environmental issues, with the social issues arisen by the SIA application on the decision-making process of the rehabilitation of mining sites.

Responsible coal sourcing: Taking the next step

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As one of the largest private utilities globally, E.ON currently operates hard coal fired power stations in Germany, Great Britain, the Netherlands, Belgium, Sweden, Italy, Spain and France with a total installed capacity of some 20.000 MW: These thermal power plants consume domestic coals e.g. from mines in Germany, Great Britain and Spain but are increasingly dependent on imported seaborne traded coals. In 2009 these volumes totalled approximately 17 mn t of coal, which was procured by E.ON´s trading arm E.ON Energy Trading GmbH.

Knowing that the company´s reputation and credibility depends in part on how E.ON lives up to the responsibilities along the entire energy value chain, E.ON takes a collaborative approach with the various suppliers. Hence, E.ON´s responsible policy also applies to the procurement of coal; the utility launched in 2009 a comprehensive Corporate Responsibility program with special focus on supply-chain audits. One of the first coal audits focussed on the Cerrejon coal mine in North eastern Colombia - being with 30 mt annual output one of the largest coal export operations world wide of which E.ON purchases approximately a tenth.

The authors will share the key learnings and experience from the Colombian audit jointly conducted with an independent auditor and E.ON experts from the Corporate CR and E.ON Energy Trading. Besides interviews with randomly selected mine employees and managers, also local community members did participate. Issues covered included the mine´s health and safety performance, as well as, working conditions, resettlement policies and land rehabilitation, the impact on indigenous population and the engagement of the Cerrejon mine with the local communities. Starting from these first steps the paper will shed a light on the way forward to E.ON´s efforts on responsible steam coal sourcing.

Social impacts of the local procurement of goods and services

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Many large resources companies recognise the potential positive impact that procurement can have on the local economy and have developed procurement policies favouring "local content". The benefits of corporate procurement from local smaller to medium enterprises (SMEs) are widely accepted. Beyond creating business for suppliers, local procurement also leads to further economic activity and attracts further investment, as suppliers engage other suppliers for inputs, and through the multiplier effects of employees spending some of their wages in their

communities. Other benefits include improving the quality of life for employees, dissemination of new technologies and innovation to other market participants, and attraction of investment in social infrastructure. However, local procurement targets can also encourage perverse behaviour and adverse social impacts. What is ultimately at issue is the capability of the community to supply goods and services. Local people are often drawn from other businesses and much-needed services in the area. SMEs can be left vulnerable to the business cycles of large corporates. Community dissatisfaction can result from seeing only menial works being given to local people. Targeting particular groups can negatively affect social cohesion. A better approach may be to transition into targets in a way that leads to community wellbeing and quality of life. This paper explores what such an approach would look like, starting with an understanding of the role SMEs play in the local economy and their barriers to participation in the supply chains of large corporates. While much has been written about SMEs as a powerful vehicle for economic growth and poverty reduction, this paper will attempt to provide a more comprehensive framework to predict, manage and monitor the social impacts at community level, with the goal of maximising the social and economic value realisable from corporate procurement.

Producing a GIS based multiple hierarchy decision making for social and environmental sustainability assessment in a copper mine in Iran

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Decision support tools will be useful in guiding regions to sustainability. Multiple Hierarchy Decision Making (MADM) is often used as a decision support tools for a wide range of applications. This method allows many criteria to be considered at one time. It does by giving a ranking of possible options based on how closely each option meets the criteria. Thus it is suited to the assessment of regional sustainability. Coupling MCA with Geographical Information System (GIS) to produces maps, allows this analysis to become visual.

Darreh-Zereshk deposit is one of the deposits supplies ore to feed to Taft copper Complex in Iran Yazd province. The Darreh-Zereshk deposit is situated underneath a village with the same name. In order to mining activities being commenced, the village should be dislocated and obviously, during mining activities all agricultural lands will be covered and concealed by mine stockpiles. The first stage in these studies is making decision about beginning of mining activities considering sustainability factors, and then optimization of mine design for a sustainable development.

This paper discusses about sustainability factors in this area including: Social and environmental effects of mining, dislocation of an old farmer community and substitution with a new blood industrial community, created and lost jobs, financial and economical factors, quality of life index, infrastructures and post-mining land use.

The results of these studies revealed that, considering the infrastructures developed for mine and plants and obtained incomes and changing the community, mining activity in this area not only do not decrease the social and regional sustainability but also improves it to a higher level.

Social license in design: Constructive technology assessment within a minerals research & development institution

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Technological innovation in the minerals industry is driven by the need to improve performance and efficiency according to economic, social, and environmental criteria. While innovation is essential to sustainability, the adoption or transfer of new technologies may also result in considerable contestation. The mining industry depends not only on the availability of resources but also on the public acceptability of the technologies and methods employed to extract and process them.

Inappropriate technology can lead to considerable harm to the public, mine employees as well as the environment. Social or environmental harm may also lead to tangible and intangible costs to industry including reputational loss, costly retro-fitting and even the closure of an operation due to a loss of social license. Conflict can be embedded in technology because, once sunk into a landscape, mining technology can be difficult and very costly to retrofit - so, to some extent, the future outcomes are set within the technology.

It is for these reasons that it is crucial to consider the future operational context within the design of mining and minerals processing technology. Constructive technology assessment during the design phase of technology development can help to understand and reduce the potential for conflict to be embedded within technology and to understand the circumstances in which a technology is contextually appropriate.

This paper outlines the possibilities and rationale for incorporating technology assessment into technology development within the CSIRO Minerals Down Under National Research Flagship. The paper will outline a process that attempts to reduce social risk and enhance the opportunities of mining technologies by utilising forecasting techniques and accounting for the perspectives and values of decision makers and likely stakeholders.

The role of employee capacity building in reducing company-community conflicts in Peru

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In Peru, the third worldwide exploration destination based on expenditure, mining conflicts have spread dramatically to the point that the country may face a crisis that could hinder the long-term viability of the nation's mining industry . The Peruvian Government has shown a lack of capacity to successfully promote the benefits of the industry, manage conflicts and remediate grievances. Mining companies need then to create new initiatives to avoid social conflicts, improve abilities for the acquisition and retention of the social license to operate, and strengthen the social capital needed to keep mining in a country with proven mineralogical riches. To address the challenge, this paper provides information about a research project that has explored the opinions, perceptions, experiences and recommendations of a resource many times overlooked by companies: the human resource.

Over 30 surveys were conducted among professionals, from different departments and from different organizational levels, working at mines in the Peruvian mining industry. The research found that participants acknowledge what may have been forgotten by companies: that mining employees play a vital role in the development of company-community relationships, and that the deterioration of those relationships originates in the way these relationships are conducted at the individual level.

Mining employees give their impressions on why initiatives implemented by international mining companies proved inefficient in Peru and provide their recommendations to succeed in a location where cultural differences have not been considered properly. Participants also express their opinions about current organizational cultures and the impact of management commitment (or lack of it) on community affairs. Employees also give their suggestions on transforming arrogant attitudes into a culture of tolerance.

Finally, the study shows that a vast majority of participants (75%) are willing to learn and build capacities to effectively deal with local communities. But it is them who enumerate recommendations, based on their experience, on how to achieve so. Proving that mining employees constitute a key feedback source and should definitely be part of the companies´ strategic plans to successfully avoid conflicts and remediate grievances.

to be announced

J.-F. Hake (Director, Forschungszentrum Jülich GmbH, Germany)

Managing land use conflicts for sustainable futures: Tourism, agriculture and mining

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This paper considers several mining ventures which are occurring in rural communities in Galicia, Spain and Western Australia, Australia. It compares and contrasts the communities where mining is taking precedence over other industries, examining the potential land use conflicts and the future of both the communities and the mines currently operating there.

The Galician case study, Trevinca, is located 200 km inland and was once a primary producing area, notable for its scenic attributes, most particularly alpine landscapes, which have since been developed for small scale tourism purposes. Consistent with other remote, rural locations, Trevinca has an ageing demographic profile, services have been rationalised and depopulation trends have been evident for some time as young people move away to seek work elsewhere. This is despite the most lucrative local industry being slate mining. Most of the workers involved in this industry drive in and drive out (DIDO) from elsewhere and hence, many of the regional economic capital derived from slate extraction flows to other communities.

The Australian case study, Boddington, by contrast, is located 100 km inland in what has traditionally been a highly productive sheep grazing area. Mining, until recently was a marginal industry in the area but due to the comparative devaluing of agriculture and the increased value of mining outputs, two mines, one extracting bauxite and the other gold and copper have increased scale and economic importance. The local population has now reversed its downward trend and there are considerable local growth pressures, particularly regarding housing. The mines´ workforce is a combination of DIDO and residential with the intention that the majority of workers will live locally.

This paper will consider the environmental, social and economic impacts that have occurred in both the case study localities and whether strategies for the lifecycle of the mine are

complimentary for the long term future of the communities supporting them. Where there have been land use conflicts, strategies for minimising the adverse outcomes will be considered.

Growing pains in Australian regions in transition: Evidence of the "resource curse" or an absence of integrated planning?

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The recent sustained expansion of export-oriented mineral extraction projects in Australia has been accompanied by socio-economic, governance and environmental trends frequently identified in the literature as markers of a "curse" that afflicts resource dependent national economies. Such trends are highly spatialized. Goodman and Worth (2008) for example draw attention to processes of deindustrialisation associated with a strengthening dollar and redistribution of high paid jobs, that have exacerbated disparities between the mineral resource rich states of Western Australia and Queensland and the New South Wales manufacturing-based economy. Simultaneously, studies in remote, sparsely populated, mining localities reveal similar intra-regional disparities between indigenous populations, the service sector and elite mining enclaves in terms of access to housing, jobs, services and key infrastructure.

This paper is concerned with elucidating the impacts of new and expanding mining operations within two established agrarian regions which are also richly endowed with mineral wealth. It draws on grounded research conducted through the CSIRO Regions in Transition project which closely examines several communities experiencing growth due to mining in localities which hitherto have been dominated by agriculture. The transition to a new industry base brings with it considerable costs and benefits associated with new population cohorts, work opportunities and regional development. Although the notion of "resources curse" offers a useful framing device, following Norman Long s(1996) observation that the global is always experienced and acted on locally, we argue that understanding complex site specific layers and networks of meaning, experience and structure through which the impacts of new mining are mediated is crucial to effective policy formulation and more equitable distribution of economic and social benefits.

Through our research conducted in entirely different parts of Australia, we examine whether the issues identified are in fact evidence of the resource curse or rather impacts occurring at the regional level that are driven by intersecting/ overlapping extra-regional, and often more powerful, influences. We also consider whether better informed and more prescient planning could avoid regional level growth problems, and thus devise strategies for other communities and regions which would assist in avoiding some of the adverse consequences experienced in the case study sites examined and the broader economy and society affected by industry change and growth.

Can human rights contribute to social sustainability?

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The proposed paper will explore how human rights can contribute to social sustainability in the mining sector, both in theory and in practice. Globally, there is an emerging consensus that companies have a responsibility to respect international human rights standards; and, depending on the operational and country context, this responsibility can go far beyond compliance with domestic laws. In order to demonstrate the appropriate human rights due diligence, mining companies should undertake human rights impact assessments (HRIAs), and should integrate human rights standards into their policies and procedures for corporate sustainability.

In an era of globalization and trade liberalization, it is understood that the conduct of companies can have significant impacts on human rights, both negative and positive. Given the large footprints of mining operations, it is not surprising that their human rights impacts are increasingly scrutinized.

In 2008, the United Nations adopted the "Protect, Respect and Remedy" policy framework that distinguishes between the State 's obligation to protect human rights; the corporate responsibility to respect human rights; and their shared duty to provide access to remedies. Respecting human rights means that mining companies are responsible to "do no harm" to the people and communities affected by their operations.

HRIAs are one of the main tools that permit companies to demonstrate due diligence for human rights.The paper will discuss the findings of the HRIA of Goldcorp `s Marlin Mine in Guatemala, in which the authors participated. The first company-supported HRIA to be published in its entirety, the Marlin Mine assessment addresses the human rights impacts associated with the company 's practices for consultation; labour relations; environmental management; land acquisition; security; social development; and, access to remedies. Goldcorp publicly responded to the HRIA and accepted the majority of the assessment 's recommendations about the Marlin Mine and committed to integrating human rights into its global operations.

In conclusion, the authors will draw the following lessons-learned:

- HRIAs should be undertaken an early stage of project development before negative human rights impacts are alleged or occur.
- Human rights should be integrated into broader policies and procedures for corporate sustainability. This includes integrating HRIAs into ESIA processes, and integrating human rights due diligence as part of corporate governance.
- Pressures on mining companies to respect human rights will not disappear; therefore, a proactive approach to human rights is a fundamental component of a broader strategy for sustainability.

How does a social licence operate? Modelling intergroup expectations, trust and behavioural intentions between companies and communities

K. Moffat (Social Research Team Leader, CSIRO, Australia), R. Parsons (Social Researcher, CSIRO, Australia)

There is often a disconnect between the measurement of sustainability indicators for resource extraction operations and engagement with local communities around issues of concern. Recent work has addressed this issue to some extent through advocating participatory approaches to indicator development and measurement by affected local and regional stakeholders. For companies, this direct engagement with communities to help frame the way in which they will be held accountable for their social, environmental and economic impacts contributes to the development of what is frequently referred to as a social licence to operate. Yet the process and mechanism of developing a social licence among key stakeholders is poorly understood. In this research, the social licence to operate construct is explored as a framework for connecting the indicator-driven sustainability and relationship-focused community engagement agendas. Moreover, the process of developing a social licence is explored in detail, drawing on corporate social responsibility, social network and social psychological literatures to develop a model of social licence that may be tested in the field. Quantitative and qualitative data will be presented from a case study in the Surat Basin region of Queensland, Australia to test this model in a resource extraction context. Specifically, using advanced multivariate statistical methods, the modelled relationship between the expectations of key stakeholder groups regarding a range of key impacts, trust, and behavioural intentions of stakeholders toward each other will be presented. Qualitative exploration of these relationships with stakeholders (i.e., the nature of

trust) will also be presented to contextualise the quantitative output. Finally, next steps in this program of research will be presented, including representing key elements of the social licence spatially as a tool to facilitate more effective engagement between stakeholders in resource extraction regions.

Influence of work culture on job satisfaction of mining engineers: A case study

K. Ram Chandar (Assistant Professor, National Institute of Technology, India)

Mining is one of the oldest profession and second after agriculture. Unfortunately Mining is not so familiar in the society. Due to lack of recognition in the society, existence of mines in remote places and comparatively working in dusty and humid conditions, led the poor response for mining engineering. In the last 25 years no institute has started a mining engineering department in India. The same situation exists in many countries world wide. Mining engineering programs have been increasingly less attractive to the student population over the years due to negative image of the mining industry and poor financial condition of past, lack of recognition, poor work culture, etc.

Generally after graduating in mining engineering, there is not much problem of employment at present. In the last 15years most of the mining engineering graduates have joined software industry. Even those joined in mining industry also left with in 2 years of service. The main reason for this is not being satisfied with job, it is not only working conditions but also work environment, work culture, remote location of the mines etc. Though many were trying to leave mining profession, the economic slow down has prompted some of them to incline towards job safety and retained to mining job.

At this juncture a systematic study was taken up to analyze the job satisfaction of mining engineers in India. A questionnaire was prepared on various aspects to assess and find the influence of work culture, work conditions, facilities provided, perception of family members etc on the job satisfaction of mining engineers. Each question was given five options like strongly disagree, disagree, cannot say, agree and strongly agree. The paper deals with the effect of work culture on job satisfaction. The data was collected from the 120 mining engineers working in different coal mines in India based on random sampling technique. Analysis was carried out to assess the influence of each parameter on job satisfaction. It was found that 9 per cent strongly 40 per normally agree that their senior officials behavior disturb the mining engineers mentally. 66 percent said the bossism is very high in mining industry (Fig.1). 64 per cent said the work culture is not at all cordial or peace full. 67 per cent said they face problems from trade unions in day to day job. The complete analysis, including the influence of each parameter on job satisfaction will be presented in full paper. This study revealed very important conclusions, in finding the main parameters which causes job satisfaction / dissatisfaction of mining engineers in India, where some important measures can be taken up. These measures will be useful to enhance the job satisfaction, which can attract the not only young mining engineers but also retain the existing people to serve the mining industry in particular and to the society in general, as the progress of a country depends on growth of Mining industry now a days.

Health research studies in British Columbia mining communities

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This paper is based on a recent project on the demographic, economic, and health fabric of mining communities in British Columbia, Canada. The project, funded by the Canadian Institutes

of Health Research, the Social Sciences and Humanities Research Council of Canada, the British Columbia (BC) Government, and supported by the Mining Association of British Columbia, and the BC Rural and Remote Health Research Network, was a collaboration between mining engineering and health researchers at the University of British Columbia and the University of Victoria. We used mixed-methods, to investigate the health of mining communities in BC. Firstly, a quantitative component merged census, mining industry, and health data to investigate the relationship between declining economic conditions and mental illness and stress-mediated cardiovascular disease. Secondly, a qualitative component investigated community health issues associated with the mining boom-bust cycle from the perspective of health and social service providers working in a Northern BC coal mining community. Thirdly, we disseminated health research findings to potential knowledge users in the hope of enhancing mine impact assessment and community sustainability planning. This paper is a synthesis of research methods employed in this dissertation, highlighting the main indicators used and the main findings, and identifies future research needs of particular importance to the health and sustainability of mining communities in BC, Canada.

FAB SESSION

Bundling of german expertise in sustainable raw material economy

H.D. Brenk (Chairman of the German Federation of International Mining and Mineral Resources and President of BS - Consultants GmbH, Brenk Systemplanung GmbH, Germany)

The German Federation of International Mining and Mineral Resources (FAB) is a federation of German companies that are active in international mining and mining related business.

The FAB presents a platform for the exchange of information about the worldwide mining commodities in the dialogue with German and foreign institutions.

The expertise of the member companies in mining and related activities is based on a long term operation and consulting experience in Germany and abroad. This forms the basis for the special international competitiveness "Made in Germany".

The FAB is particularly engaged in the following topics and tasks and acts as a focal point for:

- International project developments with the German mining industry
- Sustainable mining, consulting and equipment services
- Geological and environmental technologies
- Project financing
- Intermediation of contracts, project enquiries, professional symposia and events

The FAB acts as a contract- and coordination site for international business partners, organizations and governmental authorities. Together with the Federal Government FAB organises bilateral working group meetings in the commodity and mining sector. Project enquiries are being distributed from the FAB among their member companies.

Transfer of german environmental expertise for mine site rehabilitation challenges worldwide - A case study: Vietnam

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Vietnam is one of the world's leading producers and exporters of anthracite coal. With a total production of 38.9 Mt and a coal export of 29.8 Mt in 2006, Vietnam was one of the major suppliers of anthracite coal in the Asia and Pacific region. The majority of Vietnam's coal resources are hosted by the upper Triassic (Norian) Quang Yen basin in northeast Vietnam. The Quang Yen basin covers an area of about 5,000 km² and contains estimated anthracite resources of 3,300 Mt. Situated in the eastern part of the Quang Yen basin, the Hong Gai coal field has been the main coal mining area of Vietnam for more than 150 years. Here, various coal seams with a thickness of up to 50 m are exploited in several open pit and underground mines in the coastal area of Hong Gai / Cam Pha, situated close to the UNESCO world natural heritage site Ha Long Bay. The mining-induced environmental impacts such as dust emissions, acid mine drainage, and visual impairments due to waste dumps resulted in severe conflicts of interests regarding future land use and the protection of the world natural heritage site Ha Long Bay with its high biodiversity and its distinctive karst landforms.

In this context, Brenk Systemplanung (BS) is working within the RAME R&D project (Research Association Mining and Environment in Vietnam) supported by the German Federal Ministry of Education and Research (BMBF) and the Vietnamese Ministry of Science and Technology

(MOST) in close co-operation with the Vietnamese coal and mineral resources company VINACOMIN. The aim of BS' engagement in this context is to improve the environmental conditions in Quang Ninh by developing suitable and sustainable technology and planning measures for the mining industry in Vietnam. Major issues addressed in the frame of RAME comprise (i) water management and treatment in the mining regions, (ii) stabilisation and recultivation of waste rock dumps, (iii) dust mitigation and monitoring, as well as (iv) capacity building and building-up of environmental awareness in Vietnam's mining industry.

This case study describes concepts and planning tools (e.g. for dump construction/rehabilitation, predictive modelling, and/or monitoring) tested and approved exemplarily at VINACOMIN's Nui Beo Coal mine that then will be transferred to other mine sites and will contribute to an improved environmental and sustainable planning in Vietnam's mining industry and the reduction of environmental impacts on Ha Long Bay.

METSI - Innovative solutions and technologies for management of mining related water in South Africa

R. Schwarz (Geschäftsführender Gesellschafter, Geotec Rohstoffe GmbH, Germany), E. Pusch (Geotec Rohstoffe GmbH, Germany), A. Juch (Geotec Rohstoffe GmbH, Germany)

The presentation describes in general the objectives, goals as well as theoretical background of "METSI"-project proposal submitted to German BMBF (Federal Ministry of Education and Research). The METSI project is a starting point for technology and know-how transfer of German water purification and treatment technologies to South African Mining industry.

"METSI" is Setswana, one of the eleven official languages in South Africa, and means "water". It stands also for "Management System for the Implementation of Environmentally Sound Water Supply Technologies in South African Mining Areas with Involvement of all Relevant Stakeholders"

The team consists by August 2010 of sixteen German and nine South African institutions of science and business.

The project focuses on development, design and implementation of mathematical models that consolidate and evaluate existing data and generate substantiated projections of "water" amount and quality. For this all relevant parameters on the surface (inter alia, water catchment areas, environmental impacts caused by mine sites) and underground (inter alia, shafts, "decant" issue, acid mine drainage), will be registered and sorted according to amount of waters and parameters (inter alia, chemism, pollution level = toxic metals, uranium).

METSI covers a wide range of scientific, technical, social as well as economic questions related to "water in mining": export of technology and experience in the field of complex water management in mining areas, know-how transfer in the field of employment of specialised sensors and data management software, ecologically and economically sound use of disused mines (use of the energetic potential of hydraulic conditions and methane gas for the generation of energy in an environmentally and climate-friendly manner), recultivation of post-mining landscapes (ecological reduction of pollutant emissions, adding to the value chain and creating additional economic benefit by implementing supplementary measures such as cultivation of energy crops on devastated land) will take place.

The German water treatment and purification technologies will be adjusted to conditions at model or pilot sites. The model sites have been identified so far as following:

a. Johannesburg / Gauteng´s Central Basin,

b. KOSH area (Klerksdorp - Orkney - Stillfontein - Hartebeesfontein),

c. Welkom area (Matjhabeng Municipality), and

d. Wonderfonteinspruit.

Two other aspects are stakeholder involvement (know-how transfer in regard to a fair reconciliation of interests between all parties involved) as well as know-how transfer and capacity building.

Engineering solutions for sustainable development in German hard coal mining

H. Witthaus (Dienstleistung Bergtechnik, RAG Mining Solutions GmbH, Germany)

Various technical developments in German hard coal mining result in aspects of economical, environmental and social sustainability. The report of the RAG Mining Solutions gives examples of engineering solutions that serve the sustainable and efficient processing of the coal deposit and at the same time protecting the human resources, reservoir and the environment. Especially by the fact that the mining activities takes place as underground mining in heavily populated regions, also sustainable solutions are required for decades.

The enumerated examples describe the focus of improved efficiency and safety in underground mining, making exhaustive use of the deposit and at the same time minimizing of mine damages, as well as protection of the environment by long-term management for mining areas during and after operation of mines.

The examples describing the enhanced efficiency and safety in the German coal mining do show that both innovation in technology and understanding of complex systems are used for comprehensive engineering solutions.

The analysis and statistics of accidents in German hard coal mines demonstrate the sustainability of the improved safety in underground measures. Within the last 15 years the number of accidents was reduced consequently. As an example for technical development the safety elements on longwall equipment are figured out.

Modern and sustainable mining technology includes automated processing. The report gives an overview on modern control room technology in German coal mines. This development allows the application of intelligent machinery and sustainable High tech solutions for mining.

In cooperation with partner companies, other aspects of sustainable use of nature by RAG are met. As an example from the environmental management the report includes the demonstration that stockpiles of mine waste today arise as versatile and ecologically valuable landscape structures. Also sustainable water management in a densely populated area is realized and results in a comprehensive ground water management to avoid environment being affected in its use after closure of mines.

Services of engineering can be applied to other mining areas of the world.

RWE SESSION

Sustainable lignite mining and utilization in the Rhenish lignite area

In the Rhenish lignite area, located between the cities of Cologne, Düsseldorf and Aachen, RWE Power extracts up to 100 million tons of lignite per year from three large-scale opencast mines, Garzweiler, Hambach and Inden. Some 90% of this output is used for electricity generation in five mine-mouth power plants with a total installed capacity of 10,000 megawatts and some 10% goes to three upgrading factories to make about five million tons of dry lignite products (mainly lignite briquettes, pulverized lignite and lignite coke). Acceptance by the people living in the immediate vicinity of the lignite operations and by the general public and policy-makers crucially depends on the sustainability of lignite mining and utilization. It also requires overarching, integrated planning and approval to ensure an ongoing development of the opencast mines and the modernization/renewal of the power plants/upgrading factories under due consideration of the three goals of energy management, i.e. economic efficiency, environmental/climate compatibility and security of supply.

Meeting the statutory requirements incl the resulting stipulations under approval law, e.g. extensive dewatering to provide dry conditions in the opencast mines that requires some 550 million cubic metres of water to be raised each year in the Rhenish lignite area, is indispensable even under changing framework conditions and calls for a continuous further development of the processes and procedures applied and the technologies used.

This applies also and particularly to the three opencast mine operations themselves that, based on continuous mining and conveying technology with a total of 14 bucket-wheel excavators, 17 spreaders and some 250 km of conveyor belts of the capacity class up to 240,000 m^3/d, are designed for a production capacity of over 100 million tons of raw lignite and about 500 million cubic metres of overburden. To maintain competitive and calculable raw lignite costs over the long term and ensure environmental compatibility, e.g. protect the neighbourhood from mine-related effects, a continuous improvement process needs to be established--also with a view to increasingly stringent approval stipulations.

Another important prerequisite for acceptance is a sustainable rehabilitation of the land affected by lignite mining. With an annual approx. 300 hectares each of land consumed and reclaimed, the record in the Rhenish lignite area is a balanced one. Rehabilitation must not only fulfil exacting agricultural, forestry and environmental requirements but increasingly take account of recreational use options. This reflects RWE Power's strong commitment to the region that goes beyond the mere operation of opencast mines and power plants/upgrading factories and aims at strengthening the region over the long term, among others by jointly developing residential and commercial estates and taking other measures that add value to the post-mine landscape within the scope of regional cooperation schemes.

Holistic planning and approval of sustainable lignite mining and utilization

L. Kulik (Head of Lignite Planning and Approval, RWE Power AG, Germany)

Water management measures in lignite mining marked by the Water Framework Directive

C. Forkel (Head of Water Management, RWE Power AG, Germany), J. Wendeler (Head of Water Supply Planning, RWE Power AG, Germany)

Using the continuous improvement process to optimize opencast mine operations

D. Gärtner (Head of Opencast Mine Segment. RWE Power AG, Germany), A. Oster (Head of Inden Opencast Mine, RWE Power AG, Germany)

Recultivation and regional cooperation for a sustainable development of the post-mine landscape

M. Eyll-Vetter (Head of Mine Planning, RWE Power AG, Germany), M. Kosma (Head of Opencast Mine Planning and Environmental Protection, RWE Power AG, Germany)

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