SUSTAINABILITY OF MINERAL RESOURCES
AND THE ENVIRONMENT
BRATISLAVA 21 – 22 NOVEMBER 2016

INTERNATIONAL CONFERENCE

SUSTAINABILITY OF MINERAL RESOURCES AND THE ENVIRONMENT 2016

Bratislava 21 – 22 November 2016

CONFERENCE PROCEEDINGS

MINISTRY OF ENVIRONMENT OF THE SLOVAK REPUBLIC
SK EU2016 Slovak Presidency of the Council of the European Union
EUROPEAN UNION
euromines
SLOVAK ENVIRONMENT AGENCY
ŠTÁTNY GEOLOGICKÝ ÚSTAV DIONÝZA ŠTÚRA

This publication has been prepared by the Ministry of Environment of the Slovak Republic SUSTAINABILITY OF MINERAL RESOURCES AND THE ENVIRONMENT 2016, Bratislava 21 – 22 November 2016. The conference was organised by the Ministry of Environment of the Slovak Republic in close cooperation with Slovak Environment Agency and Euromines during the Slovak Presidency of the Council of the European Union 2016.

SK EU2016
Slovak Presidency of the Council of the European Union

PUBLISHED BY:
Ministry of Environment of the Slovak Republic
Námestie Ľ. Štúra 1
812 35 Bratislava
Slovak Republic
Tel.: + 421 2 5956 1111
web address: http://www.minzp.sk

EDITORS:
Vlasta Jánová, Ministry of Environment of the Slovak Republic
Zuzana Lukoťková, Ministry of Environment of the Slovak Republic
Veronika Sochorova, Euromines
Elena Bradiaková, Slovak Environment Agency

ISBN: 978-80-88833-69-7

9 788088 833697 >

Document completed in November 2016. Published without proof reading.

DISCLAIMER:
The information and views set out in this publication are those of the authors and do not necessarily represent the official vies of the Ministry of Environment of the Slovak Republic.

ACKNOWLEDGEMENT:
The editors of this document would like to thank all authors of papers for their contributions.

THIS DOCUMENT SHOULD BE CITED AS:
Ministry of Environment of the Slovak Republic. International Conference Sustainability of Mineral Resources and the Environment 2016, Bratislava 21-22 November 2016. Conference Proceedings. Bratislava, November 2016. ISBN: 978-80-88833-69-7. Available on the Internet: http://mineral-resources.sazp.sk/

AGENDA

Nr.	TIME	PRESENTER	PRESENTATION TITLE
November 21, 2016			
	8:00 – 12:00		**REGISTRATION, FIELD TRIP, POSTER ARRANGEMENTS**
	12:00 – 13:00		**LUNCH**
	13:00 – 13:30		**OPENING CEREMONY**
	13:30 – 15:00		**WELCOME SPEECH**
1	13:30 – 13:40	NORBERT KURILLA	WELCOME SPEECH
2	13:40 – 13:50	CHRISTIAN WIMMER	WELCOME SPEECH
3	13:50 – 14:00	ROMAN STIFTNER	WELCOME SPEECH – IMPORTANCE OF HAVING STRATEGIC RESOURCES FOR THE EUROPEAN ECONOMY
4	14:00 – 14:20	MATTIA PELLEGRINI	EUROPEAN INNOVATION PARTNERSHIP ON RAW MATERIALS AND HORIZON 2020
5	14:20 – 14:40	CONSTANTIN CIUPAGEA	INCREASING KNOWLEDGE ON RAW MATERIALS IN EUROPE: THE RAW MATERIALS INFORMATION SYSTEM
6	14:40 – 15:00	VLASTA JÁNOVÁ	MINERAL RESOURCES OF SLOVAKIA – IMPORTANCE OF MINERAL RESOURCES FOR THE SLOVAK ECONOMY
	15:00 – 15:30		**COFFEE BREAK**
	15:30 – 16:50		**SESSION 1**
7	15:30 – 15:50	ROBERT HOLNSTEINER	ACCEPTANCE OF MINING – AUSTRIAN EXPERIENCES
8	15:50 – 16:10	PAVEL KAVINA	CZECH FOREIGN TRADE ON MINERAL RAW MATERIALS
9	16:10 – 16:30	KARSTEN IVAN	COAL MINING IN SLOVAKIA & ENVIRONMENT
10	16:30 – 16:50	TOMASZ ABRAMOWSKI	THE EXPLORATION AND EXPLOITATION PHASES VALUE CHAIN AS A FRAMEWORK FOR INDUSTRIAL REALIZATION OF DEEP SEABED MINING
	16:50 – 18:00		**SESSION 2**
11	16:50 – 17:10	JOHANN FELLNER	CURRENT SITUATION FOR SELECTED SECONDARY MINERAL RESOURCES
12	17:10 – 17:30	JOANNA KULCZYCKA	WEEE (WASTE ELECTRICAL AND ELECTRONICS EQUIPMENT) IN EUROPE VERSUS CIRCULAR ECONOMY
	17:30 – 18:00		QUESTIONS AND ANSWERS
	19:30 – 22:00		**WELCOME DINNER**

AGENDA

Nr.	TIME	PRESENTER	PRESENTATION TITLE
November 22, 2016			
	08:30 – 9:50		**SESSION 3**
13	08:30 – 08:50	THOMAS GÄCKLE	EITI IMPLEMENTATION IN GERMANY
14	08:50 – 09:10	MARIE DOLLHOFER	STATE OF IMPLEMENTATION OF DIRECTIVE 2006/21/EC – ASSESSMENT OF EU MEMBER STATES IMPLEMENTATION REPORTS
15	09:10 - 09:30	PETER KOŠINÁR, JÚLIUS BUCHTA	ENVIRONMENTAL ASPECTS OF MAGNESITE MINING AND PROCESSING IN SMZ, A.S. JELŠAVA
	09:30 – 9:50		QUESTIONS AND ANSWERS
	09:50 – 10:20		**COFFEE BREAK**
	10:20 – 12:00		**SESSION 4**
16	10:20 – 10:40	W. EBERHARD FALCK	INTEGRATING ENVIRONMENTAL REMEDIATION INTO THE LIFE-CYCLE MANAGEMENT (INCLUDING DECOMMISSIONING) OF MINING AND MILLING SITES
17	10:40 – 11:00	CORINA HEBESTREIT	ENHANCING IMPLEMENTATION AND CAPACITIES: THE NEW EU MINING MENTOR CENTRE AND ITS OBJECTIVES
18	11:00 – 11:20	JAN BRONDERS	REHABILITATION CASE FROM BELGIUM: APPROACH OF A REGIONAL HEAVY METAL POLLUTION CAUSED BY NON-FERROUS INDUSTRY
19	11:20 – 11:40	DAVID PÓČ	GREEN BRIDGE COMPETITION – THE BEST REHABILITATIONS PROJECTS OF THE CZECH REPUBLIC
	11:40 – 12:00		QUESTIONS AND ANSWERS
	12:00 – 13:30		**LUNCH**

AGENDA

Nr.	TIME	PRESENTER	PRESENTATION TITLE
November 22, 2016			
	13:30 – 15:50		**SESSION 5**
20	13:30 – 13:50	JOHANNES DRIELSMA	APPLICATION OF THE MITIGATION HIERARCHY ACROSS THE PROJECT TIMELINE
21	13:50 – 14:10	EIBHLIN DOYLE	IRELAND'S A REHABILITATION POLICY ELIMINATING RISK AND PROVIDING BENEFITS
22	14:10 – 14:30	ANNA OSTRĘGA, MAREK CAŁA	RECLAMATION AND REVITALISATION IN THE EXTRACTIVE INDUSTRY IN POLAND – INNOVATIVE PROJECTS LEAD BY MINING AND GEOENGINEERING FACULTY OF AGH UST
	14:30 – 14:50		**COFFEE BREAK**
23	14:50 – 15:10	MONIKA MATEJOVÁ, MICHAL ŠEVERA	EXPERIENCES WITH ABANDONMENT OF ENVIRONMENTAL BURDEN RELATED TO CRUDE OIL PRODUCTION
24	15:10 – 15:30	LUÍS MARTINS	INDUSTRIAL AND ORNAMENTAL LIMESTONES QUARRYING INSIDE A NATURA 2000 AREA
	15:30 – 15:50		QUESTIONS AND ANSWERS
	15:50 – 16:10		**CLOSING REMARKS**

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

WELCOME SPEECH

Christian Wimmer

DG Environment, European Commission

ABSTRACT

Waste originating from quarrying and mining industries makes up a very large proportion of the total volume of waste produced in the European Union. Directive 2006/21/EC on the management of waste from extractive industries aims to prevent or reduce as far as possible any adverse effects on the environment, in particular on water, air, soil, fauna and flora and the landscape, and any resultant risks to human health, brought about as a result of the management of waste from the extractive industries. On 6 September 2016 the European Commission published a report on the implementation of this Directive on the basis of reports submitted by Member States. The presentation at the conference focuses on the main conclusions of the implementation report. The report can be downloaded from the following internet address:
http://ec.europa.eu/environment/waste/mining/pdf/report_mining_waste.pdf

IMPORTANCE OF HAVING STRATEGIC RESOURCES FOR THE EUROPEAN ECONOMY

Roman Stiftner

Euromines and Austrian Mining and Steel Association

ABSTRACT

What means strategic resources? The continued globalisation has clearly demonstrated that access to resources is still a key issue in order to develop economies and ensure well-being of populations.
Different states have defined “strategic” differently and the EU limited its considerations in the past years deliberately to “critical”. It has conducted several studies in order to identify the EU’s mineral potential in terms of primary and secondary resources. Considerable work still needs to be done, however, most of the currently available criticality assessments have been based on an analysis of the availability of raw materials for and from the current economic situation.
Some studies were done on the basis of future scenarios, looking at the development of key enabling technologies and their potential material requirements and they have led to an increased awareness of a few materials such as rare earth.
However, what has not been done is linking the two areas need and availability and transposing this into a comprehensive EU strategy supported by Member States in ensuring availability of these raw materials from own EU resources for the EU internal market.
Partnerships between Member States with raw materials potential and Member States of user industries should be forged to support economic growth.
Research and Technical Development to increase valorisation of raw materials between such Member States should be fostered.
The European Innovation Partnership (EIP) on Raw Materials and the EIT on Raw Materials as well as national funding programmes have started to make a difference to the innovation prospects in the sector. Mining 4.0 is not just a vision, but could become reality in the decade after 2020.
What has also not been done is to look at the total raw materials needs and the interplay of certain resources for specific sectors that will be considered key to Europe’s economic development. The objective of substituting individual critical raw materials is falling way to short of enabling a successful economic performance.
And last but not least, the EU needs to make its objectives of environment and health and safety protection compatible with strategic economic orientation by putting much more effort into sophisticated risk management rather than taking the easy way out and banning materials.

THE ROLE OF SLOVAKIA IN THE EIP AND H2020

Mattia Pellegrini

DG Growth, European Commission

ABSTRACT

The EU policy on Raw materials (the "Raw Materials Initiative") aims at securing the sustainable supply of raw materials to the European economy. The European Innovation Partnership on Raw Materials, which provides high-level guidance to the European Commission, Members States and private actors on innovative approaches to the challenges related to raw materials, helps implement the EU Raw Materials Initiative.
Slovakia is very active in the EIP. It is a member of the High Level Steering group, as well as several Operational Groups. Slovakia is also involved in some Raw Materials Commitments, such as EUMINET, IMPACT and INTERMIN, to mention a few.
Horizon 2020 is the biggest EU Research and Innovation programme ever with nearly €80 billion of funding available over 7 years (2014 to 2020). H2020 funds projects on mining, recycling and substitutions.
One of its societal challenges is to achieve a resource efficient and climate change resilient economy and society, the protection and sustainable management of natural resources and ecosystems and a sustainable supply and use of raw materials.
Slovakia is involved in H2020 with three projects, each one with a different partner. One of these projects is CHROMIC, with the Technical University of Košice as a partner. CHROMIC's aim is to develop highly selective metal recovery technologies processes for critical and economically valuable by-product metals from secondary resources. Furthermore, there is INREP, with the Slovak University of Technology in Bratislava as a partner. The goal of INREP is to develop valid and robust alternatives to Indium based transparent conductive electrode materials as electrodes. Slovakia is also involved in MINATURA 2020, via the State Geological Institute of Dionýz Štúr as a partner. Its objective is to develop a concept and methodology for the definition and protection of "mineral deposits of public importance", to ensure their best use in the future.

INCREASING KNOWLEDGE ON RAW MATERIALS IN EUROPE: THE RAW MATERIALS INFORMATION SYSTEM

Prof. Constantin Ciupagea

Land Resources and Raw Materials Unit, DG Joint Research Centre, European Commission, constantin.ciupagea@ec.europa.eu

JRC Mandate and the EU Policy Context

Directorate General Joint Research Centre (JRC) is providing science-evidence based support to the EU raw materials policy, as part of the European Commission's commitment to the achievement of the Strategic Implementation Plan of the European Innovation Partnership on Raw Materials (EIP RM). This includes research and analytical actions in various fields, such as: methodology development for selection criteria for raw materials considered critical to the EU economy, monitoring the progress in achieving the targets of the EIP on Raw Materials, building indicators for monitoring raw materials sectors and markets with the EU Raw Materials Scoreboard, methodological support to increasing raw materials efficiency, further developing the JRC Raw

Materials Information System as the central component of the EU's Knowledge Base on Raw Materials.

The main policy documents guiding the Commissions activities in the area of raw materials, which are implicitly setting the JRC research work programme, are numerous and increasingly inter-connected. A core set is summarized hereunder:

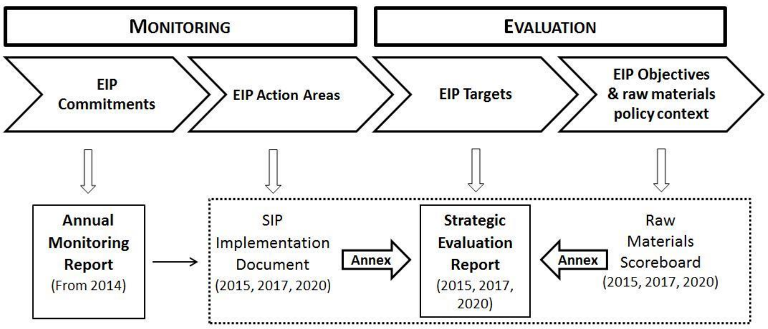
- Raw Materials Initiative (COM(2008) 0699)
- European Innovation Partnership (EIP) on Raw Materials (COM(2012) 82) and its Strategic Implementation Plan
- Circular Economy Action Plan (that is related to the 3rd pillar of the EIP's implementation plan) (COM(2015) 614)
- For a European Industrial Renaissance (COM(2014) 014)

JRC Activities in support of the European Innovation Partnership (EIP) on Raw Materials

The EIP on Raw Materials is implementing the Raw Materials Initiative stakeholder platform that brings together EU countries, companies, researchers, and NGOs to promote innovation in the raw materials sector. The main objective of the EIP is to help raise industry's contribution to the EU's

GDP to around 20% by 2020 by securing its access to raw materials, in particular to those considered critical.

Since 2012, JRC is an active contributor to the EIP-RM, including having a key support role in the Monitoring and Evaluation Scheme and with JRC activities being a large input to the Report from the Commission on the implementation of the Raw Materials Initiative (SWD/2014/0171 final).



As part of the overall Commission's efforts to implement the targets associated to the three pillars of the EIP on Raw Materials, JRC was and continues to be directly involved in the following actions:

- Developing further and improving the methodology for selecting the EU List of Critical Raw Materials (materials with a high risk of supply disruption, which could result in also high impacts to the EU economy)

- Supporting the enhancement of the EU Raw Materials Knowledge Base
- Contributing to the set-up of the indicators framework defining the EU Raw Materials Scoreboard
- Supporting the periodic evaluation of EIP RM targets (according to the Strategic Implementation Plan)

A Circular Economy for Raw Materials

The recent release of the Circular Economy Action Plan (December 2015) brought additional commitments to the JRC in support of EU raw materials policy, consequently activities are now focused on:

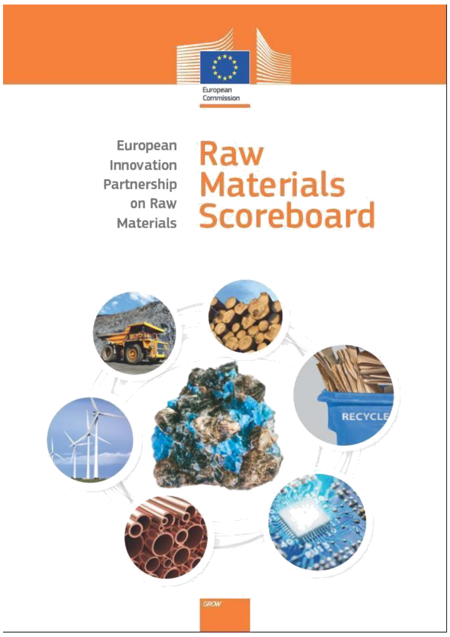
- Monitoring the Circular Economy, by contributing as author to the **EU Raw Materials Scoreboard** and developing material flow models for the EU-28
- Developing the **JRC Raw Materials Information System** (core component of the EU Raw Materials Knowledge Base), an integrated knowledge system that looks at non-energy non-food raw materials aspects across the full value chain (in a system perspective)
- Supporting the **2017 Report on Critical Raw Materials**
- Supporting methodology & standards for Electronic and Electric Waste (**WEEE Directive**), focusing on the supply chains of critical raw materials

Monitoring Raw Materials Sectors

A. Raw Materials Scoreboard

Monitoring the competitiveness and growth of primary and of secondary raw materials sectors is essential. The provision of the first EU Raw Materials Scoreboard (July 2016) was an important step made by the European Commission into this direction, which required a multi-disciplinary approach with a deep understanding of the related issues and for which DG JRC offered its expertise as co-author. A next version is foreseen in 2018, and then every 2 years, with JRC providing the scientific support for this development.

The Scoreboard provides an overview of challenges and opportunities along the entire raw materials value chain. It highlights the importance of raw materials to the EU economy and to jobs and growth in particular. It presents relevant and reliable information that can be used in policymaking in a variety of areas. It will be also used to monitor progress towards a circular economy, the recently adopted EC Action Plan aiming to boost global competitiveness, foster sustainable economic growth and generate new jobs via the use of resources in a more sustainable way. The Scoreboard is an integral part of the Raw Materials Information System, a cornerstone of the EU's knowledge base on raw materials and a key tool for monitoring and evaluation of the raw materials outlook in the EU and worldwide.



B. JRC Raw Materials Information System

The JRC's Raw Materials Information System (RMIS) is proposed by the Commission as the core component of the European Union Knowledge Base on Raw Materials. This role follows from the actions of the 3rd Pillar of the EIP on Raw Materials (and SIP) - "Resource efficiency and supply of secondary raw materials through recycling". It has been enforced through the Circular Economy Communication and Action Plan, the European Commission commiting to "further develop the recently initiated Raw Materials Information System and support EU-wide research on raw materials flows" in order to improve the availability of data on raw materials.

The RMIS will play an essential policy support and an integrator role at the heart of the EU Knowledge Base on Raw Materials and meeting related needs of the EIP RM. Through strong knowledge, Europe can benefit of informed policy measures to increase competitiveness and growth of primary and secondary raw materials sectors and to improve its economy's materials efficiency. The RMIS will facilitate the provision of key data on non-energy and non-food raw materials based on priorities stemming out of key EU needs for analyses, monitoring, trade negotiations, etc. The RMIS will structure the knowledge in country profiles, specific raw materials information sheets, sectorial/product information, etc. It includes key activities such as the definition of EU critical raw materials, the monitoring of the Raw Materials sector through the recently launched Scoreboard, or sustainability analyses related to selected scenarios for primary/secondary raw materials. RMIS will also provide structured information in support of knowledge requirements of the raw materials and circular economy policy fields, including:

- Higher availability of data on secondary RM;
- Better understanding & mapping of RM flows;
- Consideration of RM criticality
- Member States level data collection and information service, etc.

JRC launched the RMIS version 1.0 in 2015. JRC is currently developing a Roadmap and beta version for the RMIS 2.0, moving from a first version that mainly highlighted JRC raw materials activities. RMIS 2.0 will develop based on its own knowledge production and data collection, but mainly by collaborating with consortia in several Horizon 2020 projects, with the European Innovation Partnership on Raw Materials, with the EIT on Raw Materials, the EuroGeoSurveys, with statistical sources in EU Member States and with other sources of EU knowledge on raw materials. The European Commission Decision C(2016) 4614 of 25 July 2016 revised the 2017 guidelines and calls within the Horizon 2020 framework in reference to the Raw Materials area of research and innovation and asked specifically that "Co-ordination and support actions will target different parts of the raw materials value chain taking into account the wider system, including the framework conditions for sustainable primary and secondary raw materials production that would provide a stable and competitive supply from the EU sources; building the EU knowledge base of primary and secondary raw materials (EC Raw Materials Information System – *JRC* RMIS); better co-ordination of the Member States' research and innovation programmes and funded activities; as well as international co-operation with countries producing and using raw materials". The new Calls under SC5-13 to 15 are explicitly requested to feed their results into the RMIS, thus collaborating with the JRC team on raw materials.

Other JRC activities related to raw materials

The JRC is active on the production of knowledge on raw materials, but also on the evidence-based sustainability assessments of impacts of activities along the supply chains of raw materials; economic, social and environmental analyses are often associated with the internal studies or research output made in cooperation with third parties that JRC is conducting. The main new areas of interest are linked to cross-border effects of economic activities in the raw materials sectors, to the end-of-life sections of the life cycle and supply chains of products with high content of critical raw materials (improving durability, recyclability, re-use, etc.), as well as to increasing resilience and ensuring the security of the European economy by enhancing access to the supply of critical raw materials, facilitating innovation aimed at growth and more jobs and by keeping the social and environmental values as priorities for EU citizen.

MINERAL RESOURCES OF SLOVAKIA – IMPORTANCE OF MINERAL RESOURCES FOR THE SLOVAK ECONOMY

Vlasta Jánová

Division of Geology and Natural Resources, Ministry of Environment of the Slovak Republic, Slovak Republic

KEYWORDS
Mineral resources of Slovakia, geological survey, geological reserves, extraction of minerals, licenses

INTRODUCTION

Minerals and mineral-based products are the basis of production for metallurgical, electricity, chemical, brick, ceramics, tile, glass and other industries in Slovakia. According to Slovak Minerals Yearbook, 2015 mining and quarrying of minerals (including extraction of crude oil and natural gas) contributed 319,8 million €, or 0.42 %, to Gross Domestic Product (GDP) at current prices in 2014.

Minerals and mineral-based products represent an important item of foreign trade of the Slovak Republic. Because of a large import volume of mineral fuels (crude oil, natural gas, hard coal) and metals (iron ore, zinc, materials for aluminium metallurgy) foreign trade balance has been permanently passive (Fig.1). Domestic consumption of these minerals is covered mainly by import. Production of industrial minerals (magnesite, limestone, dolomite, gypsum, bentonite and barite) covers in substantial volume domestic consumption.

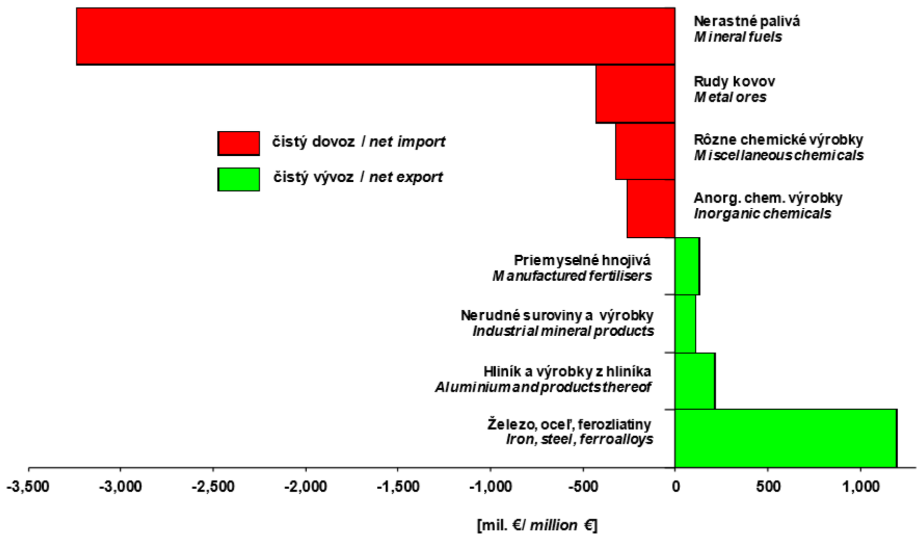


Fig. 1 Balance of trade in selected minerals and mineral-based products in 2014 (Source: Statistical Office of the Slovak Republic, 2015).

MINERAL DEPOSITS IN SLOVAKIA

Occurrences of mineral deposits are dependent on varied geological composition of Slovakia. Distribution of reserved mineral deposits is very uneven and depends on geological and metallogenic conditions. Every geological-tectonic unit has its own characteristic complex of mineral resources, conditional to geological evolution of region. At present, there are 1 128 mineral deposits recorded in the Slovak Republic (639 reserved mineral deposits and 489 deposits of non-reserved minerals). Total geological reserves of registered mineral deposits reached 19 611 Mt (up to 1 January 2015) thence 12 547 Mt were industrial minerals reserves (Fig. 2). The most important reserved mineral deposits are protected by mining law to prevent restraint of future exploitation. Protection is ensured by identifying of protected deposit area. There were 314 protected deposit areas registered in 2014.
According to the Act No.569/2007 Col. on geological works (Geological Law), amended by later regulations, geological prospection or exploration for reserved minerals could be performed by physical or fictitious person

only following the geological licence. Geological licence is granted by the Ministry of Environment of the Slovak Republic. Application for geological licence has to include list of persons with valid expert's qualification – only these persons could perform geological works. Mineral prospecting or exploration could be executed on exploration area only, granted by Ministry for 4 years (period could be extended). Yearly report on activities and results is required to elaborate for Ministry. Yearly remittance for exploration area is 99, 58 € per every open km^2 for first 4 years, then it rises to 199, 16 € after next 4 years and to 331, 93 € after next 2 years. During next years it is 663, 87 € per km^2. Payments are incomes of the Environmental Fund, 50 % of them directs to municipality on the cadastre of which exploration area lies. Geological licence is not required for surface prospecting of non-reserved minerals performed by land owners.

New geological surveys of mineral resources are carried out in 79 exploration areas. 20 % of them is focused on metal exploration, 21, 5 % on industrial minerals and 11, 3 % on mineral fuels (Fig. 3).

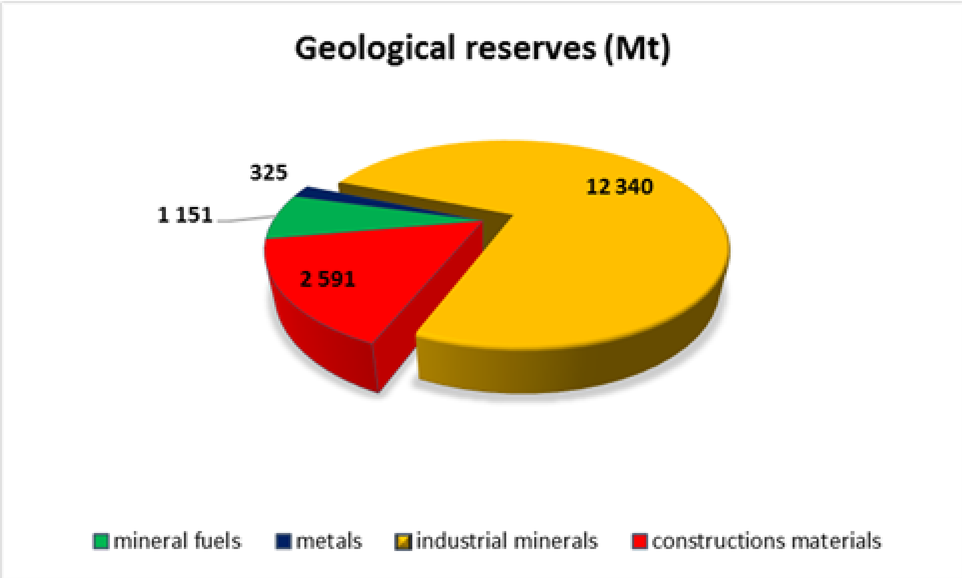


Fig. 2 Geological reserves of the Slovak Republic (Mt)

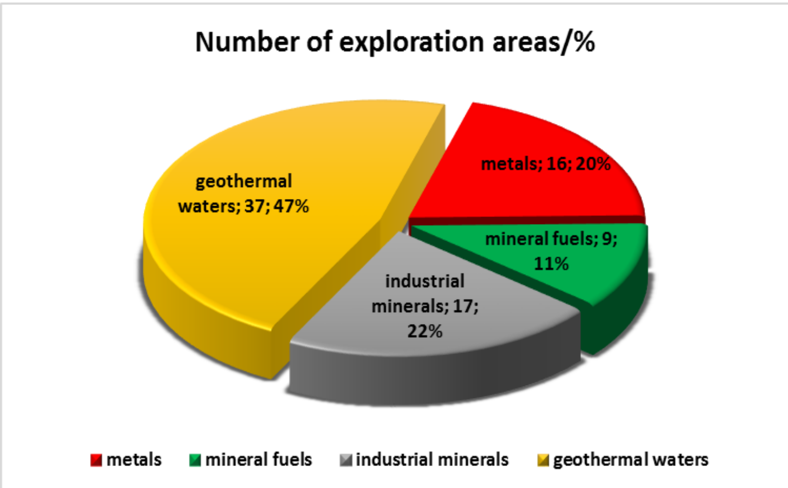


Fig. 3 Exploration areas valid in 2016

EXTRACTION OF MINERALS

Extraction of minerals is regulated by the mining acts. The right to mine exclusive deposits has the organization which has got mining license and which a mining area has been determined to. Preferential right for mining area determination has the company, that exploration area was determined to and the research was carried out at their own expense.

Yearly remittance for mining area depends on area size (km^2). The height of payment is 663, 87 € per every open km^2. 20 % of payments are incomes of state´s budget, 80 % of them directs to municipality on the cadastre of which mining licence overlies. Every mining subject exploiting minerals upon mining licence has obligation to pay remittance for mined minerals (royalties). Calculation is based on mining costs, total costs of products processing, revenue from sales and remittance tariff (0.1 to 10 % according to mineral type). Royalties are calculated quarterly. Payments are income of the Environmental Fund (state´s budget). Remittance for gases or liquids storing is 0, 0007 € per 1 m^3 of gas or 1 tonne of liquid. Payments are calculated quarterly. Payments are income of the Environmental Fund (state´s budget).

In 2015, 432 mining areas were registered in Slovakia and the exploitation was performed on 201 reserved deposits. Mining production on reserved deposits was 25, 1 Mt (Fig. 4).

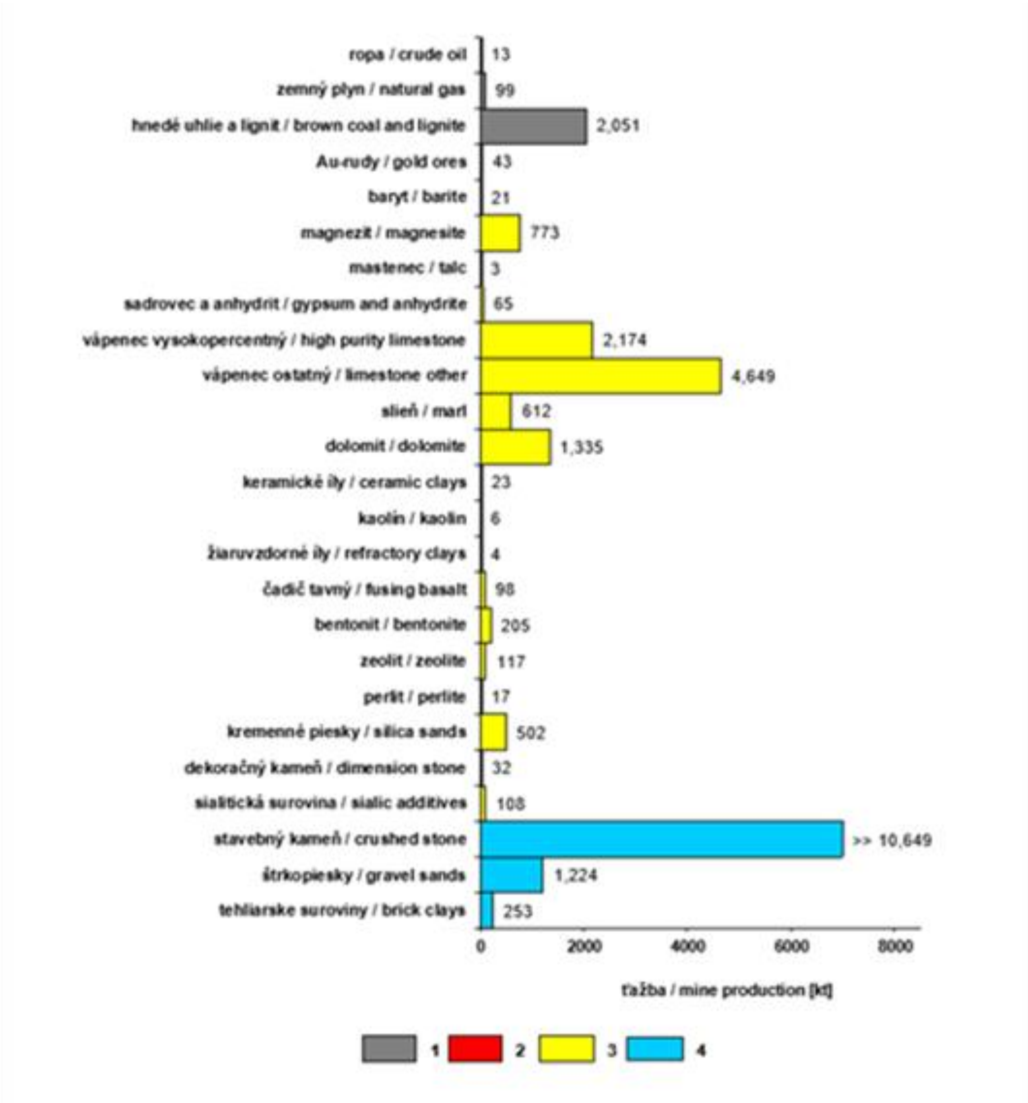


Fig. 4 Minerals mine production from reserved deposits in 2014 (1 - mineral fuels, 2 - metals, 3 - industrial minerals, 4 - construction materials) (Source: Slovak Mineral Yearbook, 2015)

From the point of mineral fuels there are 98 reserved deposits registered in Slovakia including mainly lignite, brown coal, mineral oil, natural gas and uranium ore. Total geological reserves of them reached 1 145 Mt, from which about 465 Mt (41 %) are considered as economic reserves.

Domestic brown coal production has covered 80 % of demand in the Slovak Republic in 2014; rest amount was imported, mainly from the Czech Republic (60 %). Value of imported commodities reached 37.3 million € in 2014; export was negligible. Hard coal consumption volume has been traditionally wholly supplied by imports (334 million € in 2014), mainly from Russia (27 %), the Czech Republic (25 %) and Poland (15 %).

Domestic demand for crude oil (5.4 – 5.9 Mt) is almost completely satisfied by import from Russia (97% in 2014). Domestic production covers only about 0.2 % of demand. In 2014, value of imported commodities reached 2.926 billion €. Domestic production of natural gas covered about 2.1 % consumption in Slovakia. Demand for natural gas was satisfied mostly by import, mainly from Russia (79 %) and Czech Republic (4 %). Value of imported commodities reached 1.773 billion €. Export value was 49 mil. €.

Uranium ores are not commodity of Slovakian foreign trade. Radioactive elements and isotopes (or compounds, mixtures and wastes – HS 2844) were imported to Slovakia, in 2014 value of imported commodities reached 2.5 million €. There was no mining company involved in uranium ores mining on the territory of the Slovakia.

Following the Register of Reserves of Mineral Deposits, state to 1 January 2015, 46 reserved deposits of metals were registered in Slovakia. Total geological reserves reached 326 Mt, from which only about 26 % are stated as economic reserves at present. Gold was mined and processed only on Banska Hodrusa deposit in 2015. New reserves were estimated. Majority of gold concentrate production was exported (Belgium).

There was no iron ore production in Slovakia in 2014, production stopped in 2008. Domestic consumption is satisfied by imports at present, mostly from Ukraine (55 %) and Russia (25 %). Value of imported ores and concentrates was 437 million €.

Overall 302 reserved deposits of industrial minerals were registered in Slovakia. Geological reserves reached 12 547 Mt (76 % of total geological reserves), from which about 89 % are classified as economic reserves at present. Industrial minerals share on total mining production reached 43 % (10, 8 Mt).

Demand for magnesite is completely satisfied by domestic production in Slovakia. Most of production is exported (Ukraine 41 %, Czech Republic 12 %, Russia 9 %). Exported commodities value accounted for almost 73 million € in 2014.

Employment in the mining industry of Slovakia reached 6 184 employees in 2014, 33 % of which worked in underground operations. Employment had permanently decreasing tendency during last years (Fig. 5).

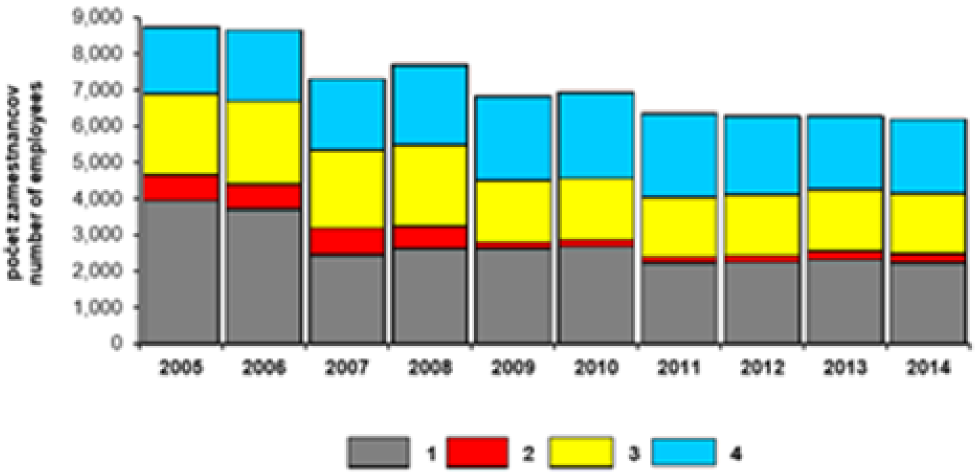


Fig. 5 Employment development 2005 - 2014 in the mining industry (1 - mineral fuels, 2 - metals, 3 - industrial minerals, 4 - construction materials) (Source: Annual Reports of the CMO 2005 - 2014).

MINING AND ENVIRONMENT

Slovakia belongs to countries with extensive historical mining and this factor along with mining in past few decades caused many problems in environmental sphere, in some cases with severe ecological consequences.

At present in relation to active mines there is in evidence:

a) In total (active and abandoned) 90 waste rocks stockpiles or heaps, from this amount 61 waste rocks stockpiles are situated in mining areas and 29 out of them, covering area of 2 556 km^2, volume 37 422,91 thousand m^3. The number of active waste rock stockpiles is 49, abandoned waste rocks stockpiles reach number 12.
b) In total 28 tailings ponds (storing tailings from ore processing) from which 13 are situated in extraction areas and 15 out of them, covering area of 2 976 km^2.

From the point of view of historical mining activities, there are more than 17,000 objects registered in the Register of old mining works and 338 closed and abandoned mining waste storage sites (314 heaps and 24 tailings ponds registered in the Information System of the Waste from Extractive Industry (Fig. 6).

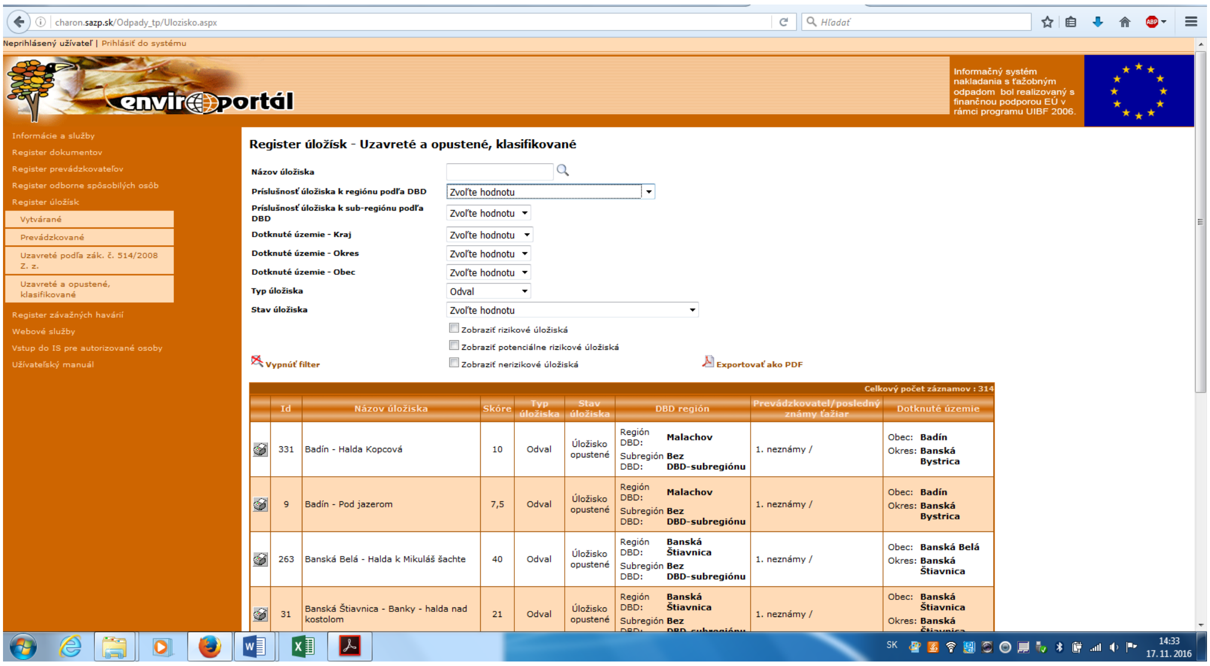


Fig. 6 Information System of the Waste from Extractive Industry

Several waste rocks stockpiles is being utilised for quarrying materials for construction industry, or as backfill material for mining pits and underground mines.

Negative impacts on environment of historical and present-day mining activities and ore processing can be summarised as follows:

- Changes of land configuration as a result of re-placement of huge volume of rock, stability disturbances, development of fractures and faults, depression of terrain, non-even consolidation of sediments, subsidence, activation of landslides, etc.,
- Changes of hydrogeological regime in undermined areas and surroundings,
- Changes of chemical composition of surface and ground waters, as well as soils in mining sites and broader surroundings,
- Disturbance of tailings dams with possibility of contamination of surface and ground water and soil by leakage from tailing ponds, waste rock stockpiles, etc.,
- Development of deep and sheet erosion related to deforestation and re-movement of vegetation cover.

CONCLUSION

According to the Report on the activities of the Central Mining Authority and District Mining Offices of the Slovak Republic in 2015, companies which carry out mining activities, paid in the period under review all payment in a total of 3 923 434.93 €, which is 307 334.82 € more than in the previous year (3616 100.11 €). The payments for mining areas were 489 946.87 €, payments for mined minerals (royalties) 2 415 732.90 € and payments for the storage of gases and liquids 1 017 775.16 €. Fines on identified infringements of mining regulations were issued in the amount of 117 984 €.

Companies which carry out exploration work, paid in 2015 for exploration areas 1 113 402 € and fines for violations of the geological act were granted in the amount of 2 850 €.

Although the share of exploration and mining activities to GDP is relatively low (0,42 %) and its downward trend continues, Slovakia still has a relatively good potential in the form of mineral resources that can increase prosperity, especially in regions with high unemployment and a lack of other employment opportunities. Considering that Slovakia is dependent on import of a number of strategic raw materials, it is necessary to focus on prospecting, exploration and exploitation of domestic mineral resources.

LITERATURE

Slovak Minerals Yearbook 2015
Statistical Office of the Slovak Republic, 2015
Report on the activities of the Central Mining Authority and District Mining Offices of the Slovak Republic in 2015
www.envirofond.sk
www.enviroportal.sk
www.geology.sk

RNDr. Vlasta Jánová, PhD.
Ministry of Environment of the Slovak Republic
Division of Geology and Natural Resources
Nám. Ľ. Štúra 1, 812 35 Bratislava
Slovak Republic
vlasta.janova@enviro.gov.sk

ACCEPTANCE OF MINING – AUSTRIAN EXPERIENCES

Robert Holnsteiner

Federal Ministry of Science, Research and Economy, Austria, Division III/7 - Minerals Policy, Denisgasse 31, A-1200 Vienna

KEYWORDS
mining, acceptance, mineral resources, minerals supply, citizen participation, Austria

ABSTRACT

Access to raw materials has become an important competitiveness factor in industrialized countries. The European Union is highly dependent on commodity imports, especially in the case of metallic raw materials and several industrial minerals. In order to maintain and improve our quality of life, an adequate supply of mineral raw materials is indispensable to our economy. The sustainable and adequate supply of mineral raw materials through mining operations is defined entrepreneurial task in Austria. Minerals supply is a core competence of the industry.

It is the duty of public administration to assist the industry by providing a properly adjusted national minerals policy respecting future orientation and sustainable development, in order to guarantee legal certainty for all parties involved and an appropriate framework as a decision base for enterprises and authorities.

It is a more or less global observation, that the acceptance of the population regarding mining activities is decreasing. Acceptance in this sense means that those directly affected and the citizens of the region consider a project to be appropriate and affirm that the challenges associated with the project are adequately solved. Acceptance does not mean that the persons concerned fully agree with the project and certainly not that all parties concerned agree with the project.

Mining as intervention in the earth's crust has always been and still is associated with unavoidable effects on the environment and the people living in the neighborhood. Although domestic mining is technologically best performing and contributes to value creation, it requires public acceptance in order to be competitive and economically successful in the long term.

It is important to recognize the reasons for this development and to analyze it in order to be able to derive recommendations for improvements starting with the awareness how important minerals are for our society, how important transparent procedure are especially conccerning the interaction between companies, licensing authorities and affected citizens. It is a society-wide task to work towards an ideological liberated raw material awareness based on knowledge rather than on fears.

Reacting on the perception of companies and authorities about the dwindling acceptance of mining activities in Austria, the Federal Ministry of Science, Research and the Economy (BMWFW) commissioned a survey on the public acceptance of mining in Austria in 2016. Since mining operators have to deal with more complex, cost-intensive and time-consuming administrative procedures, it is sensible to gain knowledge about possible problems and obstacles in advance in order to derive possible measure and recommendations.

In this opinion survey, a total of 1,000 Austrians from 16 years of age were interviewed. The subjective proximity to raw materials (ie sand or gravel pit / quarry and mine) to the inhabitants of the surveyed persons was taken into account when evaluating the results. The aim of this study was to provide answers to the questions of raw material awareness, the pros and cons of raw material extraction in Austria, the reuse of mining areas and personal perplexity, and thus to make general statements about the public acceptance of mining activities in Austria.

Basically, the Austrian population is more or less aware of the relevance of mineral raw materials for industry, with additional scope for improvements. Fossil fuels are the most important raw materials for Austrians. This awareness can be improved for other commodities, as, for example, more than a quarter of the respondents indicate that construction materials are unimportant! Two-thirds of Austrians believe that the extraction of raw materials creates many jobs in the region. The highly industrialized regions Upper Austria and Styria have the highest approval. 68% of respondents report that the production of raw materials in Austria is important for the security of industry and society. For almost two-thirds of respondents, the production of raw materials is a pillar

of industrialized society. 60% of respondents believe that recycled raw materials can only partially replace natural resources. 44% of Austrians indicate that companies of the mineral resources sector are responsible for making a municipality unattractive as a place of residence. It is striking that respondents with subjective proximity to business premises are less likely to agree with this statement than those who are not close to business. This indicates a positive performance of the respective resident company.

Noise, dust and traffic are among the most disturbing interferences for the persons interviewed. The least disturbing is the visibility of the operation sites and the impact of operation on nature. For 84% of persons interviewed citizen participation procedures are important for permitting and operation of extractive industry companies. A little more than half of the interviewees believe that they can present their interests and concerns adequately in the process of participation based on current regulations.

The Austrian Federal Ministry of Science, Research and the Economy intends to discuss the topic "Acceptance of Mining" in its a national discussion platform „Austrian Raw Materials Alliance“ founded in 2012 in the BMWFW. The results of the study will serve as input.

LITERATURE

IFES: Rohstoffgewinnung - Gesamtbericht, 2016.- unpublished report, Vienna 2016

Schönbauer, C., Holnsteiner, R. Reichl, C. & Strobl, S.: Zur Lage des bergbaus: Entwicklungen auf internationaler und nationaler Ebene, 2016.- Berg- und Hüttenmännische Monatshefte, Vol. 10, Wien (Springer).

Mag. Dr. Robert Holnsteiner, PhD, MSc.
Austrian Federal Ministry of Science, Research and Economy
Division III/7 - Minerals Policy
Denisgasse 31, A-1200 Wien
Austria
robert.holnsteiner@bmwfw.gv.at

CZECH FOREIGN TRADE ON MINERAL RAW MATERIALS

Pavel Kavina

Ministry of Industry and Trade of the Czech Republic

ABSTRACT

As with many other European countries, the Czech Republic has limited mineral potential. Therefore, some of the raw materials that are needed for the Czech economy must be imported, such as: crude oil, natural gas, all ores and metals and also some part of industrial minerals.
On the other hand some Czech raw materials are very important for Czech export - for example kaolin, feldspars, silica sand, some kinds of clays, bentonite etc., as well as other products of these commodities, for example products of glass industry or porcelain industry.

SLOVAK COAL MINING AND ECOLOGY

Karsten Ivan

HBP a.s. company

ABSTRACT

Coal has been mined in present Slovakia in industrial range for more than 109 years. Up to now more than 227 million metric tons of semi bituminous coal and lignite has been extracted, of which the vast majority was used for energy purposes. Currently is the Slovak coal mining volume slowly decreasing because of the reserves decline. According to actual forecasts within the next 10 years the domestic coal mining and its consumption will become greatly reduced. For the needs of future generations in Slovakia remain more than 1 billion tons of semibituminous coal and lignite reserves.

Since after 80 years long exploitation Slovak natural gas and crude oil supplies are practically exhausted, the lignite and brown coal are the only domestic energy sources available. Domestic lignite and semi bituminous coal currently cover approximately 30 % of the yearly domestic solid fuel consumption. The remaining hard coal, brown coal and coking coal is being imported from abroad, mostly from the Russian federation. Domestic lignite as a source of continuous supply of energy currently makes up a major strategic hub to accommodate peak demand for electricity with fast start-up performance comparable to other gas and hydro power plants.

All the lignite and semi bituminous coal are on a long-term basis mined in underground.

Subsurface mining technologies are significantly environmentally friendlier than the surface (open pit) mining methods. The waste rock from mining and coal processing are being stored in waste dumps which never get burned - unlike hard coal waste banks abroad. Due to coal relics composition our inactive waste dumps get very quickly covered with plants and trees - lignite is a natural source of humin acids and acts as a growth stimulators and fertilization agens. Waste mud from coal treatment facilities is deposited in the tailing ponds, and into the surface streams only purified water is discharged. Sewage sludge acts as a good raw material for ceramic industry, practically containing no harmful substances. It can also be used to enhance the quality of sandy soils or as a fertilizer with high humin acid content without any harmful side effects.

Novaky Thermal Power Plant technology has been completely overhauled, its dusters and filters catching practically all flying ash. Desulphurisation unit is able to absorb 98 % of Sulphur gasses. Both these waste products - flying ash and gypsum - are turned into desired building materials. At the same time the thermal power plant boilers have been enhanced with denitrification technology which enables the power station to eliminate more than 90 % of NOx gasses directly in the boilers. To meet the needs of its operation, HBP company currently utilizes the geothermal energy in amount of 10 MW of thermal output. We use part of the thermal energy from hydrothermal springs combined with thermal energy from mine water and mine air and in this way we are able to spare approximately 10 MW of electric energy in glasshouses, ventilation shaft and fish farm.

Underground coal excavation creates on the surface terrain depressions that quickly turn into lakes, wetlands and swamps. These varied water habitats are rapidly filled with rare animal and plant species. Wetlands become home for water birds, fish, amphibians and insects. Part of the Nitra river, where is the coal is being mined, is gradually changing into floodplain forest swamps & wetlands - the condition, in which the river was about 200 years ago.

THE EXPLORATION AND EXPLOITATION PHASES VALUE CHAIN AS A FRAMEWORK FOR INDUSTRIAL REALIZATION OF DEEP SEABED MINING

Tomasz Abramowski, PhD Eng.

Director General of the Interoceanmetal Joint Organization, ul.Cyryla i Metodego 9, 71-541 Szczecin, Poland

ABSTRACT

The presentation will address present developments of exploration and exploitation phases of the deep seabed mining. Deep sea mining value chain has been analyzed from the point of view of the activities performed in the deep seabed mining (DSM) and the behavior of possible sources of differentiation. The objective of the presented study is to identify decisive factors and most important assumptions having a substantial influence on the decision making process in the deep sea mining industry. Classic approach to value chain has been presented and some specific virtues of DSM value chain are discussed.

The two types of DSM value chain have been recognized: one related with the value added to the intangible assets (exploration) and the other where value increases with the commercial mining operations when ore is processed.

CURRENT SITUATION FOR SELECTED SECONDARY MINERAL RESOURCES

Assoc. Prof. Dr. Johann FELLNER

Christian Doppler Laboratory for Anthropogenic Resources, TU Wien, Karlsplatz 13/226, 1040 Vienna, Austria
johann.fellner@tuwien.ac.at

ABSTRACT

The limited availability of many natural resources has become a growing concern within the last few decades. Continuous growth in global material turnover during the last century, which has resulted in enormous resource consumption as well as recent increases in commodity prices are the main drivers of these concerns. In addition to existing efforts to intensify exploration for new deposits, proposals for higher efficiency in resource use and the recycling of materials have been put forward to overcome the potential danger of more pronounced material shortages. Based on the “Raw Material Initiative" (e.g. COM(2008)0699, COM (2011)0025, COM(2013) 442), which can be considered as a strategic pillar for “boosting resource efficiency and recycling” an EU action plan for a circular economy (COM/2015/0614 Circular Economy Package) has been released in December 2015. If foresees a “transition to a more circular economy, where the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste minimized, which is seen as an essential contribution to the EU's efforts to develop a sustainable, low carbon, resource efficient and competitive economy.”

In the oral presentation an overview of EU´s mineral resource consumption will be given and the substitution potential by secondary resources (assuming a 100% circular economy) will be highlighted. Besides a superficial analysis for different minerals on the level of the EU-28, detailed data for the scarp supply of Austria´s Aluminum industry and bottlenecks with respect to the quality of secondary resources will be discussed.
In general the results of the analyses show that the substitution potential of secondary mineral resources is not only limited due to the fact that raw material demand still exceeds current waste generation, but also due to quality constraints. The latter might become even more severe in future, when raw material demand and waste generation (supply of secondary resources) are tend to become balanced.

WASTE OF ELECTRICAL AND ELECTRONIC EQUIPMENT IN EUROPE VERSUS CIRCULAR ECONOMY

Joanna Kulczycka[1] – Henryk Karaś[2]

[1] AGH University of Science and Technology, Faculty of Management, Cracow, Poland
[2] Member of Mining Advisory Board, Ministry of the Environment, Warsaw, Poland, Chairman of the ETP on Sustainable Mineral Resources (2006-2012), Brussels

KEYWORDS
WEEE, recovery, raw materials, management, environment, policy

ABSTRACT

Nowadays, at European level it is emphasized that an essential way to deliver the resource efficiency agenda established under the Europe 2020 Strategy for smart, sustainable and inclusive growth is moving towards an idea of circular economy (CE). One of the most important advantages of CE systems is to keep the added value in products for as long as possible, eliminate or reclaim waste. This also applies to the Waste of Electronic and Electrical Equipment (WEEE). WEEE regulations are intended to reduce the amount of e-waste being disposed of and require EEE producers to pay for its reuse, recycling and recovery. WEEE can be one of the largest potential sources of raw materials. Currently, the management and recovery of materials from WEEE is on the agenda of the EU programmes and many individual countries as its improper disposal could have a significant impact on the environment. The efficient WEEE management has become a key goal, due to the pollution that could potentially result from the hazardous substances its components contain, but also because reusing its materials can be an important potential supply of many resources needed for industry. The assessment of potential raw materials from WEEE versus CE strategy will be analysed in the paper.

CIRCULAR ECONOMY – A NEW EU STRATEGY

In recent years, the strategy of adopting a circular economy (CE) has gained increasing currency as a concept for the pursuit of global sustainability (Staniškis, 2012). The most important benefit in moving to a more CE based approach is the possibility of retaining the added value in products for as long as possible (Smol et al., 2015), extracting their maximum value and eliminating waste. Circular economy is an emerging model that keeps resources in the economy as long as possible; resources can be reused for creating further value while relieving environmental pressures. Resource efficiency, as outlined in the circular economy model, is primarily based on closed-loops idea, implementing eco-design, increasing recovery and recycling, diminishing consumption, and industrial symbiosis, which involves territorial synergies to manage waste and share services, utilities, and byproduct. Therefore the concept covers not only material flow aspects but also the environmental, social and market ones. According to the EU's communication "Towards a Circular Economy: a Zero Waste Programme for Europe", the objectives and targets of the CE should become the key drivers to improve waste management, stimulate eco-innovation in recycling, limit the use of landfill, and create incentives to change consumer behaviour (COM 398, 2014). If we re-manufacture, reuse and recycle, and if one's industrial waste becomes another's raw material, we can move to a more circular economy where waste is eliminated and resources are used in an efficient and sustainable way.

RAW MATERIAL AVAILABILITY IN POLAND VERSUS CIRCULAR ECONOMY

Resources are the basis for an economy operating in quantitative terms. Therefore, a quantitative description of the resource flows, set targets and how these are assessed is necessary to promote and enable resource-use reductions (Kalmykova et al., 2016). The resource-intensity of the economy can be measured for example by Domestic Material Consumption indicator. It shows that, the average person is using about 29 kg per day of resources. In the EU the level is higher, as average European consumes 44 kg per day of materials (16 tons every year), of which 16 kg per day become waste (6 ton a year). The idea of decoupling the use of material resources from economic growth has already been implemented in many countries. Moreover, the materials security and materials criticality has also been of growing interest. The materials can be critical due to the risks of a shortage of supply and the fact that the impact of a shortage of supply on the economy is greater than those of most other raw materials. In 2014 EU presented the next list of critical raw materials which is updated every four year. Twenty raw materials were identified as critical from the list of fifty-four candidate materials of which among other are: gallium, germanium, indium, niobium, PGMs, REEs, tungsten (COM, No. 297, 2014).

Criticality of raw materials should be assessed also for individual country. The list of key non-energy raw materials for Polish economy was develop in 2015 (Kulczycka et al., 2015). The analysis was commissioned by the Ministry of Economic Development. The idea based on definition of key raw materials, i.e. they are simultaneously met the following criteria:
1) their necessity for the development of Polish industry:
a) in the short term – (in particular), they are essential to the development of industries delivering products with high added value and industry sectors with the highest growth rates (in the last 10 years) – i.e. industry branches with highest value added, and - industry branches with greatest growth dynamics throughout the recent 10 years,
b) in long term (till 2020) - in particular, they are essential to the development of industries (according to the planning documents) and they are having a high potential for innovation – i.e. industry branches identified on the basis of foresight studies, mainly smart specializations,
2) their accessibility may be problematic or risk associated (e.g. in context of size and the possibility of exploitation indigenous reserves, imports or substitution).
A methodology was chosen based both on statistical data about value added of industry detailed analysis of raw material consumption and demand, risk in supply, possibility of substitution and recycling possibility. Assessment was verified by the system of questionnaires among industries and individual experts. Finally 25 raw materials (groups of raw materials) classified as non-energy mineral raw were chosen as crucial for the Polish economy. In table 1 they are ranked according to the average annual value of the domestic consumption of raw materials in the years 2005, 2010 and 2014 of domestic consumption.

Tab. 1 Ranking of key/critical raw materials for the Polish economy

No	Raw Material	Consumption (MLN PLN)	no CN
1	Metallic magnesium	43,5	810411-19
2	Ferroniobium	16,0	720293
3	Fluorite	8,2	252921-22
4	Silicon	179,0	280461-69
5	Manganese	7,2	81110011
6	Lithium	4,3	282520, 283691
7	Germanium oxides	1,0	282560
8	Phosphate	457,0	2510
9	Magnesite (raw, calcined, roasted and melted)	160,6	251910-90
10	Talc	30,8	2526
11	Rare earths, scandium and yttrium - metals and compounds	7,5	280530, 284610-90
12	Metallic cobalt and cobalt compounds	3,8	2822, 810520
13	Titanium metal	1,8	810820
14	Bismuth metal	1,5	8106
15	Potassium salts	768,3	3104
16	Metallic tin and tin alloys	33,4	8001
17	Antimony metal and antimony oxides	20,7	282580, 811010
18	Manganese oxide	9,4	282010
19	Iodine raw materials	2,7	280120, 282760
20	Iron ores and concentrates	1623,1	2601
21	Metallic zinc and zinc alloys	416,3	790111-20
22	Manganese ferroalloys (ferromanganese)	87,5	720211-19
23	Tellurium	0,9	28045090
24	Aluminum metal and aluminum alloys	728,7	760110-20
25	Platinum group metals	23,2	7110

Source*:* Kulczycka et al., 2016.

WASTE OF ELECTRICAL AND ELECTRONIC EQUIPMENT

The WEEE can be an important potential supply of resources. The most common materials - almost half of the total weight of WEEE - are iron and steel. They account. for *almost half* of the *total weight*.The second largest component by weight are plastics, representing about 21% of WEEE. Non-ferrous metals, including precious metals, represent ~13% of the total weight of WEEE (with copper accounting for 7% Widmer et al., 2005). However, the EEE contain many materials requiring special end-of-life handling, most prominently lead, mercury, arsenic, chromium, cadmium, and plastics capable of releasing, among other compounds, dioxins and

furans. Due to the presence of hazardous substances in e-waste, when WEEE is disposed of or recycled without any controls, there are predictable negative impacts on the environment and human health.
Recovery and recycling of WEEE, such as mobile phones, computers, screens, monitoring devices, and white goods appliances can be one of the largest potential sources of mineral raw materials, but the rate of recovery is still low in Poland. It is estimated that, the growth rate of WEEE is three times higher than other types of waste (3-5% per year). According to the Chief Inspectorate of Environmental Protection (CIEP) in Poland every citizen generates about 14 kg of electronic waste annually of which about 4 kg are recovered which gives about 150,000 tons per year. Most of the waste collected is transferred to recycling processing plants (Table 2,3). It is much lower than in EU, where each citizen generates at about 17 kg of WEEE per year. It is assumed that in the year 2020 this amount will increase up to 24 kg/person (Kulczycka, Karas, 2016).

Tab. 2 The WEEE market in Poland in 2006-2014 per capita

WEEE [kg per person]	2006	2007	2008	2009	2 010	2011	2012	2013	2014
Generated	6.76	14.60	14.79	11.73	12.75	13.50	12.44	12.63	13.48
Processed	0.16	0.66	1.31	2.65	2.71	3.98	4.12	4.14	4.22
Collected	0.13	0.71	1.48	2.85	2.94	3.75	4.06	4.44	4.39*
Recovered*	0.01	0.04	0.02	0.04	0.01	0.02	0.03	0.02	0.03
Recycled	0.01	0.40	0.58	2.30	2.31	3.38	3.46	3.35	3.31
Re-used	0.00	0.00	0.00	0.02	0.01	0.02	0.02	0.03	0.02
Polish population [thousand people]	38,122	38,116	38,135	38,173	38,204	38,200	38,690	38,496	38 484

Source: CIEP, 2015; CSO, 2016.
* in processes other than recycling

Tab. 3 The WEEE market in Poland in 2006-2014 [Mg]

WEEE	2006	2007	2008	2009	2010	2011	2012	2013	2014
Generated	257,726.1	556,470.7	564,179.2	447,725.4	487,108.3	515,666.8	481,230.9	486,180.0	518 868.3
Processed	6,040.1	25,154.7	49,790.1	101,127.8	103,689.8	151,859.0	159,413.7	160,290.1	162 362.8
Collected	5,031.2	27,173.9	56,425.8	108,792.5	112,246.2	143,339.8	157,178.3	171,727.6	168 932.1
Recovered*	349.7	1,538.6	628.8	1,516.1	302.5	816.1	1,033.7	914.8	1 113.9
Recycled	457.1	15,085.6	22,137.5	87,884.4	88,162.5	129,054.2	133,701.2	129,771.0	127 190.1
Re-used	0.1	13.9	9.0	823.1	340.3	582.3	795.8	1,139.1	658.0

Source: CIEP, 2015; CSO, 2016.
* in processes other than recycling

The European Union is one of the few regions in the world where there is uniform legislation regarding the collection and processing of e-waste. This is formulated in the WEEE Directive (2012). The successor of the WEEE Directive will come into force in 2019. In here, one of the targets is to collect 85% of generated e-waste. In practice, most Member States do not reach that collection level yet. Finally, the WEEE can be processed in own country or can be exported for reuse. Although this has a higher priority in the waste treatment hierarchy, these exports can lead to improper recycling in the destination countries (Balde et al., 2014). As a result significant amount of WEEE has been traded illegally. According to *European Environment Agency* (2012) the EU reporting system does not deliver clear data on transboundary movements of e-waste. National data suggest that the amount of legally shipped e-waste is small compared to the amounts collected. As a result a substantial proportion of e-waste export goes to countries outside Europe, including West African countries, disguised as used goods. Treatment in these countries usually occurs in the informal sector, causing significant environmental pollution and health risks for local populations. The main challenge in e-waste management is curbing illegal shipments and making sure that e-waste is collected and properly treated within EU recycling infrastructure. It was also confirmed by the research undertaken in the project Countering WEEE Illegal Trade (CWIT) where it was showed that in EU from total amount of WEEE generated in 2012 of 9.45 million tons only 35% (3.3 million tons of all the e-waste discarded in 2012) ended up in the officially reported amounts of collection and recycling systems of Member States and the other 65% o(6.15 million tons) was either exported - 1.5 million tons (documented 0.2 million tons of UEEE and 1.3 million tons of undocumented UEEE and

WEEE), or recycled under non-compliant conditions in Europe - 3.15 million tons (includes 2.2 million tons of WEEE which are mixed with metal scrap and 0.95 million recycled under non-compliant conditions).
In Poland there are still many legal loopholes in e-waste management system, connected with inadequate monitoring and supervision of companies putting EEE on the market, even with implemented Extended Producer Responsibility system. The enterprises putting in the market household equipment are obliged to collect at least 45% by weight of the equipment they have introduced onto the market in the previous calendar year. And from 1 January the following year they will need to achieve a minimum level of 65% collection rate, and it will has to be achieved in Poland no later than 14 August 2021, if not they have to pay a product fee. The enterprises putting EEE on the market can sign the agreement with Organization of Electrical and Electronic Equipment Recovery (OEEER) which are responsible for fulfilling the collecting and recycling obligation on behalf of enterprises. OEEER can sign the agreement with processing plants and based on received documents they proved the obligation. However the "gray zone" exists - caused issuing false documents. As a result the price for such service has been dropping. In 2008 the OEEER paid for realization the obligation 0,90 PLN for 1 kg of processed WEEE, now it is 0,07 PLN/kg, whereas the total cost of collecting, transport, recycling and recovery amounted 0,97 PLN/kg (Okońska-Kubica, 2016). This will lead to increase illegal trade both in export and on domestic market, i.e. dismantling of collected equipment outside processing plants, in unauthorized places, withoutt authorization and without the need to satisfy a number of requirements and standards. As CE is a priority also in Polish economy it is necessary to find effective solution to create an effective system for promoting recycling and for recovery valuable raw materials, which are critical (key) for Polish economy. Some good practices are related to field such as creation of The Waste Management and Recycling Cluster where enterprises, business organizations and research institutions cooperate for promotion recycling, conducting lobbing activities, consulting legal, marketing and technology solutions.

LITERATURE

Baldé, C.P., Wang, F., Kuehr, R., Huisman, J., 2015: The global e-waste monitor – 2014, United Nations University, IAS – SCYCLE, Bonn, Germany.
CSO (Central Statistical Office of Poland): Database, viewed September 2016, from http://stat.gov.pl/en/.
CIEP (Chief Inspectorate of Environmental Protection), 2015: Reports on the functioning of the waste electrical management for the years 2006-2014.
Commission of European Communities. Communication No. 297, 2014: On the review of the list of critical raw materials for the EU and the implementation of the Raw Materials Initiative.
Commission of European Communities. Communication No. 398, 2014: Towards a circular economy: A zero waste programme for Europe.
Countering WEEE Illegal Trade, Summary Report, Market Assessment, Legal Analysis, Crime Analysis and Recommendations Roadmap, August 30, 2015, Lyon, France.
European Environment Agency Report No 7/2012 Movements of waste across the EU's internal and external borders.
Kalmykova Y, Rosado R., Patrício J., 2016: Resource consumption drivers and pathways to reduction: economy, policy and lifestyle impact on material flows at the national and urban scale, Journal of Cleaner Production, v. 132.
Kulczycka J. Karaś H., 2016: Legal and illegal trade in waste in electrical and electronic equipment – the consequences and risks (in Polish), Cuprum 2/2016.
Kulczycka J., Pietrzyk-Sokulska E., Galos K., Koneczna R., Lewicka E., 2016: Key Raw materials for Polish economy (in Polish), IGSMiE PAN Kraków.
Okońska-Kubicka J., 2016: Cost assessment and its impact on profitablity of WEEE recycling (in Polish) http://www.klasterodpadowy.com/page/konferencje-organizowane-przez-klaster
Smol, M., Kulczycka, J., Henclik, A, Gorazda, K, Wzorek, Z., 2015: The possible use of sewage sludge ash (SSA) in the construction industry as a way towards a circular economy. Journal of Cleaner Production, 95, 45-54.
Staniškis, J. K., 2012: Sustainable consumption and production: how to make it possible. Clean Technologies and Environmental Policy, 14(6), 1015-1022.
Widmer, R., Oswald-Krapf, H., Sinha-Khetriwal, D., Schnellmann, M., Böni, H., 2005: Global perspectives on e-waste. Environmental Impact Assessment Review 25 (5), 436–458.

Dr hab. Joanna Kulczycka prof. AGH
AGH University of Science and Technology
Faculty of Management
Gramatyka 10, 30-067 Cracow, Poland
kulczycka@meeri.pl

Henryk Karas
Member of Mining Advisory Board
Ministry of the Environment, Warsaw, Poland,

Chairman of the ETP on Sustainable Mineral R esources (2006-2012) - Brussels
h.karas@data.pl

EITI IMPLEMENTATION IN GERMANY

Dr Thomas Gäckle

Head of Directorate „Raw Materials Policy”, Federal Ministry for Economic Affairs and Energy, Germany

ABSTRACT

The Extractive Industries Transparency Initiative (EITI) was launched in 2003 and today represents a global movement towards greater financial transparency and accountability in the natural resource sector.
51 countries are currently implementing the EITI on a voluntary basis. Germany is part of this international movement. The overarching goal of the EITI is to publish credible and easy-to-understand information that will facilitate public debate about revenues from resource extraction and the way such funds are used. Since the EITI was established in 2003, Germany has been supporting the initiative both politically and financially in many developing and emerging economies. Germany is thus a leading supporter of the EITI. In July 2014, the German federal cabinet took the decision to implement EITI in Germany and to submit an official application to become an EITI Candidate. Parliamentary State Secretary Mr Uwe Beckmeyer from the Federal Ministry for Economic Affairs and Energy has been appointed Special Federal Government Commissioner for EITI implementation in Germany. In March 2015, the German Federal Government formed a multi-stakeholder-group (MSG), which has developed a working plan and candidature application. In February 2016, the EITI International Secretariat accepted Germany as candidate country to the EITI. In the time up to August 2017, Germany will prepare and publish its first EITI Report containing contextual information on the German extractive sector and a disclosure of government extractive industry revenues and material payments to government by oil, gas and mining companies.
By implementing the EITI, Germany wishes to contribute to the acceptance of the EITI as a global standard for anti-corruption and transparency. The initiative can contribute to worldwide sustainable development, transparent markets and a level playing field for companies. At national level, Germany would like to strengthen dialogue and transparency in its resource policy and extractive industry, in order to increase the acceptance of resource extraction. A particular challenge is implementation the EITI in the federal states: Germany has 16 independent states and as many governments, tax and mining authorities. Nevertheless, it has set itself the goal of minimising the reporting burden for the extractive industry by harmonising EITI requirements with existing reporting requirements deriving from relevant EU law. Germany is thus highly interested in the exchange of experiences on EITI implementation with other EU countries facing similar challenges.

STATE OF IMPLEMENTATION OF DIRECTIVE 2006/21/EC – ASSESSMENT OF EU MEMBER STATE IMPLEMENTATION REPORTS

Marie Dollhofer[1], Edward Sims[2], Ferdinand Zotz[1], David Parker[2], Harry Symington[2]

[1] BiPRO GmbH, Munich, Germany
[2] Oakdene Hollins, Aylesbury, Buckinghamshire, United Kingdom

KEYWORDS
Extractive waste, implementation, European Union, Member States, Directive 2006/21/EC, extraction and refining industries

ABSTRACT

In the EU, wastes deriving from the extraction and refining industries are regulated under the Extractive Waste Directive 2006/21/EC ("the Directive" or "EWD"). In the Directive, extractive waste is defined as

> "*Waste resulting from the prospecting, extraction, treatment and storage of mineral resources and the working of quarries";*

in terms of what is "waste", the EWD makes reference to the definition as provided by the Waste Framework Directive 2008/98/EC

> "*any substance or object which the holder discards or intends or is required to discard*".

The Directive provides for measures, procedures and guidance to prevent or reduce as far as possible any adverse effects on the environment, in particular water, air, soil, fauna and flora and landscape, and any resultant risks to human health, brought about as a result of the management of waste from the extractive industries. To this end, the Directive contains a number of different elements.
The scope of the Directive covers extractive waste as defined above, including waste rock (unused extraction product), and mine tailings which are defined in the Extractive Waste Directive as:

> "*waste solids or slurries that remain after the treatment of minerals by separation processes (e.g. crushing, grinding, size-sorting, flotation and other physico-chemical techniques) to remove the valuable minerals from the less valuable rock*".

However, according to its Article 2(1), the following is excluded from the scope of the Directive:

> *"waste which is generated by the prospecting, extraction and treatment of mineral resources and the working of quarries, but which does not directly result from those operations;*
> *waste resulting from the offshore prospecting, extraction and treatment of mineral resources;*
> *injection of water and re-injection of pumped groundwater as defined in the first and second indents of Article 11(3)(j) of Directive 2000/60/EC, to the extent authorised by that Article."*

Further, it is important to note that a number of the EWD's requirements, namely on permitting, do not apply for

> *"Inert waste and unpolluted soil resulting from the prospecting, extraction, treatment and storage of mineral resources and the working of quarries and waste resulting from the extraction, treatment and storage of peat"*, unless deposited in a Category A waste facility.

In addition, the competent authority may reduce or waive EWD's requirements for the deposit of

> "*non-hazardous waste generated from the prospecting of mineral resources, except oil and evaporites other than gypsum and anhydrite, as well as for the deposit of unpolluted soil and of waste resulting from the extraction, treatment and storage of peat*"

as long as it is satisfied that the general requirements of Article 4 of the Directive are met. Finally, Member States (MS) may decide to reduce or waive certain requirements for non-hazardous non-inert waste, unless deposited in a Category A waste facility.

Extractive Waste within the EU

According to Eurostat statistics, the mining and quarrying industry produced 671,810,000 tonnes of waste in 2010, in the EU-27[1]. This is equivalent to around 30% of the total waste generated in the same countries.
According to Eurostat statistics, the EU-28 produced over 730 million tonnes of mining waste in 2012, a volume which is growing broadly in line with economic upturn since 2008 (see
Fig. **1**).

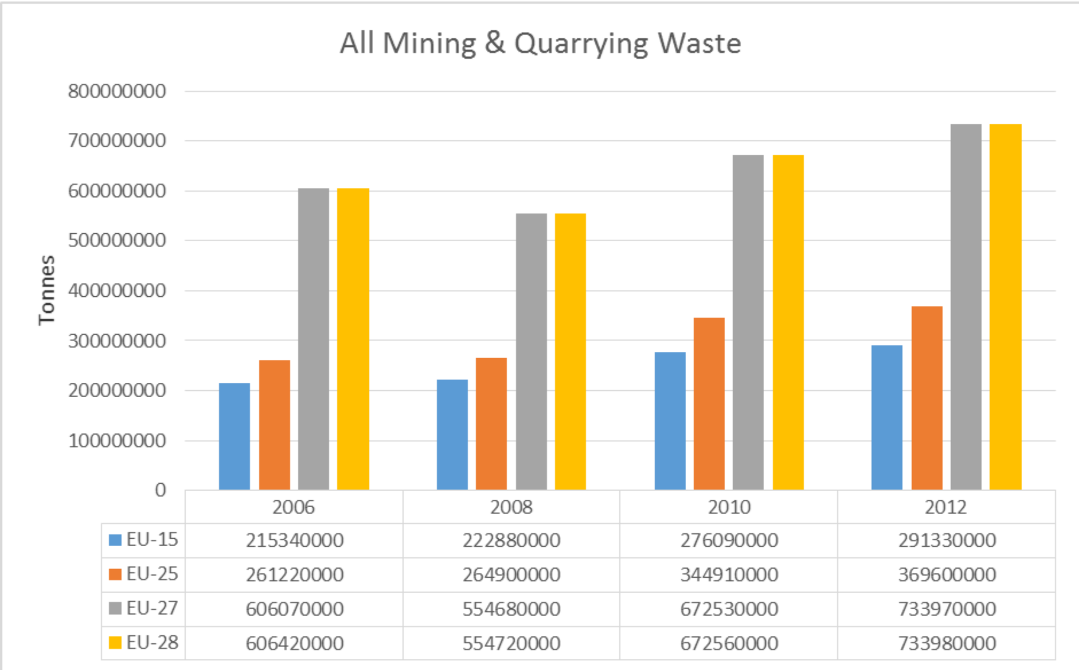


Fig. 1 Generation of mining waste within the EU (Eurostat2006-2012) (NACE_r2)

In mass terms, this accounts for around 30% of all waste generated by these MS (MS). However, there is a large variation in the fraction of total waste by MS that is attributable to mining waste. According to percentages of waste by sector per MS Bulgaria, Estonia, Finland, Greece, Poland, and Sweden have extremely high percentages of mining waste out of their totals (Eurostat 2012 data). This is attributable in part to the importance of the sector to their economies.

Elements of the Extractive Waste Directive

In broad terms, the EWD consists of the following elements:

1. Description of subject matter; Scope; Key definitions; Classification system of waste facilities;
2. Obligation for MS to report to the EU Commission; Exchange of information; Procedure and subject of Comitology Committee; Transitional periods; Transposition; Entry into force (Articles 18, 21 to 26 of the Directive);
3. Measures and requirements of the Directive (described in the table below).

Tab. 1 The Directive's substantial basic requirements

EWD substantial basic requirements	Article	applies to …
Develop a **waste management plan** for the minimisation, treatment, recovery and disposal of extractive waste	5	All facilities
Develop a **major-accident prevention policy**, including a safety management system and internal emergency plan;	6	Category A facilities

[1] Accessed via Eurostat Mining & Quarrying Waste landing page
http://epp.eurostat.ec.europa.eu/portal/page/portal/waste/waste_generation_and_management/generation/mining_quarrying

EWD substantial basic requirements	Article	applies to …
Allow no extractive industry waste facility to operate without a **permit** issued by the competent authority;	7	In principle all facilities, but see (1)
Ensure **public participation** by providing information and allowing the public to prepare and participate effectively	8	In principle all facilities, but see (1)
Requirements for **placing extractive waste back into the excavation voids** for rehabilitation and construction purposes	10	All facilities
MS have to ensure that **waste facilities are managed by a competent person** and that technical development and training of staff are provided	11	In principle all facilities, but see (1) and (2)
Closure and after-closure procedures of a waste facility and monitoring are to be organised by MS pursuant to the requirements of the Directive	12	In principle all facilities, but see (1) and (2)
Preventive measures must be taken against water and soil contamination, including from cyanide-containing waste tailings	13	In principle all facilities, but see (1) and (2)
Waste facility operators must provide a **financial guarantee** before the beginning of waste processing operations	14	In principle all facilities, but see (1) and (2)
In accordance with Directive 2004/35/EC[2], operators of waste facilities are subject to a **presumed liability** in respect of environmental damage caused by their operation	15	All facilities
Provision of information to other MS and the public in the case of **transboundary effects**	16	Category A facilities

Notes:
(1) Cf Article 2(3) first para: “Inert waste and unpolluted soil resulting from the prospecting, extraction, treatment and storage of mineral resources and the working of quarries and waste resulting from the extraction, treatment and storage of peat shall not be subject to Articles 7, 8, 11(1) and (3), 12, 13(6), 14 and 16, unless deposited in a Category A waste facility”
(2) Cf Article 2(3) third para: “MS may reduce or waive the requirements of Articles 11(3), 12(5) and (6), 13(6), 14 and 16 for non-hazardous non-inert waste, unless deposited in a Category A waste facility”

The addressees of the Directive are the MS (Article 27 EWD), which have not only to implement the respective provisions into national law, but also ensure that the standards described in the Directive are met, via decisions on permits reflecting the EWD’s requirements, and through enforcement measures (such as inspections, Article 17 EWD), both to be taken by competent authorities. The Directive introduces the “operator” as a main actor, who has (within MS’ legislation) to be held responsible for key obligations the EWD mentions. “Operator” is in the EWD defined as “the natural or legal person responsible for the management of extractive waste, in accordance with the national la w of the MS in which waste management takes place, including in respect of temporary storage of extractive waste as well as the operational and the after-closure phases”.
Important to note that the EWD distinguishes between certain categories of facilities, as follows:

- Category A waste facilities; Waste facilities for non-hazardous non-inert waste;
- Waste facilities for unpolluted soil, non-hazardous prospecting waste, waste resulting from the extraction, treatment and storage of peat and inert waste;
- Waste facilities not meeting one of the criteria described above (i.e. for instance facilities where hazardous waste is stored but below the threshold of meeting the Category A facility definition, see directly below).

Of particular importance are the Category A facilities. A waste facility shall be classified as Category A in line with Annex III of the EWD and Commission Decision 2009/337/EC[3], if

[2] Directive 2004/35/CE of the European Parliament and of the Council of 21 April 2004 on environmental liability with regard to the prevention and remedying of environmental damage (OJ L 143, 30.4.2004, p. 56).
[3] 2009/337/EC: Commission Decision of 20 April 2009 on the definition of the criteria for the classification of waste facilities in accordance with Annex III of Directive 2006/21/EC of the European Parliament and of the Council concerning the management of waste from extractive industries (notified under document number C(2009) 2856) (OJ L 102, 22.4.2009, p. 7).

- a failure or incorrect operation, e.g., the collapse of a heap or the bursting of a dam, could give rise to a major accident, on the basis of a risk assessment taking into account factors such as the present or future size, the location and the environmental impact of the waste facility if the predicted consequences in the short or the long term could lead to non-negligible potential for loss of life; serious danger to human health; serious danger to the environment; or
- it contains waste classified as hazardous under Directive 91/689/EEC[4] (now: Directive 2008/98/EC) above a certain threshold; or
- it contains substances or preparations classified as dangerous under Directives 67/548/EEC[5] or 1999/45/EC[6].

Reporting under the Extractive Waste Directive

As general reporting requirements MS have to report

- to the Commission on the implementation of the Directive for a three years period, on the basis of a Questionnaire adopted by the Commission (Article 18(1) EWD)
- to the Commission on particular events and accidents every year (Article 18(2) EWD), and
- to Community statistical authorities, where requested for statistical purposes, information contained in permits granted under Article 7 EWD (Article 7(5)).

In addition, MS have to establish a publicly available inventory regarding closed and abandoned waste facilities.

Replies to Questionnaire (Article 18(1) EWD)

In particular as regards the mentioned Questionnaire, the relevant Commission Decision 2009/358/EC[7] in its Annex III contains two Parts

- for Part A, answers had to be provided during the first reporting period; subsequently, submission of information is only necessary in case the current state deviates from the information provided earlier); and
- for Part B, submission of information is necessary for each reporting period.

The assessment of national implementation reports may assist in identifying the challenges that exist in the implementation of the Extractive Waste Directive and at determining whether and/or how these challenges have been addressed by the MS. In turn, the assessment of reporting also may reveal where the Directive's provisions are differently understood and applied by the MS.
There have been two reporting periods (1st May 2009-30th April 2011, and 1st May 2012-30th April 2014). The result of the assessment of the first period (as prepared within the 2012 report of Ecologic Institute[8], Final Report prepared for. DG Environment – European Commission) has shown the shortcomings of the current reporting system and the need to introduce changes. In particular, the report emphasised doubts that the main provisions (as understood in that report) were fully implemented by MS. The report covering the assessment of the second reporting period has been elaborated by BiPRO and Oakdene Hollins in 2016, its main results are summarised hereafter.[9]

---

[4] Council Directive 91/689/EEC of 12 December 1991 on hazardous waste (OJ L 377, 31.12.1991, p. 20), as amended. Note that the Directive has been repealed by Waste Framework Directive 2008/98/EC with effect from 12 December 2010. References to the repealed Directive shall be according to Article 41 of Waste Framework Directive construed as references to this Directive, and shall be read in accordance with the correlation table set out in Annex V.

[5] Council Directive 67/548/EEC of 27 June 1967 on the approximation of laws, regulations and administrative provisions relating to the classification, packaging and labelling of dangerous substances (OJ 196, 16.8.1967, p. 1), as amended.

[6] Directive 1999/45/EC of the European Parliament and of the Council of 31 May 1999 concerning the approximation of the laws, regulations and administrative provisions of the MS relating to the classification, packaging and labelling of dangerous preparations (OJ L 200, 30.7.1999, p. 1), as amended.

[7] 2009/358/EC: Commission Decision of 29 April 2009 on the harmonisation, the regular transmission of the information and the questionnaire referred to in Articles 22(1)(a) and 18 of Directive 2006/21/EC of the European Parliament and of the Council on the management of waste from extractive industries (notified under document number C(2009) 3011)
OJ L 110, 1.5.2009, p. 39.

[8] Ecologic Institute (2012), Study on "Implementation report for Directive 2006/21/EC on the management of waste from extractive industries (Mining Waste Directive)", Final Report prepared for DG Environment – European Commission.

[9] The entire final report is available online at http://ec.europa.eu/environment/waste/studies/

Assessment of completeness of MS' reports

The Commission has received implementation reports from the 28 MS of the Union. 22 of these reports were provided to the project team (all except Bulgaria, Greece, Ireland, Italy, Luxemburg and Sweden).
These national implementation reports were assessed in terms of their completeness with respect to the requirements of the Directive and the Commission decision on reporting. To this end, tables were established indicating missing data and information. MS were then asked to comment and to confirm certain cases of doubt. As a result of the exchanges, for each MS conclusions were drawn as regards the completeness of the information submitted, including a comparison of the results between the two reporting exercises. The reports of most MS were rated complete; however, for different reasons – mostly for inconsistency of provided figures – the reports of the following MS were assessed as incomplete: Belgium, Czech Republic, Spain, France, and Portugal.
In addition, the Commission Services have assessed the completeness of the remaining six MS, and has rated the reports of the following MS as incomplete: Bulgaria, Greece, Ireland, Italy, and Sweden.
The completeness of MS' reports has overall improved in comparison with the first reporting period.

Identification and analysis of the main provisions
Out of the 28 MS that reported, six reported not to have any extractive waste facility covered by the Directive within their territory.[10] Such statements have been accepted as working hypothesis, even if there are information on extractive activities that, in some cases, could contradict them.
MS' answers in terms of implementation of main provisions have been summarised and analysed. Regarding the so-called main provisions, for reasons of consistency and comparability, the same approach as within the report covering the first reporting exercise was chosen, thus leading to five main provisions to be assessed:

- **Main provision 1:** Measures in relation to waste management plans and major-accident prevention and information
- **Main provision 2:** Practical arrangements ensuring information transmission
- **Main provision 3:** Number of Category A facilities with potential transboundary impact
- **Main provision 4**: Number of missing external emergency management plans for Category A facilities
- **Main provision 5:** Number of inspections for Category A facilities.

Further, additional figures provided by the MS in terms of Category A facilities were compiled and analysed. The results show that overall the MS have completed the process of transposition of the Directive, and thus generally having set in place means for implementation of main provisions 1 and 2. In terms of the picture regarding the development of main provisions 3 to 5, the figures reported for these main provisions by the MS are presented in the figure below, plus some further information deemed to be of interest.

[10] Denmark, Latvia, Lithuania, Luxembourg, Malta and the Netherlands.

Category A											
	In operation	In operation with permit	of which "Seveso"	In transition	In closure phase	Having an impact on another Member State	External emergency plans	Missing external emergency plans	Number of (Category "A" and "other" inspections)	Closed or abandoned	Total (including closed/abandoned sites)
AT	0	0	0	0	0	0	0	0	0	0	0
BE	0	0	0	0	0	0	0	0	0	0	0
BG	2	2	/	/	/	/	/	/	/	/	/
CY	1	0	0	0	0	0	1	0	1	0	1
CZ	0	0	0	0	0	0	0	0	0	0	0
DE	3	3	0	0	2	0	0	5	46	0	5
DK	0	0	0	0	0	0	0	0	0	0	0
EE	0	0	0	0	1	0	0	0	0*	1	2
ES	25	25	0	0	1	2	26*	0	78*	78	104
FI	9	7	7	0	0	0	4	5	41	0	9
FR	1	0	0	0	0	/	/	/	1	0	1
GR	1	1	0	0	0	0	0	1	/	0	1
HU	6	6	0	0	23	0	3	3	115	1	30
HR	0	0	0	0	0	0	0	0	0	0	0
IE	2	4	0	0	2	4	2	2	49	0	4
IT	/	4*	126	/	/	2	4	/	0	219	/
LT	0	0	0	0	0	0	0	0	0	0	0
LV	0	0	0	0	0	0	0	0	0	0	0
LU	0	0	0	0	0	0	0	0	0	0	0
MT	0	0	0	0	0	0	0	0	0	0	0
NL	0	0	0	0	0	0	0	0	0	0	0
PL	1	1	0	0	0	0	1	0	1	0	1
PT	3	3	0	0	0	0	0	3	18	1	4
RO	2	2	1	0	0	0	2	0	17	0	3
SI	0	0	0	0	0	0	0	0	0	0	0
SK	3	2	0	0	0	0	2*	1*	15	0	2
SE	/	/	3*	/	2*	2	4*	11*	/	300*	/
UK	4	4	1	0	0	0	2	2	7*	278	282

Note: / = No answer for second reporting period; * = No comparison possible with first reporting period, or estimation made by the project team (please consult the respective chapter as applicable)

Fig. 2 Overview table on figures provided by selected MS in terms of Category A facilities

Generally, for the 22 countries assessed, the figures on Category A facilities show a very varied picture, with huge discrepancies between the MS. Overall, figures seem to be certainly lower than one could expect taking into account the dimension of mining activities, the industry practice of waste management and the generation of waste, including hazardous waste, connected to it. Firstly, only 11 MS of the 22 assessed confirm that there are Category A facilities in operation at all. These 11 MS report a total of only 58 Category A facilities in operation. The number of Category A facilities with potential transboundary impact is very low. The number of missing waste management plans for Category A facilities is around 18 (without considering the case of Spain where no concrete figures for the 25 Category A facilities on its territory are provided). The number of inspection varies greatly between the MS; in some MS, none or very few inspections have been conducted in the three-years-period of the reporting, in other MS, both the total figures and the ratio between facilities and inspections is significantly higher. Then again, since no definition is provided in the EWD or in the Questionnaire what an inspection is and how to count it, these figures have to be seen as merely an indicative factor.

Analysis of further figures regarding the other categories of facilities under the scope of Directive shows that similar issues with the data of MS exist. The overall picture is, even when taking into account obvious different understandings by the MS, very varied and overall not very clear. There are huge discrepancies between the MS and no visible pattern regarding the figures, e.g. in terms of which is the most frequent category of installation. Certainly, the figures overall seem to be surprisingly low.

General conclusions regarding the main provisions

As visible from the high share of answers left unchanged in comparison with the first reporting period concerning Part A of the Questionnaire, the general framework for application of the EWD seem to be now established in most MS. Where the answers have been modified in this respect, this has been due to completion of legislation (such as Denmark), reporting coverage of the entire territory (such as Belgium), new administrative arrangements (such as Romania), or more in-depth information (such as for the UK). Overall, the impression is that the MS have completed the process of transposition of the Directive, and thus generally having set in place means for implementation of main provisions 1 and 2.

Generally, the figures on Category A facilities show a very varied picture, with huge discrepancies between the MS. Overall, figures seem to be lower than one could expect taking into account the dimension of mining

activities, the industry practice of waste management and the generation of waste, including hazardous waste, connected to it. Firstly, only 12 MS of the 22 which have been assessed by us confirm that there are Category A facilities in operation at all. These 11 MS report a total of only 58 Category A facilities in operation. Most of the concerned 11 MS report very low figures on Category A facilities for their territory – only Hungary (6), Finland (9), and Spain (25) indicate a number higher than five facilities in operation, where Spain counts for nearly 50 % of the total Category A facilities in operation reported for that period by the 22 MS which replies have been assessed.
Further findings are:

- Most of the Category A facilities in operation (53 of 58) do obtain a permit in line with the requirements of the EWD.
- The share of facilities falling under the scope of Seveso regime is rather low (9 out of 58).
- External emergency plans, in accordance with Article 6 EWD, are missing for around one third of the facilities. In these cases, it is in the majority of cases added that these plans are currently elaborated.
- The number of facilities have a potential impact on another MS is very low (from the 22 reports assessed and the 58 reported facilities in total, there are only two with such an impact, both located in Spain).
- The number of inspection varies greatly between the MS; in some MS, none (EE) or only one (PL) inspections have been conducted in the three-years-period of the reporting, in other MS, both the total figures and the ratio between facilities and inspections is significantly higher (e.g. HU: 6 Category A facilities, 115 inspections). Then again, since no definition is provided in the EWD or in the Questionnaire what an inspection is and how to count it, these figures have to be seen as merely an indicative factor.

Validity of the results of the assessment

The assessment of the information from MS has allowed identifying differences in their understanding of both basic concepts of the Directive and other broader concepts related to waste and hazardous waste. In other words, even if the National Reports are intended to provide the answers to the same questions, it is not sure that this was actually the case. That is why the findings of this assessment should be read and presented as trends rather than as individual, comparable national situations.

ENVIRONMENTAL ASPECTS OF MAGNESITE MINING IN SMZ A.S., JELŠAVA

Peter Košinár[1] - Július Buchta[2]

[1] Production director, SMZ, a.s. Jelšava, Slovak Republic
[2] Research and development department, SMZ, a.s. Jelšava, Slovak Republic

KEYWORDS
Environment, non-waste technology, emission reduction, magnesite

ABSTRACT

Magnesite mining and production has more than a 130 years tradition in Slovakia. The most important independent producer after the breakup of the former state company has become SMZ, a.s. Jelšava.
Simultaneously with the development of environmental consciousness and legislation in former Czechoslovakia in the past, environment responsibility has been developed in SMZ. The long-term objectives of SMZ, a.s. Jelšava are to develop a closed-cycle mining and raw magnesite processing technology, meet the strict EU's emission limits with a comfortable margin and a step by step elimination of consequences from the production from 25 years ago. This article presents some of the successes made by the company in these areas.

Environmental aspects of magnesite mining in SMZ a.s., Jelšava

Magnesite belongs to the most important mineral resources of Slovak republic. It is the only mineral resource mined in Slovak republic of European and even worldwide importance. The existence of magnesite reserves enabled the establishment of the magnesite industry, whose production capacity exceeded the needs of Slovakia and magnesite became a very interesting exporting product.
Approximately 1% of the worldwide magnesite deposits is located in Slovakia. Slovak republic has been a long-time leader in magnesite mining, processing and production of magnesia goods. SMZ, a.s., Jelšava is the most important Slovak producer which exports more than 90% of its production to more than 50 countries.
A large magnesite deposit stretches across the south east part of Slovakia over a length of 150 km, approximately from Lučenec to Košice. 23 deposits of industrial importance were confirmed in this area and nowadays only three are active: Jelšava - Dúbravský masív (Dubrava massif), Lubeník - Lubeník deposit and Hačava - Mútnik.
The deposit called Dúbravský masív in Jelšava has the dominant position and is the largest in Europe. Despite the fact that the geological research performed here was not completed in full depth, it showed that the massif contains approx. 75% of total Slovak reserves and has an expected mining lifetime of more than 100 years at the current mining volume (approx. 0,8 mil. tonnes per year).
The whole deposit Dúbravský masív, located north of Jelšava, contains high-quality magnesite of “Alpine type” with a Fe_2O_3 content of 3,5 % in the magnesite raw material. The mass of carbonates holding the magnesite deposit stretches in the length of 4,5 km from east to west, with average thickness of 600m.
Simultaneously with the development of environmental consciousness and legislation in former Czechoslovakia, environment responsibility has been developed in SMZ. Technological processing of magnesite in Jelšava has undergone various changes from the environmental standards point of view. Since the company became private, the company management aspires to achieve environmental protection exceeding the legal requirements.
In the 1970s production capacities were expanded, the heavy suspension processing plant was build and 3 rotary kilns were brought into use. The main issues of the company, after this period in the area of Work Safety and Environment were:

- lower mining safety connected to the mining method (open stope) in connection with the waste material accumulation on stockpiles
- high volume of solid emissions leading to a “moon country” creation
- high volume of CO_2, SO_2 emissions
- high industrial water consumption
- fine fraction deposition into a settling pit

Measures taken to eliminate the negative environmental impacts

1. Improvements in the efficiency of the mining method and work safety

The development of mining methods was based on quantitative and qualitative requirements of further material processing. In the early 1970s the most common mining method used in the Dúbrava mine was the open stope method with short and semi-long drilling holes. Later in years 1968-1993 the method "modification of Mikova open stope" was used.

The biggest disadvantage of this method was a high raw material pollution based on the geology of the currently mined part, as 4-5 thousand tonnes of material were extracted in one blasting. Another significant disadvantage was the waste stockpiling. Material not suitable for further processing from the quality point of view was stockpiled. During the history of the Jelšava mine huge piles were created, which reached a volume of almost 4 million tonnes of waste material. This particular mining method did not enable to dispose of these even in the future.

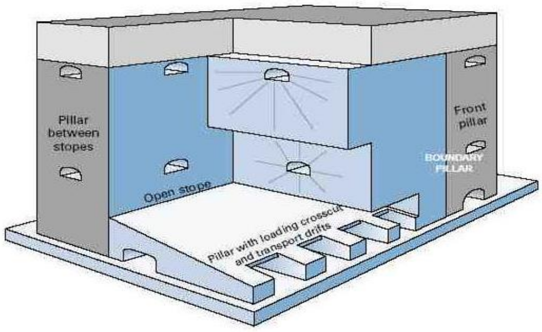
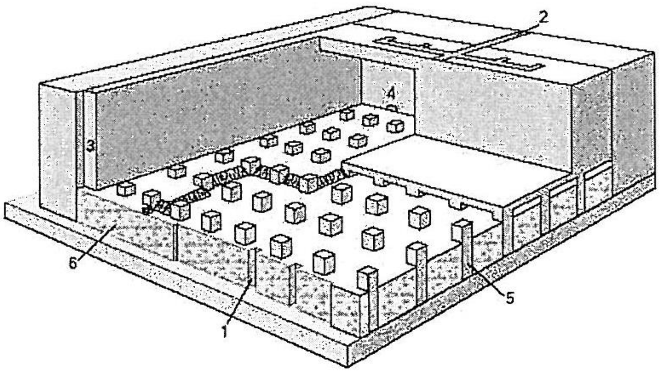


Fig. 1 Open stope mining method

At the present (since 1985) a new mining method called: overhand stoping with filling is being used on the deposit Dúbravský masív. This mining method assures maximum mining safety from the geo stability point of view because no open chambers are created in the mining area. This method also assures higher mining efficiency, reduced mining preparatory work and a higher mining performance per manpower and shift. Higher level of selective mining is also achieved as only 400-500 tonnes of material were extracted in one blasting and low quality material is remaining in the mine.



Legend:
1 - retraction chimney
2 - upcast
3 – extraction area
4 - back-filling chimney
5 - intrablock pillar
6 - back-filling

Fig. 2 Overhand stoping with filling

A great environmental advantage of this mining method is, that waste material previously stockpiled is now used as a backfilling material in volume of 200 000 t per year.

This mining method on the other side requires more sophisticated work and mining management.

2. Reduction of solid emissions (SE)

In the 1970s a "moon country" was formed in the surroundings of the factory in Jelšava, due to high magnesite emissions from the current rotary kiln technology. The issue was first addressed by building cyclone separators and definitely by building fabric filters behind rotary kilns in the early 1980s. The factory was already complying with the allowed emission limits shortly before the transformation of the former State enterprise in 1992.

A revitalization project was already drawn up in that period, but was not realized due to lack of time and resources. The company was purchased by the PLC, where over 95% of the stocks were purchased by the former employees.
Since the establishment of SMZ, a.s. Jelšava increasing attention has been paid to the environment. Care for the environment was mainly focused on reduction of solid emissions and SO_2 emissions. As shown in table 1, after implementation of many measures and reconstructions there has been a substantial reduction of solid emissions from the sintered magnesite production.
Whereas in 1983 4403 tonnes of solid emissions were released into the air, in 1990, 5 years later after installation of the de-dusting system Amertherm the volume was 695 tonnes. After further improvements on the system and its reliable operation in 1995 the volume decreased to "only" 186 tonnes. This amount was further reduced due to optimisation of the technology of filtration cycles adjustments and mainly due to further development and purchase of improved filtration textiles, which were used to make filtration hoses for this system.

Tab. 1 SMZ, a.s., Jelšava solid emissions in tonnes / years (1983-2015)

Year	1983	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
SE	4403	695	186	145	47	52	48	32	10	14	14	10	8	8	7

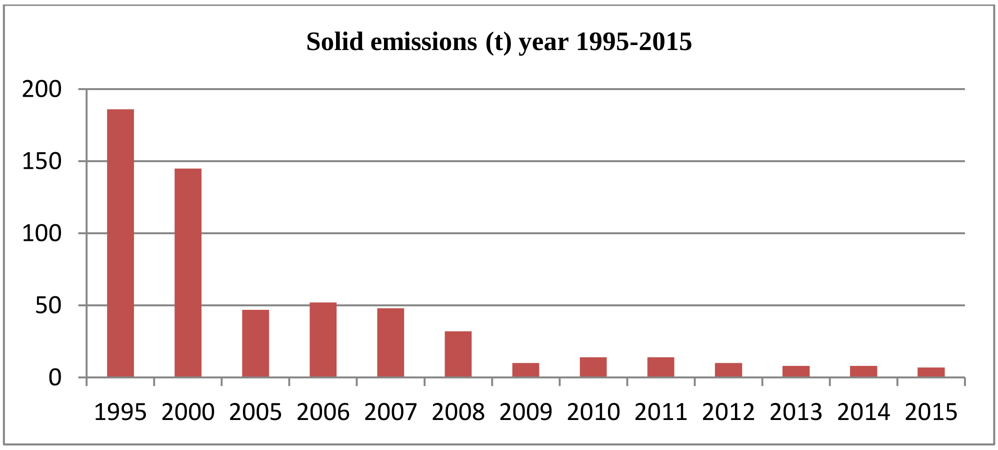


Fig. 3 Solid emissions (1995-2015)

Further improvements were achieved in 2008, when new generation filtration hoses made from glass fiber fabric with a special PTFE membrane were mounted into the Amertherm system behind each rotary kiln. Even though the whole change was quite expensive (more than 500 000 €), the benefits are visible in further reduction of solid emissions. These hoses with a guaranteed 5 year operating life and already a 30 000 hour of usage currently facilitate solid emissions values less than 5 mg. Nm-3, which represents only 10% of the allowed emission limit 50 mg. Nm-3.
Due to the negative environmental impact in the early 1970s there was a building ban issued in Jelšava for any other mining equipment. In 1999, after 10 years of compliance with the emission limits, based on improvements in the solid emissions the ban was lifted. Thanks to the above mentioned facts also the vegetation in the company surroundings significantly improved.

3. Reduction of gaseous SO_2 and CO_2 emissions

Even though there was a long term emphasis on solid emissions reduction which had devastating impact on the environment, measures to reduce gaseous emissions were not neglected, mainly reduction of SO_2 and CO_2 emissions. The amounts of SO_2 emissions are shown in Table 2 and Figure 4.

Tab. 2 SO2 emissions in tonnes / years (1983-2015)

Years	1983	1990	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
SO_2	863	1074	561	849	651	545	147	105	97	37	32	38	31

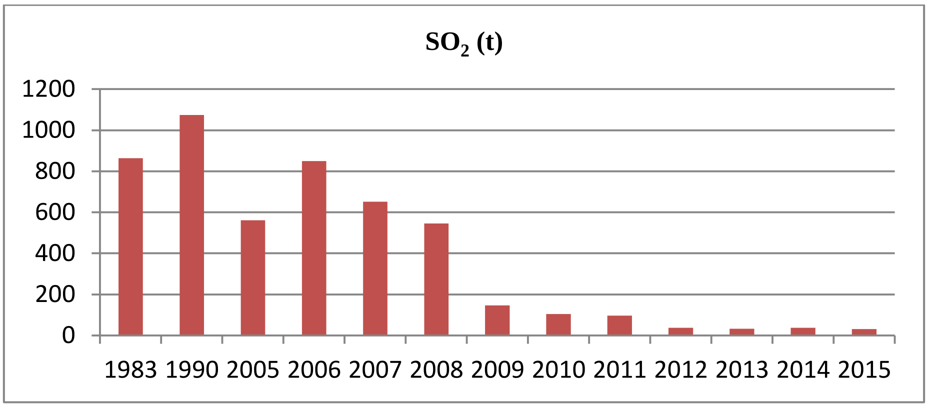


Fig. 4 SO_2 emissions

The key factor in SO_2 emissions reduction since 2009 was to substitute natural gas as a technology fuel for heavy fuel oil used previously. Already at the end of 2005 an operational test proved the possibility to use natural gas as a sole fuel in rotary kilns. After the liberalization of natural gas prices the company was able to successfully apply the use of combustion of natural gas with oxygen-enriched air within a one year period. Therefore a storage unit was built in 2008 increasing the oxygen storage capacities (investment of more than 100 000 €). Liquid oxygen requires a difficult logistics process of supply and stock maintenance. With the elimination of heavy fuel oil SO_2 emissions were significantly reduced and solely using natural gas as a fuel with lower carbon content a reduction of CO_2 emissions of 35 000 tonnes per year was achieved.

Implementing many other technological measures enabled a reduction of specific technological fuel consumption in individual furnace units as follows: shaft kilns Jelšava by 18,3%, rotary kilns Jelšava by 16 %, technological unit Bočiar by 39,9%; taking into consideration that customer demands for firing quality are continuously increasing.

The bellow summary of CO_2 emissions per 1 tonne of magnesia produced proves a performance quality in this area; whereby years 2013-2015 are vitiated by increase in demand for higher firing (which requires higher energy consumption).

Tab. 3 CO2 emissions amounts in tonnes per year and per tonne of concentrate (2005-2015)

Years	2005	2008	2010	2011	2012	2013	2014	2015
CO_2	555 444	495 682	453 069	447 170	372 546	339 240	330 204	304 056
Concentrate production	336 030	313 285	290 837	298 828	249 211	234 211	218 468	210 240
CO_2 / t CP	1,653	1,582	1,558	1,496	1,495	1,448	1,511	1,446

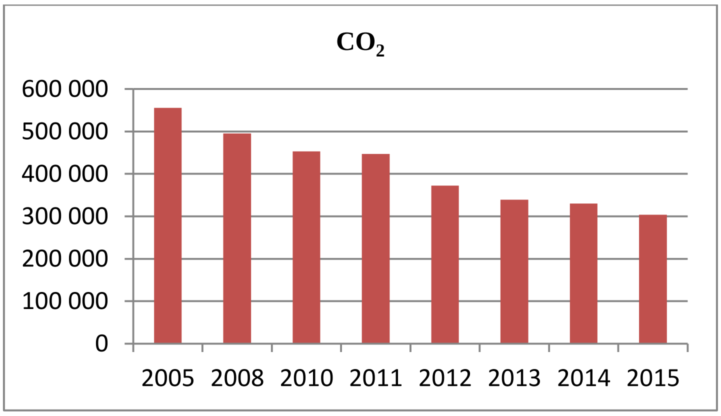


Fig. 5 CO2 emissions in tonnes/year

4. Reduction of industrial water consumption

Besides air as an environmental component, other components such as water and waste are paid attention to. Efficiency in water usage is not only a benefit for the environment, but also an economic indicator. This can be also applied to waste management, where thorough sorting reduces amounts to be disposed and increases the possibility of usage as secondary raw material for sale to various organizations or employees.

Industrial water consumption in SMZ, a.s. Jelšava is mostly connected to the wet granulation sorting in the Heavy suspension processing plant, where over 85 % of total water consumption occurs. This was due to the lack of efficiency of fine fraction sedimentation of material in the deposition tanks – DORRs and pumping diluted sludge into the settling pit.

Flocculation implemented in 2010 in order to increase the speed of sedimentation and enable the usage of clarified water in the closed circle system led to reduction of volume of sludge to 50-60% of the original volume. The current usage of mine water in amount of 25 - 40 thousand m^3 per month and other optimization enabled to reduce the purchase volume of industrial water as shown in table 4 and figure 6.

Tab. 4 Industrial water consumption in m3 and m^3/tonne of concentrate

Year	Consumption in m^3	Monolithic production	m^3 / t M mixes
2004	1 177 190	362 010,45	3,25
2005	1 108 079	336 030,00	3,30
2008	1 011 729	313 285,00	3,23
2009	513 086	208 507,00	2,46
2010	284 247	290 837,00	0,98
2011	64 326	298 827,80	0,22
2012	104 080	249 211,12	0,42
2013	20 570	234 211,00	0,09
2014	0	218 468,00	0,00
2015	9 639	210 240,00	0,05

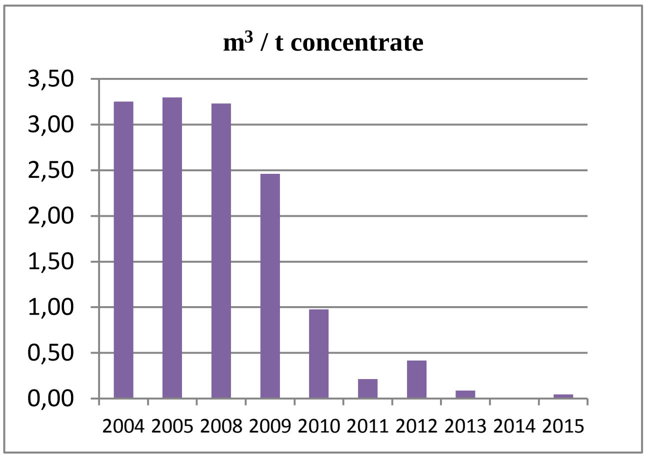


Fig. 6 Industrial water consumption

The company could be self-sufficient in terms of water usage, but due to the high mineralization of the mine water it is required to purchase industrial water in amount of approx. 2-3% of the total water demand for usage for cooling during raw material heat-processing.

5. Fine fraction siltation elimination into the settling pit

The usage of the settling pit represents loss of usable magnesite raw material, and an increasing safety concern due to the need for raising the settling pit dam. Despite the fact that the settling pit capacity would be sufficient for another few decades, and the height of the dam (approx. 30m) and the storage of internal materials was not a particularly acute issue, the company management decided to procure a technology for sludge separation and drainage, and to eliminate the pumping of sludge into the settling pit. The planning stage begun in 2013, realization, trial runs and optimisation of the technology process were finished in 2015. Since the beginning of 2016 the drainage line is fully operational and pumping of sludge into the settling pit was stopped. The technology provided by an experienced supplier meets all operational requirements. Investment cost amounted to 1,3 mil. €.

Fig. 7 Sludge drainage line

This technological line has provided a fully non-waste magnesia raw material processing in SMZ, a.s., Jelšava.

Measures resulting from tightened legislation in recent years and other measures

The previous segment described how SMZ, a.s., Jelšava and the company management handled solid emissions, SO_2 and CO_2 emissions from the point of view of mining technology and the use of raw magnesite. The company achieved significant success in this area, but in recent years new regulations concerning the environment have resulted in the following measures.

1. NO_X emissions in the mining environment

With regards to increased standards of NO_X concentration in the mining environment electro-hydraulic drilling machines and usage of trucks and loaders using urea for NOx reduction were implemented. After purchase of measuring probes, which are 10 times more sensitive than the probes used before it was discovered that the NO and NO_2 concentrations are below the new established standards. It is possible that the measuring methodology might need to be adjusted, the currently measured values are under 1,5 ppm for NO and under 0,5 ppm for NO_2.

2. CO emissions in clinker production in heat aggregates

Limit values of CO in magnesia production will be binding for Slovak magnesia producers from the second quarter of 2017. Even though a similar technology in a relatively close industry has a 40 times higher limit value the management has accepted the implementation of the 1000 mg of CO/Nm^3 limit value as a great challenge.
It is an interesting fact that this emission limit is an issue only in case of shaft kilns, which energy requirement is only 65% of the energy requirements of rotary kilns, where this issue does not exist.
After evaluation of many technological measures in collaboration with VRP BERG faculty of Technical University Košice, a technological solution on shaft kilns which will result in emissions very close to the limit values is currently being established. It will be interesting to see how other European companies producing magnesia clinker will handle the limits for the more energy efficient shaft kilns.

3. Measures to improve appearance of the company surrounding

Over the last 15-20 year period of following strict emissions limits the company has achieved a great improvement of the surroundings of the company.
Despite there are no legislative requirements the company management has decided to re-cultivate an approximately 20 000 m2 large slope area. This area was badly affected by rotary kiln production prior to the textile filters implementation. After some landscaping of the difficultly accessible terrain sludge from the waste water treatment plant was applied and suitable soil was placed. Thereafter hydroseeding was applied and the slopes are turning green now.

Fig. 8 Revitalised areas before and after

Approximately 150 of wood species were test planted where there can be seen successful growth of most of the 6 types. This result can be seen as a successful solution to be realized on other areas.

4. ISO 14 001 and GMP+ production technology certificates

Based on results achieved in the environmental area the company has undergone certification according to ISO 14001/2004. The certification ran in two steps and the certificate was issued by Lloyd´s Register QA on 7th of December 2012. The aim of the certification was a systematic solution of continual progress in the environmental area. Long-term objectives include total liquidation of stockpiles, transition to complete utilization of mined ore without the use of the settling pit, as well as further reduction of energy intensity (CO_2, NO_X, SO_2 emissions) and waste management.

Another field were a certification process was completed is the possibility to produce caustic calcined magnesia for food industry and agriculture. Due to a usage of CCM in the food industry it was a very challenging process as it required GMP+ certification where some requirements were similar to requirements in “sweets production”. Even this complicated task was managed and the GMP+ certificate was issued on 8th of May 2013.

Conclusion

I would like to state, that despite the company is far below the limits in terms of meeting emission regulation standards, we have no room for complacency. The company management is committed to assure continuous improvement of the current environment.

INTEGRATING ENVIRONMENTAL REMEDIATION AND DECOMMISSIONING INTO THE LIFE-CYCLE MANAGEMENT OF MINING AND MILLING SITES

W. Eberhard Falck

WEFalck Scientific Advisory Services, 1 rue de Béarn, F-92210 Saint-Cloud, France

ABSTRACT

Modern mining takes a life-cycle approach, that covers the temporal evolution of a site from exploration to the final end-state or re-use of a mining and milling site.

The picture the public has of mining today is still shaped by the past, when mining companies have exhibited often a nonchalant attitude towards social and environmental impacts. Historically, this has its roots in shareholder-value considerations, when the costs of environmental and social impacts were tacitly externalised. It has resulted in a large number of mining legacy sites world-wide, the remediation of which continues to require considerable (public) resources.

Mining and milling operations will permanently alter to some degree their site and their surroundings. A complete return to greenfield conditions will generally not be possible. Open cast mines, spoil heaps, and/or tailings management facilities will remain at the surface. Underground open mine workings will also remain. These features will become eventually their legacies with which the local population will have to live. A life-cycle approach to mine planning takes this into account and will also involve the local population in the planning and decision finding processes. A mine has to integrate into the local socio-economic context and add value to the host communities, if possible beyond its active life-time.

The classical engineering paradigm in residues management is to somehow contain the alien material, in other words to design for resistance. As a result, such structures above ground have significant amounts of potential energy stored in them, which means that they require maintenance for ever. When designing impoundments for mining and milling residues it is, therefore, wise to minimise the amount of potential energy stored in them, for instance by going underground. Impoundments are often designed with only the operational requirements in mind, not considering their long-term fate. This will require extensive remediation works at the time of the closure of a mine. Such works should not be left to the end, but impoundments should be prepared for long-term care during the operational phase, as and when they are not needed anymore.

Decommissioning of above-ground and underground mine-infrastructure requires resources and knowledge. Once the mine is closed, both will become scarce rapidly. It is, therefore, wise to integrate decommissioning into the operational plan. Again, works should be carried out as soon as infrastructure is deemed superfluous. While it is appreciated that planning ahead for years, or decades in the case of mines exploiting large occurrences, is difficult, it is wise to develop a mine-management plan that already includes a decommissioning plan. Buildings and other infrastructure can also be designed to facilitate decommissioning and decontamination, if required.

This paper will make a case for integrated operational, decommissioning, and closure plans that go beyond the active life of a mine with a view to minimise resources requirements, and environmental and societal impacts.

ENHANCING IMPLEMENTATION AND CAPACITIES: THE NEW EU MINING MENTOR CENTRE AND ITS OBJECTIVES

Dr. Corina Hebestreit

Euromines
hebestreit@euromines.be

Waste from the extractive industry provides a challenge and an opportunity in times where the EU is committed to circular economy and wishes to secure access to raw materials in order to ensure its economic growth. It is therefore important that the EU continues to follow different avenues in order to improve its waste and land management: resource efficiency needs to drive recovery of primary and secondary raw materials from extracted materials, old mine waste disposal sites as well as end-of life products. Rehabilitation of old sites and application of modern techniques need to ensure the return of the land to society in an adequate condition for future use.

RTD and innovation into new techniques achieving higher environmental and health and safety protection has been and needs to be supported and in order to achieve better implementation across the EU efforts needs to be made in capacity building of all concerned stakeholders.

The objective of the newly formed EU Mining Mentor Centre is to provide to the industry and other public and private stakeholders high quality expertise and support on in the area of mine and quarry issues (as maybe stipulated by EU or related national legislations) including environmental management, water management, material recovery for added-value, and mine closure and site remediation and aftercare. Mine closure and site remediation is a long term and complex process. Not only the technical implementation, but also social and health impacts, safety regulations, specific legislative expertise, etc. are needed to deal with in this complex process.

The EU Mining Mentor Centre is capable of providing the necessary competences with a proven track-record of the experts involved.

APPROACH OF A REGIONAL HEAVY METAL POLLUTION CAUSED BY NON-FERROUS INDUSTRY A CASE FROM BELGIUM

J. Bronders[1,*], I. Van Keer[1], I. Joris[1], N. Desmet[1], J. Vos[1], P. Seuntjens[1], E. Fierens[2]

[1] VITO, Flemish Institute for Technological Research, Boeretang 200,2400 Mol, Belgium
[2] OVAM, Flemish Waste Agency, Stationsstraat 110, 2800 Mechelen, Belgium
[*] Corresponding author E-mail: jan.bronders@vito.be

KEYWORDS
Heavy metals, non-ferro, soil, grundwater, pollution, remediation

ABSTRACT

1. INTRODUCTION

The Kempen region, located in the north-eastern part of Flanders (Belgium) and the south-eastern part of the Netherlands, is polluted with heavy metals due to the former activities of non-ferro industry smelters (see Figure 1). This pollution, developed during the last century, has a regional character and covers an area of 700 km2. Soil, ground and surface water are polluted with mainly zinc and cadmium (average regional groundwater concentrations for Zn vary between 500 – 3000 µg/l; for Cd concentrations are observed up to 20µg/l). Studies have been carried out in this area since 1995. As a result a good overview has been obtained of all the aspects related to the source, the fate and the risks of the pollution, resulting in a holistic approach including remedial actions and protective measures. An important part of the study focused on actual and potential risks. Hereby, current pollution risks and future changes in the pollution status of water bodies (groundwater and surface water) were highlighted. In this framework a groundwater model has been developed. An overview of the followed approach together with the results and conclusions related to the evaluation of protective measures and the assessment of the status of water bodies in the area is briefly described and will be presented.

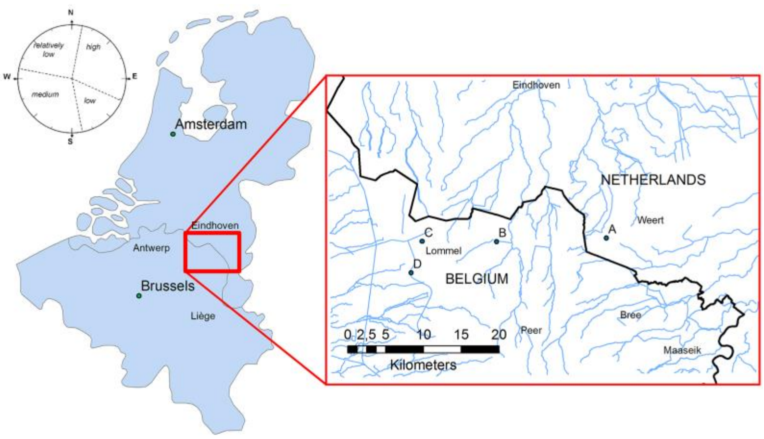


Fig. 1 Location of the area; A, B, C and D are sites of non-ferro industries (A, B and D are still active plants)

2. MODEL APPLICATIONS

2.1 Fate of the pollution

The model was used to calculate the fate of the heavy metal pollution in soil and groundwater. Overviews of concentrations for different heavy metals as function of time and location were calculated allowing to evaluate future movement of the pollution. As an example calculated leachate concentrations (to the groundwater) are given in figure 2.

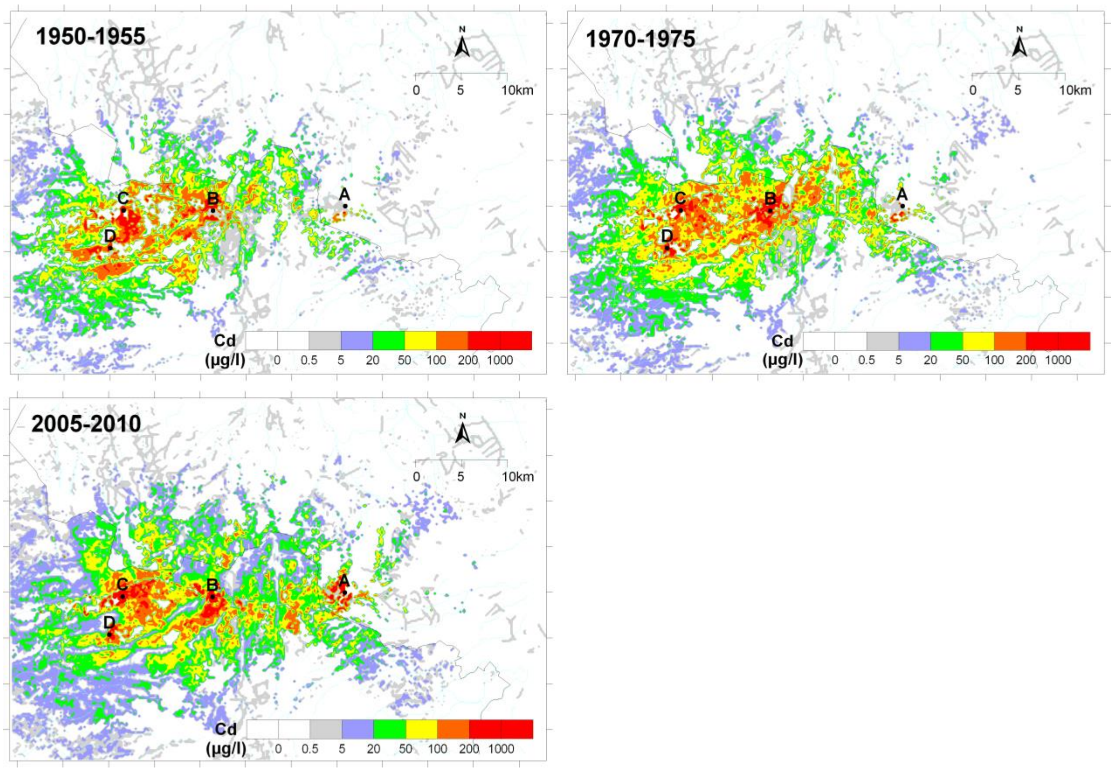


Fig. 2 Maps of concentration of Cd in leachate in 1950 (top-left), 1970 (top- right) and 2005 (bottom) (Joris et al. 2014)

2.2 Evaluation of remedial actions

Related to remediation it was concluded that an evaluation of possible actions (on regional and on local scale) was needed in order to define their efficiency. The modelling approach was used to get a good understanding of possible measures.

The following types of measures (local or regional) were taken into account:

- hydrodynamic measures (pumping) at the different (non-ferro industrial) sites;
- drainage (pumping) in certain areas in the region;
- drainage (draining system) along watercourses in (highly) polluted areas, possibly combined with additional infiltration of water;
- excavation of contaminated topsoil and zinc ashes.

These measures were evaluated using the hydrogeologic model. As an example, calculated cadmium concentrations in the surface water of the river Molse Nete are given in figure 3 as function of selected remedial actions. The presence of cadmium is caused by groundwater drained into the surface water.

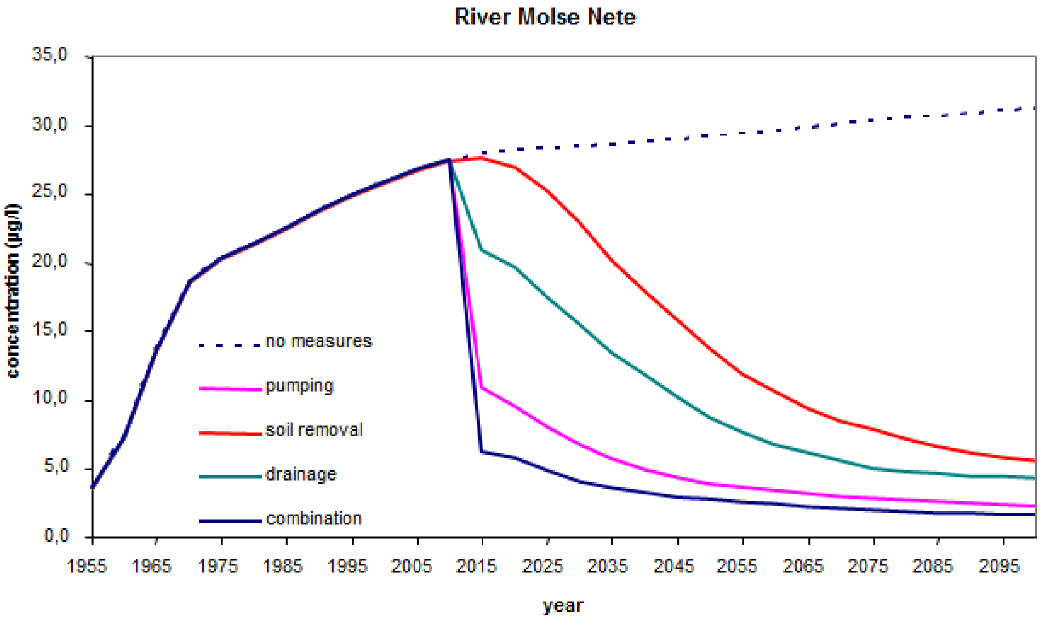


Fig. 3 Calculated concentration of Cd in surface water based on polluted groundwater discharging (draining) to the river Molse Nete for a selection of remedial actions including: reference situation (no measures), pumping of groundwater at the nearby site D (see Figure 1) of non-ferro industry, removal of poluted top soil, additional drainage in the area, combination of pumping + drainage + soil removal.

2.3 Status of the water bodies

In the area different water bodies are defined according to the EU Water Framework Directive (WFD). The WFD obliges the EU member states to monitor and evaluate the status of these water bodies. The WFD states that measures have to be taken to ensure a good status, or at least to ensure that no more deterioration takes place. However, as the considered regional pollution area affects multiple water bodies and the demarcation of these water bodies is far from matching the polluted area, it is difficult i) to interpret the status of the water body; ii) to evaluate the relation to the regional pollution and iii) to interpret the evolution of the pollution as function of time and taking into account remedial actions.

The modelling approach allowed to: i) evaluate the effects of the pollution in relation to the status of the water bodies; ii) estimate the future changes of water quality, iii) evaluate the effectiveness of certain measures or define such measures. The calculations allow to identify when a certain change in the water quality trend is visible (and thus affecting the status of a groundwater body). It is also possible to indicate to what extent the considered pollution is "responsible" for the status of the water body considered in order to allow future studies to focus on certain actions.

3. RESULTS AND CONCLUSIONS

Related to possible remedial actions it was concluded that the proposed measures to reduce metal concentrations in groundwater, on a regional scale (diffuse contamination), were not very effective or not feasible (e.g. removing the top soil in the whole area). Only actions were recommended at the industrial sites itself (where high concentrations of metals are present in the groundwater plumes, concentrations of zinc up to several 10000 µg/l). The only significant measure to reduce loads entering the river systems is the instalment of local draining (in zones where higher discharge of polluted groundwater to the rivers is present).

The model results indicate that the status of the considered water bodies is not significantly changing before 2027. Without remedial actions an improvement of the water quality is only visible at the end of this century. Based on the model results, taking into account a selection of measures an improvement of groundwater quality is clearly observed. Resulting is less pollutant discharge towards rivers. In any case, remedial actions or not, only after a long period the status, of the water bodies (ground or surface water) present in the region, is improving. The modelling and future date collection will be used to follow the status of the waterbodies. This will allow to identify if improvement (positive trend) is present or if at some places more effort (actions) is needed to reduce the pollutant flow towards receptors such as local rivers.

4. ACKNOWLEDGEMENT

This project was financially supported by the Flemish Waste Agency, OVAM.

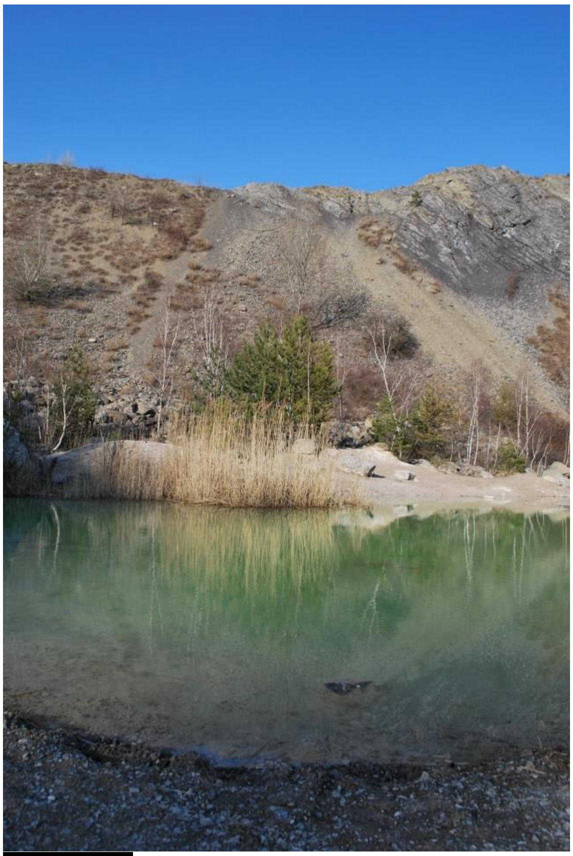
EXAMPLES OF THE SUCCESSFUL REHABILITATIONS IN THE CZECH REPUBLIC

David Póč

Těžební unie, poc@tezebni-unie.cz
Těžební unie (Czech Republic Mining Association)

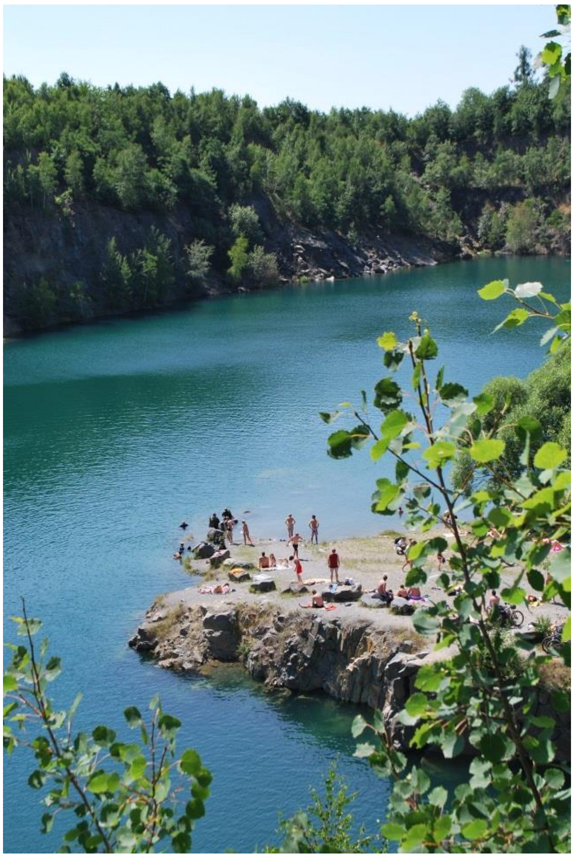
KEYWORDS
social responsibility, rehabilitation, local communities, geological parks, green bridge competiton

One of the key challenges for the mining industry in the Czech Republic is to show to the general public that places with **mining history have a wide range of applications and are not a negative factor in the development of the area.** With appropriate regional management, a place previously described with negative connotations (mostly by local inhabitants) can be transformed into a geologically or biologically interesting site beneficial for the region as one of the centers of tourism. The Czech Republic has a great potential in tourism and mainly thanks to its historical monuments, it belongs among very popular destinations in Europe. However, its potential for the development of tourism associated with the mining industry or geology still remains, untapped.



Růženin lom

Růženin quarry – example of the rehabilitation close to nature by Těžební unie (Czech Republic Mining Association), Czech Republic

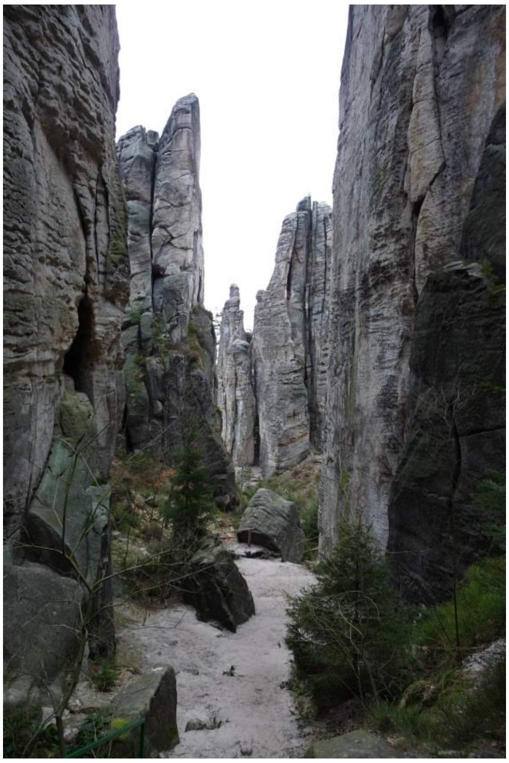


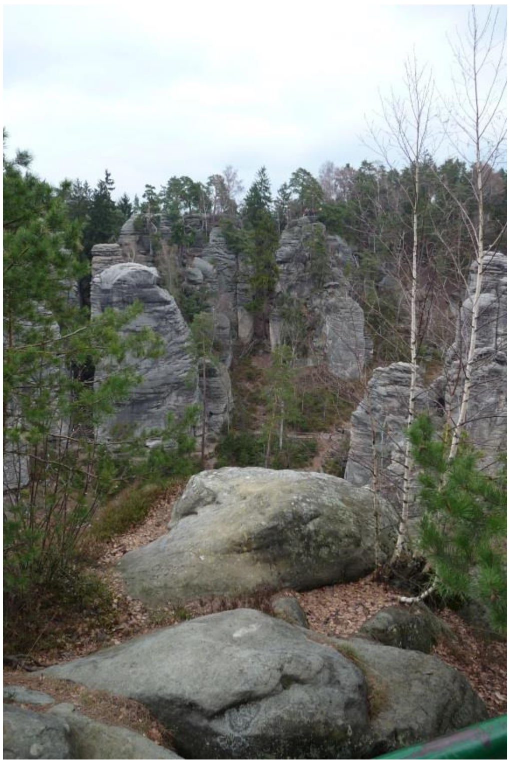
Výkleky quarry – popular tourist destination by Těžební unie (Czech Republic Mining Association), Czech Republic

If we look at the potential of the Czech Republic associated with geology and geomorphology, we can see that currently, one of the most important projects is the support of a **system of geoparks in the Czech Republic**. It is a concept that goes beyond local communities, but it involves their cooperation (it often starts as an initiative of several connected communities), and is implemented as a **regional or national project** (the evolving project is managed under the auspices of the Czech Geological Service in an effort to support development of geologically interesting sites in the Czech Republic). The term **geopark refers to an area that provides a picture of geological development of the Earth and demonstrates the influence the local natural wealth**

has on economic and cultural development of the society. A geopark is designed in regions where the geological structure offers an interesting interpretation of geological processes (and is hence presented in this way to the public), and where a functional infrastructure is built from local groups to support traditional as well as new geotourist activities.

The system is built on a possibility to exchange experience among individual geoparks in order to support application of tools to support tourism. The main coordinating body of the national network of geoparks is ***the National Geoparks Council of the Czech Republic operating under the Ministry of the Environment of the Czech Republic***. The council helps implement the principles of the geoparks concept, helps run their activities, and also decides which candidate sites to include to the national network of geoparks.





Czech Garden of Eden by Těžební unie (Czech Republic Mining Association), Czech Republic

The Czech system of geoparks is connected to ***the European network of geoparks that was established in 2000 and by the mid-2010 included 37 sites in 15 countries in Europe***. The main objective of geoparks is, according to ***the European Geoparks charter***, protection of geological sites, research, education and promotion of the Earth Sciences, the development of Geotourism and sustainable development within a given territory. Only a site that has proven its quality and functionality as a national geopark can become a European geopark. According to Madonie declaration (2004), every European Geopark becomes automatically a UNESCO Geopark. There are currently four certified national geoparks in the Czech Republic: Bohemian Paradise, Egeria, GeoLoci and the Železné hory Mountains. Bohemian Paradise is also listed by UNESCO. A highly significant indicator of the importance of geoparks not only for tourism, but also for education purposes, is the fact that six other geoparks are waiting to be included to the national network, i.e., they are undergoing a certification process. After their inclusion, the Czech Republic will have a network of ten geoparks covering different geological periods and offering a great potential to increase tourism almost in all regions of the country.

It is evident that within the rehabilitation projects that are being carried on both on the former as well as in the parts of active mining sites, the respects for local conditions including needs of communities is becoming the most important part of planning processes.

Geoparks are one of the examples how the mining company could project the operations in socially acceptable way, so the local company could profit from outcomes of the project. So upon the planning of rehabilitations, ***the mining organizations more and more often unite with the representatives of local organizations or non-profit organizations not to obtain the results of the rehabilitation activities that are "only" technically correct, but mainly fulfil a specific objective for which the rehabilitation was intended***. Beside the aforementioned geo-park concepts, it is then possible to find a number of rehabilitation projects, which are directly aimed at a support of tourism in the given region, be it in a form of sports centres, unique localities with protected flora and fauna, or localities for social realization. Unique concepts of ***creation of geo-parks then shows the possibility of accentuating also the use of large areas affected mainly with opencast mining, with regard to tourism of leisure time activities.*** The support of the geo-park concept by the Ministry of Environment of the Czech republic is an important element here, as it is can be presumed that in the future the public service will deal more intensively with the possibilities of support of concept-based rehabilitations also on larger areas.

The rehabilitation works also take place in a close cooperation between the investor – the mining organization – on the one side and architects, representatives of the local community or non-profit organizations on the other side. This is also in the Czech Republic one of the few ways of bridging the mistrust of the public toward mining with respect to concerns resulting from not only extraction itself, but also the consequences that remain after it. The proactive and ***responsive approach of mining companies to the problem of further use of the mining areas these days clearly shows support for "Corporate Social Responsibility" as part of each undertaking, which is integral to the modern mining industry***. The situation in the Czech Republic shows that also in the countries of the former "communist bloc" the mining industry can make large step forward in the approach to the environment or communication with local communities.

The main challenge is now to further continue in an active communication with the local communities, with the aim to assist the future development of mining localities after mining itself has ceased. A significant support to this is the exchange of the best accessible practices in the form of various information platforms (for instance, the European association Euromines) or contests promoting rehabilitations in compliance with the intentions of the local communities (e.g. the Green Bridge of the Mining Association of the Czech Republic).

One of the examples of the appreciation of the of the best practices are also particular contents of the specific companies – for example HeidelbergCement Quarry Life Award (international scientific and educational competition aimed at promoting and raising awareness of biodiversity in mining areas, held in 22 countries on 4 continents, open for students and young researchers to propose projects on biodiversity related topics (scientific research, management, education, rehabilitation/reclamation). ***In last year winner from the Czech Republic - in the category “Biodiversity Enhancement”*** – project “Research of the biodiversity at the Tovacov lakes” by Jan Ševčík, Czech Republic. The Tovacov lakes offer habitats for many (protected) plant and animal species. To improve the function and quality of these biotopes, and to increase their current biological value, a set of 17 recommendations were developed.

Another very convincing example is the Ruzenín lom rehabilitation. The applicant and author of the project is Eva Wagnerová, the investor being the company Českomoravský cement a.s., succession company. ***The author took into consideration the position of the location in the edge of the urban conglomeration and the position of the extraction body among the protected relicts of relatively well preserved nature, connecting them into one significantly larger complex, that will serve in a better way to the protection purposes.*** Protection of important geological phenomena is connected with many diversified areas suitable for protection and propagation of flora and fauna. The methodology of controlled succession in the quarry has been processed in the best and the most thorough way of all the presented projects. The correctness of selected solution is proved by spontaneous dissemination of several species of orchids, being an indicator of natural conditions and occurrence or nesting of bird species requiring conditions that are much similar to original natural conditions. Due to its position on the edge of the town conglomeration, Růženin lom is under strong anthropogenic pressure and it was hit by vandal interventions of non-disciplined visitors***. Apparently, the author supposed and expected such pressures and most of re-cultivation measures are proposed in such a way so as to eliminate the above stated negative features to the maximal possible extent.*** From the point of view of targets of the Green Bridge competition organized by the Těžební unie (Czech Republic Mining Association) it is possible to say that this project pointed out in the best and most effective way the thesis that suitably and professionally re-cultivated mining area is not just a permanent scare in the countryside, but it may also support development of locations that had not been in the original location and increase the species diversity.

Research of the biodiversity at the Tovacov lakes by Jan Ševčík, Czech Republic

Another example of the socially sensitive restoration project is ***the reconstruction of a historical pilgrimage route next the Osek monastery, Czech Republic***. With the gradual onset of mining in the area, the countryside was subject to significant changes. First the changes unveiled slowly, but in the 20th century the scale of the countryside took a dramatic turn. The Bílina quarry (Northern Bohemia) takes up an extensive territory which has been entirely transformed by surface excavation. ***With the development of the mining industry the traditional pilgrimages deteriorated and the composition of local inhabitants totally changed. The old settlers of German ethnicity were entirely replaced by newly settled people from central areas of the country.*** The new inhabitants probably brought along their customs and the old traditions were interrupted. Social traditions changed along with traditional care for the countryside, farming and forestry. The landscape also underwent radical changes during decades under the communist government. Entire villages were sacrificed and disappeared.

Gradually, reclamation of excavated areas began. It would be interesting to capture the development of this area as part of the restored pilgrimage routes – both the social development but also the characteristic development of local countryside. ***Although it is not possible to restore the presumable original historical pilgrimage routes it is very valuable to show their fragments to new pilgrims today who can observe how the recent decades marked them.*** These fragments, albeit pilgrimage chapels, crosses or alleys of old fruit trees lining roads have a high information value. We should protect them with great care and respect. It is also beneficial to show areas which have undergone reclamation changes.

The reconstruction of a historical pilgrimage route next the Osek monastery by Těžební unie (Czech Republic Mining Association), Czech Republic

Another specific example of the social acceptability of the mining activities in connection with the rehabilitation projects, are the different events launched by the mining companies in these sites. ***One example could be site next to the city of Chrudim. Event named "The Gate to the Iron Mountain or Rocks rock to the Chrudim" was built on the principle to apply geology to the seemingly unrelated topics like gastronomy, culture etc.*** In the center of the event was the regional trade market with geological content – regional producers from the different areas. Part of the event was based also on the activity where participants could try themselves the gold placer mining. This event for held under the auspice of the Czech Republic Ministry of Environment.

Participants of the event Rocks rock to the Chrudim by Vodní zdroje Chrudim, spol. s.r.o., Czech Republic

APPLICATION OF THE MITIGATION HIERARCHY ACROSS THE PROJECT TIMELINE

Johannes Drielsma

Euromines
drielsma@euromines.be

The Cross Sector Biodiversity Initiative (www.csbi.org.uk) is a forum to provide leadership in developing and sharing good practice related to biodiversity and ecosystem services in the extractive industry. The initiative was formed by IPIECA.org, ICMM.com/Euromines.org and the Equator Principles Association to support innovation and transparent application of the mitigation hierarchy with respect to biodiversity and ecosystem services throughout extractive project activities. Its membership has recently expanded to include the International Finance Corporation, the Inter-American Development Bank and the European Bank for Reconstruction and Development. Three key deliverables of the CSBI will be presented including examples of how impacts on biodiversity have been avoided, minimised, restored and offset within the mining industry in Europe and Canada. The CSBI Tools and case-studies serve to illustrate how modern Rehabilitation and Restoration of mine sites is an activity that is undertaken throughout the life of a mining project, beginning even before feasibility studies are undertaken.

IRELAND'S MINE REHABILITATION POLICY ELIMINATING RISK AND PROVIDING BENEFITS

EurGeol Dr. Eibhlín Doyle P.Geo

Exploration and Mining Division Ireland
Department of Communications, Climate Action and Environment,.

KEYWORDS
Remediation, CRAMP, Tailings Management Facility

ABSTRACT

Ireland has a long history in mining that can be traced back to the Bronze Age. Evidence of mine operations from the 17th – 19th century is dotted around the country. These mine sites bear the hallmarks of those times when the emphasis was to win the metal for an industrial age, providing much needed employment with little consideration of the environment. Break through engineering feats were celebrated and are evidenced by the engine houses and chimneys which allowed miners to excavate to deeper levels. There was no remediation in these early times and a number of the old mine sites contain public health and safety risks as well as environmental risks to varying degrees inherited from a time which had a different focus.

The 20th century was for Ireland the birth of a nation. Ireland sought to develop indigenous industries, provide employment and improve the conditions for the Irish people. The mineral industry played its part in contributing to Ireland's economic development. Significantly a small group of Irish entrepreneurs working in the Canadian mineral industry returned to Ireland in search of mineral deposits in the 1950's. They were successful and within a few years deposits such as Silvermines, Tynagh and Gortdrum were discovered and developed having obtained planning permission and the appropriate State Mining Facility (SMF). Strong Government support provided the confidence for investment in the mineral industry.

It is worth noting that despite these early times, SMFs contained a clause requiring mine closure to be carried out such that "the site would be left in a clean and tidy state". The mines closed and while some remediation was carried out on many sites, the lack of funds and the absence of a comprehensive plan meant that sites were often left with a variety of issues. These old mine sites are often held out as examples to illustrate the poor environmental record of the minerals industry despite being from a different era.

This is the historic backdrop for the modernisation of Ireland's rehabilitation policy along with the emerging outlook of a more developed society towards protection of the environment. One of the key issues in the remediation of these older mines was the lack of funds when the mines closed.

Recognition of the deficiencies of the 'environmental clause' in the early SMF prompted the requirement for a closure plan and associated financial provision to be put in place prior to commencement of mining. The closure plan was made an integral part of the overall operation. The discovery of Galmoy in 1986 established these terms in relation to mine closure and financial provisions. Galmoy's Tailings Management Facility (TMF) was designed with remediation in mind. The TMF was designed in a cellular mannerwith the three cell design enabling progressive remediation. A full mine closure, remediation and aftercare plan was developed and funds were ring fenced for that activity so that the remediation could be carried out when the mine closed. Galmoy closed in 2012 and has remediated its TMF to a combination of agricultural endpoint and wetland providing improved biodiversity for the area (Figure 1).

In 1990 Lisheen was discovered and it followed suit providing both a mine closure plan and associated financial provisions prior to any mining development. Their TMF was originally designed to a wet end point but the company changed its plan, with the consent of the authorities, as it approached closure and it too moved to a dry end point similar to that at Galmoy.

The mine closure plan reports are considered dynamic documents and are reviewed regularly. Additional funds may be sought during these reviews if they are considered necessary. It is important that they are dynamic documents and it was this policy which allowed Lisheen to change from a wet end point to a dry end point in recognition that this was a better, and a more robust and sustainable closure solution.

Ireland's rehabilitation policy was developed to reduce risk and ensure that mine site closure provides a positive contribution to the area. The policy built on that which went before and has been revised and developed to suit today's practices. Mine operations now remediate TMFs to more productive end points e.g. agricultural endpoint at Galmoy and Lisheen. New business are attracted into the area to use the mine offices and facilities, this provides continued employment opportunities for the local community. In addition, workforce plans are put in place allowing for retraining of the workforce to ensure their continued employment, following mine closure.

The rehabilitation policy represents a significant change in Ireland. Two mines are now successfully closing under an agreed Closure, Restoration and Aftercare Mining Plan, known as a CRAMP. This system provides examples of the modern practices of the mineral industry. Mine operations now plan for closure and remove the risk often associated with a closed mine. In addition to removing risk, mines can leave behind a framework for other industries to operate in the area. This change in policy has been embraced by all and is likely to improve the overall standing of the mineral industry into the future.

Fig. 1 Galmoy TMF remediated to an agricultural endpoint.

Dr. Eibhlín Doyle
Exploration and Mining Division,
Department of Communications, Climate Action and Environment
29-31 Adelaide Road,
Dublin D02 X285
Ireland

RECLAMATION AND REVITALISATION IN THE EXTRACTIVE INDUSTRY IN POLAND – INNOVATIVE PROJECTS LEAD BY MINING AND GEOENGINEERING FACULTY OF AGH UST

Assist. prof. Anna Ostręga, DSc, PhD, Eng., Professor Marek Cała, DSc, PhD, Eng.

Faculty of Mining and Geoengineering, AGH University of Science and Technology

ABSTRACT

Reclamation is a final stage of mining activity, which is a duty of mining operator. However the initial stage for revitalisation process is usually conducted by other parties. In this connection cooperation between all actors in reclamation and revitalisation processes and vision of target redevelopment of post-mining areas are key factors of success. In its research activities, the Faculty of Mining and Geoengineering of the AGH UST covers all stages related to the management of mineral resources, including mine closure, reclamation and revitalisation of post-mining areas. Faculty has been co-operating with main actors in reclamation and revitalisation processes: mining operators and local governments. One of it referred to Faculty's flagship project called Tarnowskie Lakeland – revitalisation of the complex of sand and gravel open pits inspired by and draw on local culture and nature. Several municipalities, mining operators and private investors are taking part in this innovative revitalisation project. It shows the significant potential of post-mining areas, which (if skilfully adapted) can be used to both enrich biodiversity and meet community needs, as well as strengthen local identity. Selected results and a win-win situation case studies of cited complex project are presented in the paper.

EXPERIENCES WITH ABANDONMENT OF ENVIRONMENTAL BURDEN RELATED TO CRUDE OIL PRODUCTION

Michal Ševera[1] – Monika Matejová[2]

[1] NAFTA a.s., Director of service division, Bratislava, Slovak Republic
[2] NAFTA a.s., Technician of HSE department, Bratislava, Slovak Republic

KEYWORDS
Oil, Gas, Underground storage, Disposing, Decontamination, Recultivation, Gathering centers, Wells

ABSTRACT

NAFTA a.s. is an underground gas storage operator and oil & gas producer with more than 100 years of experience in exploration and production of hydrocarbons in Slovakia. It was the first place where the crude oil was explored in Austro-Hungarian Empire. Together with production of crude oil and gas we have also developed our knowledge about abandonment of depleted wells, unused centers and mud pits. We managed abandonment of approximately 100 wells, several centers and mud pits in years 2004 to 2006. This was our biggest job to return natural character to these places, and it was also our most expensive environmental project. After a decade, we look back and we can prove that it was a successful step and all that places are fully integrated with surrounding nature.

ENVIRONMENTAL BURDEN – EXPERIENCES AND METHODS

The crude oil production started in Austrian-Hungarian monarchy in 1914 in Gbely. The crude oil was found in shallow horizons from couple of tenth meters to 300 meters. Nobody cares about environmental impact, the main goal was to follow the industrial revolution. Waste was stored just near to well in mud pit – it was simple pit without any isolation and collecting of crude oil was made by trench.
In 2004 the owners of NAFTA a.s. decided to dispose the environmental burdens. Firstly had to be identification of wells, centers mud pits owned by NAFTA. The goal was to define financial provision for each center and well in case that it will be not use anymore. For each well was define project of subsurface liquidation, potential contamination model and estimation of costs, technical and biological recultivation. For each center was define project of wrecking of the buildings and technology equipment and similar as a well - potential contamination model and estimation of costs, technical, biological recultivation.
Forasmuch as we had small experiences from previous abandonments. There were several experiments with in-situ decontamination that takes a long time and needs permanent care so we decided to use ex-situ decontamination. As a method of decontamination we decided for biodegradation. So we started active communication with potential suppliers to make bigger market competition. There was expected to deliver more than 50 thousand tons of contaminated soil. We identified approx. 150 crude oil wells and 10 centers where we expected contamination of soil. We made several sample pollution monitoring. Monitoring was not detailed but only for rough estimation with expected accuracy about 30%, because we had no time and money to make monitoring of all the places. So we was looking for correlation between production data and polluted area around the well and we decided to use three parameters for calculating of costs estimation - drilling year, amount of produced crude oil and area index which represent the ground water level.
For decontamination works was there the supervisor who done supervision for works, sampling and evaluation of result from laboratory, final report form each site. Before technical recultivation we invited the regional environmental officer. When we were sure that the area is without pollution after that follows technical and biological recultivation, means heap up of new layer soil, alignment and planting of naturally occuring vegetation.

STATION – OS GBELY

Gathering station – OS Gbely was clean up and removed from old environmental burdens between 2006 and 2007. The pollution of this area was cause by the operation of crude oil that was transported to a dewatering station from the nearest oil wells and another collection centers. Decontamination of this center consisted of selective extraction of soil contaminated by oil substances after these were installed monitoring wells and area of land was return to the original state.

Fig. 1 a-c OS Gbely

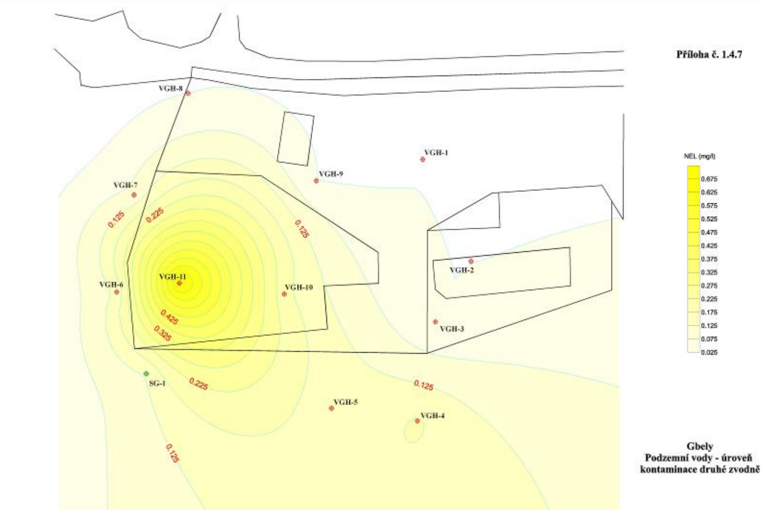


Fig. 2 Pollution of groundwater – OS Gbely

Fig. 3 Recultivation area of OS Gbely after 10 years

STATION – STUDIENKA 9

Gathering station – Studienka 9 was central station for collection and storage of crude oil from nearest wells. Equipment of station were 2 x 100m3, 4 x 50m3, 1 x 42 m3 oil tanks, one sedimentation tank and tank for mining water. Clean up, removed from old environmental burdens and technical recultivation was between 2006 and 2007, biological recultivation started 2007 and finished at 2011.

Fig. 4 a-c Station – Studienka 9

Fig. 5 Recultivation area of Studienka 9 after 11 years

STATION – ZÁVOD 5

Gathering station – Závod 5 was central station for collection and storage of crude oil from nearest wells and other stations. Clean up and removed from old environmental burdens started in 2006.

Fig. 6 a-c Station – Závod 5

Fig. 7 Recultivation area of Závod 5 after 10 years

THE OIL WELL AT GBELY - G 114

Fig. 8 a-b Oil well Gbely G 114 – past and today

EVALUATION

Disposing of the abandonment environmental burden was cheaper than our cost estimation. We had very good defined process, tendering which we degreased prices for more than 60% of soil biodegradation.
Between years 2004 – 2006 were disposed more than 100 oil wells, up to date was disposed more than 450 wells. Biological recultivation returned all locations to their original state.

LITERATURE

Kyclt R., Slánský T., ENVISAN-GEM, a.s., 2006: Provedené sanační práce a momentální stav areálu Odvodňovací stanice-Gbely. ENVISAN-GEM, a.s.
Kyclt R., Slánský T., ENVISAN-GEM, a.s., 2006: Sanace strediska Studienka 9. ENVISAN-GEM, a.s.
Kyclt R., Slánský T., ENVISAN-GEM, a.s., 2006: Sanace okolí sondy Závod 5. ENVISAN-GEM, a.s.
Cahlíková Z., 2007: Pruskum znečitení nesaturované zóny a podzemných vod v prostoru bývalé odvodňovací stanice a její okolí, ALTEC International s.r.o.

Ing. Michal Ševera
Director
NAFTA a.s.
Plavecký Štvrtok č. 900, 900 68 Plavecký Štvrtok,
Slovak Republic
michal.severa@nafta.sk

Ing. Monika Matejová
Technic
NAFTA a.s.
Plavecký Štvrtok č. 900, 900 68 Plavecký Štvrtok
monika.matejova@nafta.sk

INDUSTRIAL AND ORNAMENTAL LIMESTONES QUARRYING INSIDE A NATURA 2000 AREA

Célia Marques, Miguel Goulão, Luís Martins

Assimagra, Portugal

KEYWORDS
Ornamental and Industrial Limestones, Mining and Environmental Sustainability, Land Use Planning

ABSTRACT

In the field of spatial planning and sustainable management of the territory, ASSIMAGRA, a Portuguese mining association, in partnership with the Institute for Nature Conservation and Forestry, Public Institute (ICNF, IP) developed the project "Environmental sustainability of the Extractive Industry on the Limestone Massif of Estremadura, Portugal", with the objective of promoting efficient management of mineral resources (ornamental and industrial stones) in a region of Portugal with a strong economic and social component known as Estremadura Limestone Massif (MCE) and covered in large part by the Natural Park of Serra d'Aire and Candeeiros (PNSAC) and NATURA 2000 Network.

Indeed, the extractive industry sector in Portugal, in particular of ornamental rocks, is currently very supported in the production of ornamental limestone from this region of the country. At present, are in operation in this region about 300 of quarries, most dedicated to the production of ornamental limestones. It supports 1500 direct jobs, producing wealth of more than 100 million euros. However, in recent years, the extractive activity in this region has gone through great difficulties, due to the exhaustion of the licensed areas, coupled with the absence of alternative areas contained in the territory management tool with a typology of use compatible with this type of activity. This situation can provoke short-term bottlenecks of this activity, with heavy economic implications, since it will affect the entire value chain.

On the other hand, the MCE closes a vast natural heritage related to their geological peculiarities, including the fact that constitute the most important repository of limestone formations existing in Portugal, where the landscape, shaped by the karstic morphology, reveals a vigorous dash, which associates a paleontological legacy sometimes monumental and a subterranean morphology characterized by the presence of caves of dimension and unique beauty and one of the most important national aquifers.

Critical factors of environmental, social and economic (especially geo-economic ones) nature which could condition the proposals for land use planning at the level of the PNSAC, were mapped, as well as determine and evaluate the areas of best suitability for exploitation of mineral resources.
Thus, the project made it possible to develop land use plans conciliating the rational management of the extraction of mineral resources, the expansion of the quarries, the recovery of degraded areas and the conservation of the existing natural heritage taking into account the landscape and environmental sensitivity of the surrounding areas, with the objective to promoting the socio-economic development and the well-being of the populations in a sustained manner.

The purposes of the management of the territory in this region allowed the industry to organize a robust partnership, uniting the extractive sector, represented by the ASSIMAGRA (as a leader) and the ICNF, IP, which has as its main responsibility the management of their natural resources. The project featured a concerted action between the various stakeholders involved, directly or indirectly, in the Sector, which was one of the keys to success.

The project won the 1st Prize for Support to Ecological Markets and Resource Efficiency on the European Enterprise Promotion Awards 2015.

POSTER PRESENTATIONS

Nr.	PRESENTER	PRESENTATION TITLE
1	ELENA BRADIAKOVÁ	PROJECTS OF THE SLOVAK ENVIRONMENT AGENCY RELATED TO CONTAMINATED SITES
2	PETER JOHANSSON	THE EVALUATION AND MANAGEMENT PROJECT OF THE CUMULATIVE ENVIRONMENTAL EFFECTS OF THE MINING CLUSTER IN NORTH FINLAND
3	MIKKO JOKINEN	NATURE-BASED TOURISM MEETS MINING INDUSTRY – WIN-WIN SITUATION OR UNHAPPY ARRANGED MARRIAGE?
4	LAURA S. LAURI	SUSTAINABLE MINING AND REGIONAL GROWTH IN FINNISH LAPLAND
5	ALENA LUPTÁKOVÁ	BIOLOGICAL-CHEMICAL METHODS FOR METALS REMOVAL FROM ACID MINE DRAINAGE
6	ANDREJ MACHLICA	MODIFIED MAGNESITE AS SUITABLE MATERIAL FOR PASSIVE TECHNOLOGY OF PERMEABLE REACTIVE BARRIERS FOR REMEDIATION OF HEAVY METALS FROM GROUNDWATER
7	VESA NYKÄNEN	MINERAL PROSPECTIVITY MODELLER– GIS TOOLS FOR MINERAL EXPLORATION
8	TATSIANA PILIPTSEVICH	MINING FROM POLYMETALLIC DEPOSITS – CHALLENGES ON THE WAY TO SUSTAINABILITY
9	VESNA TUNGUZ	RECULTIVATION OF LANDFILLS, BOSNIA AND HERZEGOVINA
10	VESNA TUNGUZ	THE TOTAL CONTENT OF CADMIUM IN DUMPS

PROJECTS OF THE SLOVAK ENVIRONMENT AGENCY RELATED TO CONTAMINATED SITES

Elena Bradiaková, **Zuzana Ďurianč íková, Jaromír Helma, Katarína Paluchová**

Slovak Environment Agency, Directorate for Environmental Sciences and Project Management, Department of Analyses, Environmental Assessment and Environmental Service, Unit of Environmental Services
Tajovského 28, 975 90 Banská Bystrica, Slovak republic
e-mail: elena.bradiakova@sazp.sk

KEYWORDS
Environmental contamination, Operational Programme 'Environment', investigation, remediation and monitoring of contaminated sites, Environmental Contamination Information System (ECIS)

From 2006 to 2008, an inventory of contaminated sites was conducted throughout Slovakia, establishing the number of likely contaminated sites, confirmed contaminated sites and remediated, reclaimed sites. The 2009 amendment to Act No. 569/2007 Coll. on Geological Works (the Geological Act) as amended incorporated the issue of environmental contamination, at least partially, into Slovak law. In March 2010, the Slovak government adopted a strategic plan for addressing the issue – the National Programme for the Remediation of Environmental Contamination (2010 – 2015). The overarching legal framework is provided by Act No. 409/2011 Coll. on Certain Measures Related to Environmental Contamination and on the Amendment of Certain Acts. Coming into force on 1 January 2012, the Act allows the issue of environmental contamination to be addressed comprehensively, a process that is now in its final phase: projects involving the study, remediation and monitoring of contaminated sites are underway. Given that this is a very costly affair, especially when remediation work is concerned, the primary sources of finances are currently European Union funds.

OPERATIONAL PROGRAMME 'ENVIRONMENT' (2007 – 2013)

The Operational Programme 'Environment' (OPE) was the Slovak Republic's programme document for obtaining aid from European Union funds for the environmental sector from 2007 to 2013. The document was prepared by the Slovak Ministry of Environment in its capacity as OPE Governing Body, and it was approved by the European Commission on 8 November 2007. In terms of budget, it is the second-largest operational programme in Slovakia, with a total budget of over € 2.14 billion.

The overall goal of the OPE is to improve the state of the environment and use resources frugally by finalising and improving Slovakia's environmental infrastructure in accordance with EU and Slovak regulations and by making the environmental components of sustainable development more efficient. This goal is fulfilled via more specific goals, which correspond to the following priority axes and their operational objectives:

- Priority Axis 1: Integrated Protection and Rational Utilisation of Water Resources
- Priority Axis 2: Flood Protection
- Priority Axis 3: Air Protection and Minimisation of the Adverse Effects of Climate Change
- Priority Axis 4: Waste Management
- Priority Axis 5: Protection and Regeneration of the Natural Environment and Landscape
- Priority Axis 6: Technical Assistance
- Priority Axis 7: Creation of a Flood Warning and Forecasting System

Environmental contamination falls under Priority Axis 4: Waste Management, Operational Objective 4.4: Addressing the Issue of Environmental Contamination, Including its Removal. The specific objective of this priority axis is fulfilled by the implementation of three groups of activities, focused respectively on:

- monitoring and investigating contaminated sites and producing hazard analyses
- remediation of the most hazardous contaminated sites
- finalisation of the Environmental Contamination Information System

Within these groups, the following activities can be supported:
Group I: Monitoring and investigating contaminated sites and producing hazard analyses:
A. projects focused on the production of hazard analyses, remediation feasibility studies and inspections of contaminated sites
B. projects focused on the study of high-priority likely contaminated sites
C. projects focused on thorough and repeated investigation of the most hazardous contaminated sites, in line with the established priorities

D. regional studies of the environmental impacts of contaminated sites
E. projects focused on the development of monitoring systems for the most hazardous contaminated sites, in line with the established priorities
Group II: Remediation of the most hazardous sites of environmental contamination:
A. projects focused on the remediation of contaminated sites that present a major hazard to human health and the environment, in line with the established priorities
Group III: Finalisation of the Environmental Contamination Information System (ECIS):
A. implementation of the ECIS as a component of the government's information system
B. preparation of the Atlas of Remediation Methods as a component of the ECIS
C. projects focused on public relations, public awareness and promotion of activities related to the remediation
of contaminated sites

Between 2007 and 2013, the Slovak Ministry of Environment made four calls for applications for non-repayable grants (NRGs) as part of Priority Axis 4, Operational Objective 4.4: Addressing the issue of environmental contamination, including its removal. A total of 20 projects were supported, 5 of them were implemented by the Slovak Environment Agency (Tab. 1).

PROJECTS OF THE SLOVAK ENVIRONMENT AGENCY RELATED TO CONTAMINATED SITES SUPPORTED BY THE OPERATIONAL PROGRAMME 'ENVIRONMENT' (2007 – 2013)

Tab. 1 Supported and accomplished projects related to contaminated sites implemented by the SEA (Operational Programme 'Environment' 2007 – 2013)

Project no.	Project title	Project duration	Total eligible expenditure – drawn (€)
1.	**Regionálne štúdie hodnotenia dopadov environmentálnych záťaží na životné prostredie pre vybrané kraje (regióny)** Studies Assessing the Environmental Impact of Contaminated Sites in Selected Regions	10/2008 – 7/2010	319,485.75
2.	**Dobudovanie informačného systému environmentálnych záťaží** Finalisation of the Environmental Contamination Information System	09/2009 – 09/2014	922,733.88
3.	**Osveta, práca s verejnosťou ako podpora pri riešení environmentálnych záťaží v SR** Awareness: Working with the Public to Facilitate the Handling of Environmental Contamination in Slovakia	05/2012 – 08/2015	419,716.04
4.	**Integrácia verejnosti do riešenia environmentálnych záťaží** Involving the Public in Addressing Environmental Contamination	09/2014 – 08/2015	239,694.71
5.	**Štátny program sanácie environmentálnych záťaží 2016 – 2021** The National Programme for the Remediation of Environmental Contamination 2016 – 2021	04/2015 – 12/2015	72,953.00

BASIC INFORMATION ABOUT PROJECTS

1. **Project title** **REGIONÁLNE ŠTÚDIE HODNOTENIA DOPADOV ENVIRONMENTÁLNYCH ZÁŤAŽÍ NA ŽIVOTNÉ PROSTREDIE PRE VYBRANÉ KRAJE (REGIÓNY)**
STUDIES ASSESSING THE ENVIRONMENTAL IMPACT OF CONTAMINATED SITES IN SELECTED REGIONS

Acronym STUDIEEZ

Main objective of the project	• assess the environmental impacts of contaminated sites in Slovakia's individual regions
Specific objectives	• develop a unified rubric of methods for regional studies of the impacts of contaminated sites in Slovakia • use this rubric to prepare evaluation reports/regional studies for Slovakia's individual administrative regions
Finantial tool	The Cohesion Fund of the European Union within the Operational Programme 'Environment' 2007 – 2013
Project duration	10/2008 – 7/2010
Total eligible expenditure	319,485.75 €
Project code (ITMS)	24140110016
Project manager	Jaromír Helma
E-mail	jaromir.helma@sazp.sk
Web	http://www.sazp.sk/public/index/go.php?id=1745

Fig. 1 Environmental Contamination in Predajná, Slovakia.

Information and public awareness activities of the project STUDIEEZ (2010) – publications.
Number of accomplished information and public awareness activities of the project – 2.

2. **Project title**	**DOBUDOVANIE INFORMAČNÉHO SYSTÉMU ENVIRONMENTÁLNYCH ZÁŤAŽÍ** FINALISATION OF THE ENVIRONMENTAL CONTAMINATION INFORMATION SYSTEM
Acronym	DOBUDISEZ
Main objective of the project	• finalise the Environmental Contamination Information System • carry out an informational/educational campaign in the form of regular informational and instructional trainings

Finantial tool	The Cohesion Fund of the European Union within the Operational Programme ‘Environment’ 2007 – 2013
Project duration	09/2009 – 09/2014
Total eligible expenditure	922,733.88 €
Project code (ITMS)	24140110017
Project manager	Katarína Paluchová
E-mail	katarina.paluchova@sazp.sk
Web	http://www.sazp.sk/public/index/go.php?id=1746

Fig. 2 The Environmental Contamination Information System – Identification of monitored object via Google Street View service. (Monitored object databases MV – 2A Integrated monitoring of pollution point sources in the vicinity of environmental contamination MI (1989)/Vojany - EVO Vojany – stockpile of inflammables).

Information and public awareness activities of the project DOBUDISEZ (2009 – 2013) – the informational/educational campaign towards state government staff, staff of local governments (regional and municipal), experts.
Number of accomplished information and public awareness activities of the project – 33.

3. **Project title**	**OSVETA, PRÁCA S VEREJNOSŤOU AKO PODPORA PRI RIEŠENÍ ENVIRONMENTÁLNYCH ZÁŤAŽÍ V SR** AWARENESS: WORKING WITH THE PUBLIC TO FACILITATE THE HANDLING OF ENVIRONMENTAL CONTAMINATION IN SLOVAKIA
Acronym	OSVETA
Main objective of the project	• raise the general public’s awareness concerning the issue of addressing environmental contamination, including its remediation
Specific objective	• help the public to be better informed about the issue of environmental contamination
Finantial tool	The Cohesion Fund of the European Union within the Operational Programme ‘Environment’ 2007 – 2013
Project duration	06/2012 – 08/2015
Total eligible expenditure	419,716.04 €

Project code (ITMS) 24140110232
Project manager Elena Bradiaková
E-mail elena.bradiakova@sazp.sk
Web http://www.sazp.sk/public/index/go.php?id=2222

Fig. 3 The informational and educational meeting with delegates of state government staff, staff of local governments (regional and municipal) and experts engaged in the issue of addressing environmental contamination in Bratislava, Slovakia (13 May 2014, project OSVETA)

Information and public awareness activities of the project OSVETA (2013 – 2015) – 6 publications, 7 films, 2 conferences, 7 courses and meetings, 10 methodical trainings for teachers, 2 school games, 3 school publications, 3 field trips).
Number of accomplished information and public awareness activities of the project – 40.

4. **Project title** **INTEGRÁCIA VEREJNOSTI DO RIEŠENIA ENVIRONMENTÁLNYCH ZÁŤAŽÍ**
INVOLVING THE PUBLIC IN ADDRESSING ENVIRONMENTAL CONTAMINATION

Acronym	INTEGRÁCIA
Main objective of the project	• promote and involve the wider public in activities relating to environmental contamination, including its remediation
Specific objective	• promote and inform the public about the issue of environmental contamination
Finantial tool	The Cohesion Fund of the European Union within the Operational Programme 'Environment' 2007 – 2013
Project duration	09/2014 – 08/2015
Total eligible expenditure	239,694.71 €
Project code (ITMS)	24140110300
Project manager	Ing. Zuzana Ďuriančíková
E-mail	zuzana.duriancikova@sazp.sk

Web	http://www.sazp.sk/public/index/go.php?id=2466

Fig. 4 Field trip during the training course for university-level instructors and doctoral candidates to the contaminated site Quarry Srdce in Devínska Nová Ves, Bratislava, Slovakia (January 2015, project INTEGRÁCIA)

Information and public awareness activities of the project INTEGRÁCIA (2015) – 2 publications, 1 international conference, 5 courses, 10 methodical trainings for teachers.
Number of accomplished information and public awareness activities of the project – 18.

5. **Project title 2016 – 2021**	**ŠTÁTNY PROGRAM SANÁCIE ENVIRONMENTÁLNYCH ZÁŤAŽÍ**
	THE NATIONAL PROGRAMME FOR THE REMEDIATION OF ENVIRONMENTAL CONTAMINATION 2016 – 2021
Acronym	SANÁCIE
Main objective of the project	• work out the National Programme for the Remediation of Environmental Contamination in Slovakia for the period 2016 – 2021
Finantial tool	The Cohesion Fund of the European Union within the Operational Programme ‘Environment’ 2007–2013
Project duration	04/2015 – 12/2015
Total eligible expenditure	72,953.00 €
Project code (ITMS)	24140110302
Project manager	Katarína Paluchová
E-mail	katarina.paluchova@sazp.sk
Web	http://www.sazp.sk/public/index/go.php?id=2467

Fig. 5 The integral part of the National Programme for the Remediation of Environmental Contamination 2016 – 2021 are the awareness and informational activities for various groups of the general public

Information and public awareness activities of the project SANÁCIE (2015) – 4 press releases, 1 informational meeting with general public.
Number of accomplished information and public awareness activities of the project – 5.

BIBLIOGRAPHY

Frankovská, J., Kordík, J., Slaninka, I., Jurkovič, Ľ., Greif, V., Šottník, P., Dananaj, I., Mikita, S., Dercová, K., Jánová, V., 2010: Atlas sanačných metód environmentálnych záťaží [Atlas of Remediation Methods for Contaminated Sites]. Dionýz Štúr State Geological Institute, Bratislava. ISBN 978-80- 89343-39-3.
Problematika environmentálnych záťaží na Slovensku [The Issue of Environmental Contamination in Slovakia]. Slovak Environmental Agency, Banská Bystrica, 2010. ISBN 978-80-88850-98-4.
www.minzp.sk
www.opzp.sk
www.enviroportal.sk
www.sazp.sk

THE EVALUATION AND MANAGEMENT PROJECT OF THE CUMULATIVE ENVIRONMENTAL EFFECTS OF THE MINING CLUSTER IN NORTH FINLAND

Peter Johansson – Vesa Nykänen – Hannu Panttila – Raija Pietilä – Jouni Pihlaja

Geological Survey of Finland, Rovaniemi, Finland

KEYWORDS
Mineral exploration, natural environment, geochemical studies, geological data, monitoring methods, sustainable development, North Finland.

ABSTRACT

The purpose of the Evaluation and Management Project of the Cumulative Environmental Effects of the Mining Cluster in Northern Finland is to evaluate the overall impact of Northern Finland's mining projects from the perspective of sustainable development and regional well-being, and to increase knowledge of the basic condition of the environment in the northern region. The goal is to develop monitoring methods in a more comprehensive and cost-efficient direction and to create results that serve companies and municipalities in their decision-making, while promoting the responsibility of the mining industry and obtaining of social license. This work requires different kinds of competences that the organisations participating in the project, the Geological Survey of Finland (GTK) and the Finnish Environment Institute (SYKE), provide. The competences of these organisations complement and support each other. This cooperation strengthens the expertise of research institutions, promotes the development of new, innovative monitoring methods and improves possibilities for international networking.

The project aims to evaluate the good and weak points of the current data collection and monitoring, and to pay attention to development targets. The project aims to provide new monitoring methods that can be utilised, decrease the administrative load on the public sector and operators, and support decision-making. The project has been granted regional ERDF funding.

The work in the project is divided into four work packages:
1) Project management (GTK)
2) Mineral exploration and mining activities (GTK)
3) Natural environment (soil and groundwater) (GTK)
4) Natural environment (rivers and streams) (SYKE)

In addition to the closed and existing mining projects in the region, the "Mineral exploration and mining activities" and "Natural environment" work packages will pay attention to the development prospects of the region by utilising the analysis of mineral potential. The work packages will also estimate the basic condition of the region, the most efficient methods for monitoring the state of the environment and the future potential for mining industry in the light of geological data.

The "Natural environment" work packages will develop methods for evaluating environmental impact while taking into account the needs of different parties (the party planning the project, contact authorities and the impacted parties) in order to create a common view of the current state of soil and waterways and possible changes to them. The work package will examine the geochemical properties of Lapland's soil and groundwater by using existing geochemical material as data and create a comprehensive picture of the region's special characteristics and possible geochemical zones as well as uranium deposits and distribution. Geophysical methods are used to produce location-specific digital maps based on natural radiation, and measurement methods will be developed to meet the requirements of environmental research.

Data on water quality and water biology will be used to examine the background concentration and the compositions of aquatic organism populations in the area of impact of mines that are still operating as well as those that have been closed. They will be compared with the rivers and streams in the mines' control areas while taking into account the geological properties of the region. This allows us to more accurately evaluate the natural ecological state of the region and the environmental impact of mining operations. The goal is to get a comprehensive picture of how harmful substances accumulate in the food chain. We will also compare the functionality, usability and cost efficiency of various passive samplers in evaluating the loads caused by heavy metals and mercury in order to monitor the waterways below mines. The work package will also develop the use

of drones to support the environmental measurement of aquatic flora with the purpose of creating a cost-effective indicator for evaluating the natural cleaning of waterways.

The goal is also to expand the Evaluation and Management Project of the Cumulative Environmental Effects of the Mining Cluster in Northern Finland project to the international level. We encourage international partners interested in the project to join us in developing broader cooperation.

LITERATURE

Johansson, P., Pietilä, R., 2016: The evaluation and management project of the cumulative environmental effects of the mining cluster in Lapland. In: P. Sarala & P. Eilu (eds.) 12th Finnish Geochemistry Days 2016. 21. – 22.4.2016. Åbo Akademi, Turku, Finland. Abstracts. Vuorimiesyhdistys, B98, 9.

Senior Specialist Peter Johansson, PhD.
Geological Survey of Finland
P.O. Box 77, 96101 Rovaniemi
Finland
peter.johansson@gtk.fi

Research Professor Vesa Nykänen, PhD.
Geological Survey of Finland
P.O. Box 77, 96101 Rovaniemi
Finland
vesa.nykanen@gtk.fi

Geologist Hannu Panttila
Geological Survey of Finland
P.O. Box 77, 96101 Rovaniemi
Finland
hannu.panttila@gtk.fi

Geologist Raija Pietilä
Geological Survey of Finland
P.O. Box 77, 96101 Rovaniemi
Finland
raija.pietila@gtk.fi

Head of Unit Jouni Pihlaja
Geological Survey of Finland
P.O. Box 77, 96101 Rovaniemi
Finland
jouni.pihlaja@gtk.fi

NATURE-BASED TOURISM MEETS MINING INDUSTRY – WIN-WIN SITUATION OR UNHAPPY ARRANGED MARRIAGE?

Mikko Jokinen

Natural Resource Institute Finland LUKE – mikko.jokinen@luke.fi

ABSTRACT

Large natural resource projects were key strategy for Finland after Second World War. Since 1980s the scene has changed. Several mines were closed and nature-based tourism grew as one of the major sources of income in Lapland providing jobs and keeping remote areas inhabited. But recent years mining industry has started a comeback. According studies, tourism of Lapland is built on mental images of beautiful landscapes, intact nature and tranquility meanwhile mining industry can have vast changes in physical environment and thus threat prerequisites of tourism business. The crucial question is: can tourism and mining co-exist in space and time?
In northern Finland opening or re-opening of a mine has met either strong resistance or support from local tourism sector and local communities. Our empirical studies with four case areas (Figure) conducted between 2012 and 2014 show that natural conditions (landscape, purity, tranquility) are most important reasons for tourists to visit Northern Finland. Tourism is business that sells images of the place and image of nature-based tourism destination can be highly vulnerable due to mining.

It is essential that every case is unique and should be reviewed individually. Analogies between different cases are easily invalid because mines and their environments are often different. Key factors are size and location of mine, volume, nature of processes and ore, infrastructure and transportation, existence of toxic and radioactive matters. In our case studies two mining projects (Hannukainen & Kuusamo) are located close to tourist destination and especially tourism entrepreneurs see reconciliation and co-existence difficult or even impossible. Customers are less critical but great deal of tourists (44-69%) estimate that their willingness to revisit the destination declines if mining takes place. However, couple of mining projects (Kittilä & Mustavaara) studied show that co-existence and perhaps even win-win situation can be possible. Long distance (over 25 kilometers) from tourist destination, underground mine and relatively small scale mining are conditions that help the reconciliation of mining and tourism industry.

Sustainable coexistence of mining and tourism can take place if certain conditions are taken care of. These conditions concern 1) products, processes and locations of these industries, 2) impact assessment and scenario building, 3) reconciliation process and finally 4) allocation of costs and benefits. Our results highlight the key elements, both natural and social, for probable disputes or happy end of mining and nature-based tourism.

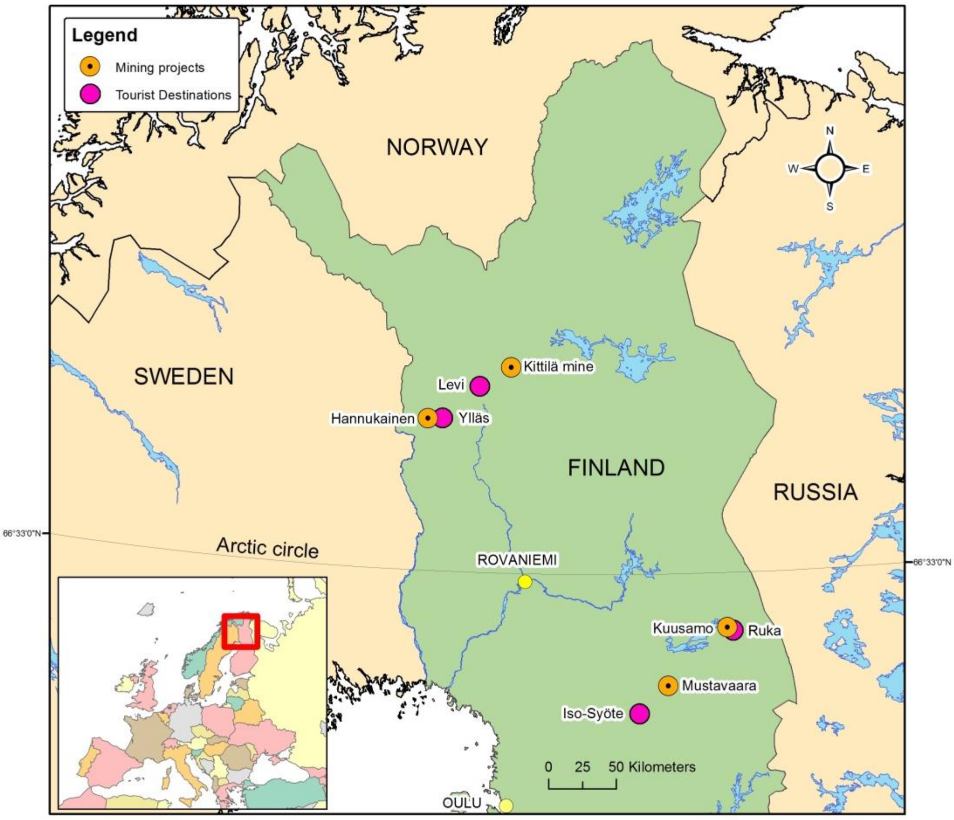


Fig. 1 Four mining cases and tourist destination of the study.

Fig. 2 Distance between Levi tourist destination and Kittilä gold mine is 27 km. Mine is underground, operates locally, does not have continuous heavy transportation from the site. Thus mine is almost invisible, odorless and silent to tourism.

LAPLAND: ABOVE ORDINARY
A MODEL MINING REGION

Laura S. Lauri[1], Pamela Lesser[2], Rauno Toppila[3] and Kristiina Jokelainen[4]

[1] Geological Survey of Finland, Rovaniemi, Finland
[2] Arctic Centre, University of Lapland, Rovaniemi, Finland
[3] Lapland University of Applied Sciences, Kemi, Finland
[4] Regional Council of Lapland, Rovaniemi, Finland

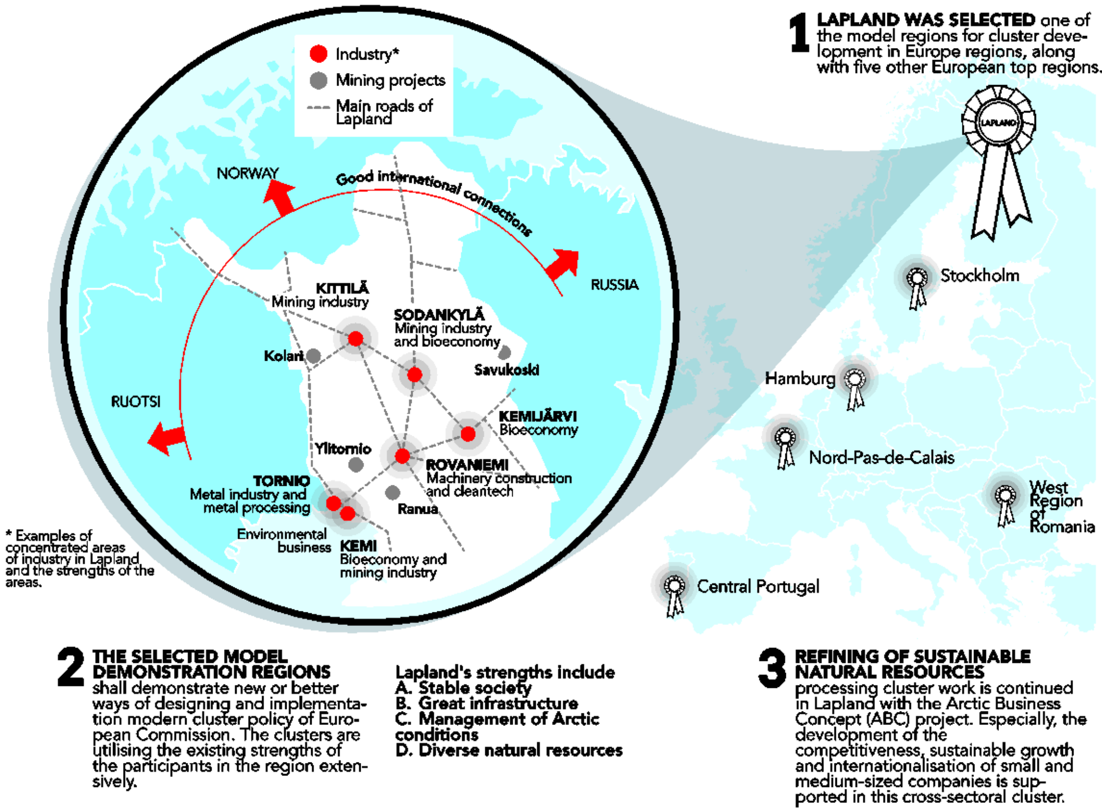
KEYWORDS
Lapland, sustainable mining, smart specialization, Arctic, regions, social license to operate

ABSTRACT

Lapland is the northernmost region of Finland and the EU. It is sparsely populated with roughly 200,000 people and mining is one of the mainstays of the local economy. With its highly educated population and world class research institutions, such as the Geological Survey of Finland (GTK), the University of Lapland, the Lapland University of Applied Sciences and the Natural Resources Institute Finland, Lapland is fast becoming a leader in innovative sustainable mining practices and technologies.

As the mining industry is a key contributor to the regional economy, it has been selected as one of the focal points of the Regional Council of Lapland's Smart Specialisation Strategy (RIS3). The region of Lapland was one of the first to adapt the concept of Smart Specialization, which seeks to help the region become a leader in exploiting and commercializing Arctic natural resources. In order to operationalize the smart specialization concept, a special "Arctic Smartness" regional development approach was created with the aim of making the best use of regional expertise and resources while simultaneously creating strategic networks across borders. In more concrete terms, the Arctic Smartness concept envisioned five distinct but integrated clusters focusing on the competitive advantages of Lapland. The real work in terms of further defining and realizing the clusters (Arctic Development Environments, Arctic Design, Arctic Industry and Circular Economy, Arctic Smart Rural Community and Arctic Safety) began under the Arctic Smartness Portfolio (ASP) project in 2015-2016. During the ASP project, mining activities were included within the Arctic Industry and Circular Economy cluster, whose ultimate goal was to make Lapland a model of sustainable natural resource utilization by balancing industrial expertise with the commitment to sustainably develop natural resources. As a result of the ASP project, a clear need emerged to develop a cluster focused solely on mining.

The Arctic Smart Mining Cluster (AMIC) integrates the RDI-sector and industrial partners working in the mining industry into a multi-regional cluster in Lapland and North Karelia, which represents another strong mining and extraction industrial region in Finland. The RDI partners and regional consulting services collect the regional mining industry know-how in Lapland and North Karelia into a larger network that enhances the mining sector and improves the partners' chances to participate in international consortia. The AMIC cluster will enable stronger networking of the mining industry in Lapland and North Karelia at the national and international levels and promote the social licensing of the mining sector by increasing and disseminating knowledge of the sector throughout society. As a part of the cluster work, the AMIC team is participating in the EIT Raw Materials KIC, where GTK is a partner organization.



Cooperation between mining regions is growing increasingly important for the survival of the industry. Many companies work across national borders. The growing importance of mining's social dimension also increases the need for cooperation, because in addition to legal requirements and economic uncertainty, companies now also need to obtain a 'social license to operate' from communities throughout Europe. As Lapland is well integrated into the global mining industry's international network of mining regions, and plays a significant role in the EU industrial policy, the Regional Council of Lapland is leading the implementation of the recently accepted 'MIREU' (Mining Regions of EU) Raw Materials Commitment. MIREU's consortium, comprised of 24 members from 11 countries, is committed to supporting EU level policy changes to ensure the sustainability of raw materials value chains and actively seeks synergies between regional development programs and smart specialization strategies.

MIREU has built a strong consortium for the mining and raw materials regions in order to fulfill European targets and support EU level policy change toward more sustainable raw materials value chains in terms of social acceptance, environmental soundness and economic viability. One of the objectives is to illustrate the right raw materials framework conditions based on good practices, including administration, land use planning, investment conditions and attracting a skilled workforce. The Commitment conforms to the European Union's Raw Materials Policy and its aim of making the EU more independent in the mining of critical raw materials.

Mining is a global industry and the region of Lapland is a significant global player because Finland is a leader in developing and implementing sustainable mining practices and best available technologies. However, there are also problems yet to be solved in order to make mining a consistently sustainable activity and solving these problems requires a multi-disciplinary approach and a broad array of skill sets. As a result, those involved in Lapland's mining sector are working on solutions to such diverse problems as how to obtain a social license to operate, clarify the framework conditions for sustainable mining, the nexus between responsible mining and land use policies, and to ensure protection of the environment both during and after operations have ceased. All of these activities are in accordance with the overall industrial strategy of Lapland, which is that natural resources must be refined with respect for nature and people and in cooperation with other trades.

BIOLOGICAL-CHEMICAL METHODS FOR METALS REMOVAL FROM ACID MINE DRAINAGE

Alena Luptáková[1] – Eva Mačingová[1] – Jana Jenčárová[1]– Dominika Rudzanová[1]

[1] Department of Mineral Biotechnology, Institute of Geotechnics, Slovak Academy of Sciences, Košice, Slovak Republic

KEYWORDS
Acid mine drainage, heavy metals, sulphate-reducing bacteria, selective sequential precipitation

ABSTRACT

The formation of Acid Mine Drainage (AMD) represents the most severe environmental problem created by mining industry (Johnson a Hallberg, 2005). The high acidity and the presence of toxic metals in AMD waters degrade soil and water quality, and detrimentally impact vegetation and aquatic life. Consequently, mine waste waters, prior to being released into the environment, must be treated to meet government standards for the amount of metal and non-metal ions contained in the water (Akcil and Koldas, 2006). The stratiform deposit Smolník belongs to the historical best-known and richest Cu – Fe ore deposits in Slovakia. In 1990 the mining activity at the locality was stopped. The mine-system represents partly opened geochemical system into which rain and surface water drain. The continuation of AMD generation at the locality of Smolník is no chance for situation self-improvement. It is necessary to develop methods for their treatment (Bálintová and Luptáková, 2011). Therefore the main aim of the present work was to demonstrate the technical feasibility of biological-chemical methods for remediation of aforementioned AMD (Fig. 1).

Fig. 1 The effluent of AMD from the shaft Pech (old mine Smolnik in Slovakia)

The chemical composition of the mine water is shown in Table 1 in comparison with the limits allowed by Regulation No. 296/2005 Coll. of the Government of the Slovak Republic. The principle of the biological-chemical method was the application of sulphate-reducing bacteria (Fig. 2). It was isolated using the nutrient Postgate's medium C from potable mineral water (Gajdovka spring, Kosice-north, Slovakia). Investigated was the process of the heavy metals precipitation by bacterially produced hydrogen sulphide with the combination of the metals precipitation by sodium hydroxide at the various values of pH AMD that is the process of the selective sequential precipitation (SSP).

Tab. 1 Examined parameters of AMD sample collected from the shaft Pech

Parameter	pH	Concentration (mg/L)					
		SO_4^{2-}	Fe	Al	Mn	Zn	Cu
Value	3.8	2938	405.25	108.38	35.50	12.00	8.38
Value*	6-8.5	250	2	0.2	0.3	0.1	0.02

** Limit values of Government Regulation No. 296/2005 Coll.*

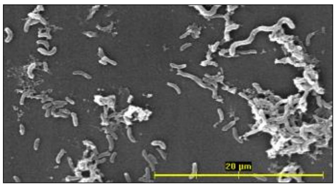


Fig. 2 Sulphate-reducing bacteria isolated from potable mineral water - Gajdovka spring

Tests have been carried out after chemical ferrous precipitation by H_2O_2 that permitted a complete Fe removal. Table 2 summarizes the operating steps, conditions, and the results of optimized SSP. Bioprecipitation processes has been demonstrated the technical feasibility to decrease the heavy metals concentration. Achieved results of the bioprecipitation processes demonstrate the selective 98-99% precipitation of Cu, Zn, Al and Mn (Table 3). These results can be used for suggestion of technology for selective metal recovery from acid mine drainage from Smolník.

Tab. 2 Results of the optimized heavy metals selective sequential precipitation

Step	**1**	**2**	**3**	**4**	**5**	**6**
pH	2.8	3.7	3.7	5.0	5.0	9.5
Added reagent	H_2O_2	NaOH	H_2S	NaOH	H_2S	NaOH
Removed metals	Fe	Fe	Cu	Al	Zn	Mn
Form of removed metals	$Fe(OH)_3$	$Fe(OH)_3$	CuS	$Al(OH)_3$	ZnS	$Mn(OH)_2$

Tab. 3 The metal removal efficiency from real AMD

Metal	**Fe**	**Cu**	**Al**	**Zn**	**Mn**
Input concentration (mg/L)	405.25	8.38	108.38	12.00	35.50
Output concentration (mg/L)	< 0.05	< 0.02	< 0.04	< 0.01	< 0.03
Metal removing (%)	99.99	99.76	99.96	99.92	99.92

LITERATURE

Johnson, D. B., Hallberg, K.B., 2005: Acid mine drainage remediation options: a review. In: Science of the Total Environment, 338, p. 3-14.

Akcil, A., Koldas, S., 2006: Acid mine drainage (AMD): causes, treatment and case studies. In: Journal of Cleaner Production, 14, p.1139-1145.

Bálintová, M., Luptáková, A., 2012: Úprava kyslých banských vôd. TU v Košiciach, Stavebná fakulta, 131 s. ISBN 978-80-553-0868-5.

Ing. Alena Luptáková, PhD.
Slovak Academy of Sciences
Institute of Geotechnics
Department of Mineral Biotechnology
Watsonova 45, 040 01 Košice
Slovak Republic
luptakal@saske.sk

Ing. Jana Jenčárová, PhD.
Slovak Academy of Sciences
Institute of Geotechnics
Department of Mineral Biotechnology
Watsonova 45, 040 01 Košice
Slovak Republic
jencarova@saske.sk

RNDr. Eva Mačingová, PhD
Slovak Academy of Sciences
Institute of Geotechnics
Department of Mineral Biotechnology
Watsonova 45, 040 01 Košice
Slovak Republic
macingova@saske.sk

Ing. Dominika Rudzanová
Slovak Academy of Sciences
Institute of Geotechnics
Department of Mineral Biotechnology
Watsonova 45, 040 01 Košice
Slovak Republic
rudzanova@saske.sk

MODIFIED MAGNESITE AS SUITABLE MATERIAL FOR PASSIVE TECHNOLOGY OF PERMEABLE REACTIVE BARRIERS FOR REMEDIATION OF HEAVY METALS FROM GROUNDWATER

Andrej Machlica[1] – Pavel Raschman[2] – Gabriel Sučik[2] – Tomáš Binčík[3]

[1] DEKONTA Slovensko, spol s r.o., Odeská 49, 821 06 Bratislava, Slovak Republic
[2] Institute of Metallurgy, Faculty of Metallurgy, Technical University of Kosice, Letna 9, 042 00 Košice, Slovak Republic
[3] Department of Economic Geology, Faculty of Natural Sciences, Comenius University, Mlynská dolina, Ilkovičova 6, 842 15 Bratislava, Slovak Republic

KEYWORDS
caustic calcined magnesia (CCM), magnesite, reactive barrier, heavy metals

ABSTRACT

Modified magnesite, named caustic calcined magnesia, was used in the project titled "Authentication using the technology of permeable reactive barrier (PRB) for the remediation of acidic groundwater contaminated with heavy metals". The project consists of two parts – a laboratory part and pilot tests in the field.
The laboratory tests were performed in the laboratory of the Institute of Metallurgy, Faculty of Metallurgy, Technical University of Kosice, which is the principal investigator of the project. The laboratory tests aimed to find the most appropriate reaction carrier material and the material that would be capable of removing heavy metals from the contaminated groundwater. After several attempts, the most suitable used material was modified magnesite named caustic calcined magnesia (CCM) with a carrier, which are wood shavings measuring approximately 1.5 x 3 cm. The mixture was then tested to determine the best ratio to remove most of the pollution from the used groundwater.


Fig.1 crystalline magnesite


Fig.2 Caustic calcined magnesia


Fig.3 Laboratory equipment

The most important compound of magnesium, which is used in various branches of industry, is MgO. The MgO occurs naturally as the mineral periclase, which is characterized with colorless crystals with a cubic lattice. Periclase is exceptionally stable mineral, while natural periclase occurs in the lower layers of the earth's crust. It is successfully used in various industrial fields. Magnesite $MgCO_3$ and sea water are the most often used as a raw materials for the production of magnesium oxide.
Caustic calcined magnesia is produced by burning the natural magnesite $MgCO_3$ at a temperature above the temperature of the thermal decomposition of $MgCO_3$, but at the same time below the sintering temperature.
When firing the natural magnesite, the maximum hydraulic activity of a caustic magnesite is achieved in a temperature range 650-900°C, at higher temperatures, the activity decreases and above the temperature 1400°C a dead-burned magnesite is created. In a process of decarburization of $Mg(CO_3)$ at the temperatures up to 1000°C, a magnesium oxide is formed (Fig 2), which differs from the periclase in a lattice failure rate, parameter of the crystal lattice, lower refractive index, anomalous anisotropy, lower microstrenght and porous texture crystals.

Slovak crystalline magnesite (Fig 1) deposits are among the largest and most important in the world. The CCM is used in the refractory industry, and is also used in the construction, agriculture and in the chemical industry and cellulose industry.

Course of the clotting reaction is greatly influenced by pH. Changes in pH values and their dependence on concentrations of Mg^{2+} and Ca^{2+} were observed during the experiment. The used caustic calcined magnesia

(CCM) had high proportion of CaO. Therefore during the first hours of the experiment, the calcium oxide CaO took part in the precipitation reactions, while increasing pH to 12. Only after the exhaustion of inserted CaO, the MgO entered the reaction, reduced the pH to values around 10, and remained constant afterwards. Several tests with different variations of flow and retention time were carried out subsequently (Kyslytsyna, 2016).

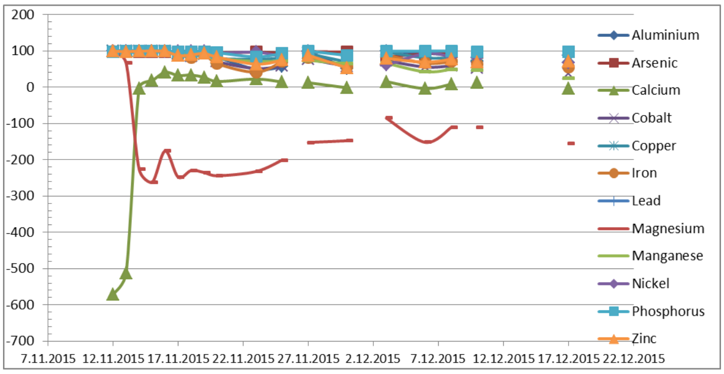


Fig.4 Technological equipment for a pilot line

Fig.5 Removal efficiency for individual contaminants during the test

The CCM was used in the technology simulating the conditions of PRB. During the 7 day duration of the pilot plant testing, a complete removal of the monitored contaminants was virtually achieved - the maximum efficiency values reached 98 to 100%. In the next stage of the experiment, there was a gradual decline in the efficiency for aluminum (100% at 14.11 to 88% at 17.12.), arsenic (from 98% to 97%), cobalt (from 100% to 37%), copper (from 98 % to 84%), iron (from 100% to 55%), manganese (from 100% to 25%), nickel (from 100% to 67%) and zinc (from 100% to 72%). Reported results created a basis for inputs for a pilot plant test. The results achieved during the pilot plant test will be helpful for optimization of the flow of water in the technology.
Investigated combination of reaction material and the carrier appears to be an optimal solution also for the practical application, although with a necessity to set all the technology according to the specific circumstances at a given location. The technology can achieve the status of an universal application of technology used in the PRB and on the other sites, where dominant forms of pollution, such as heavy metals and pH of the water, are characterized by the acidic conditions.

ACKNOWLEDGMENT

This work was supported by the Slovak Research and Development Agency under the contract No. APVV-0351-12. We would like to thank multiple subcontractors for their part on the project.

REFERENCES

Kyslytsyna, M., 2016: Reactive materials for PRB technology with adjustable hydraulic conductivity, Institute of Metallurgy, Faculty of Metallurgy, Technical University of Kosice, diploma work, 53 p.
Raschman, P., Súčik, G., Machlica, A., 2016: Final report of the project with No. APVV-0351-12, Institute of Metallurgy, Faculty of Metallurgy, Technical University of Kosice
Directive of the Department of the Environment of Slovak Republic from 28. January 2015 No.1/2015 – 7. To carry out risk assessments of contaminated sites

RNDr. Andrej Machlica, PhD.
DEKONTA Slovensko, spol. s r.o
Odeská 49, 821 06 Bratislava
Slovak Republic
machlica@dekonta.com

prof. Ing. Pavel Raschman, CSc.
doc. Ing. Gabriel Sučik, PhD.
Institute of Metallurgy
Faculty of Metallurgy, Technical University of Kosice
Letna 9, 042 00 Košice
Slovak Republic
pavel.raschman@tuke.sk

Mgr. Tomáš Binčík
Department of Economic Geology
Faculty of Natural Sciences, Comenius University
Mlynská dolina, Ilkovičova 6, 842 15 Bratislava
Slovak Republic
bincik2@uniba.sk

MINERAL PROSPECTIVITY MODELLER– GIS TOOLS FOR MINERAL EXPLORATION

Vesa Nykänen and Maarit Middleton
Geological Survey of Finland, Rovaniemi, Finland

KEYWORDS
Mineral exploration, prospectivity, digital data, geographical information systems (GIS), North Finland.

ABSTARCT

Enhanced data-analysis techniques are essential due to increasing amount of digital data collected during mineral exploration. The expanding mineral exploration and mining activity set demand for the development of time-saving, cost-effective and environmentally neutral exploration techniques. There are several mathematical and statistical techniques available for recognizing patterns in spatial data, thereby making effective use of the exploration data that is collected continuously by exploration companies on annual basis. This quantitative analysis of spatially referenced information is also called spatial data analysis or spatial modeling, in which the spatial distribution of the observations is taken into account in data analysis and interpretation of the results.

Mineral exploration is done in several scales from regional to target scale. The project Mineral Prospectivity Modeller (MPM) project is aiming to create workflows and tools to optimize the target scale modeling by adding new information into the models during the project evolution, which can take several years. This will be demonstrated by using a historic case study. In a typical mineral exploration project the amount of data is increasing in the course of the project but the information gained might not increase parallel. This project aims to solve this issue by providing new tools for data exploration.

There is a variety of advanced machine learning methods available for spatial modeling applied to mineral prospectivity mapping, and the selection of a specific technique is often made depending on the data that are available. Bonham-Carter (1994) divides these spatial modeling methods into two main groups based on the approach: data and knowledge driven. For 'brown-fields exploration' in mature mineral exploration terrains, where abundant data are available and many mineral deposits are already known, an empirical (or data-driven) approach is very often applicable. This project is aiming to study the effect of combining the empirical and conceptual approaches and investigate the model optimization possibilities for target scale conceptual modeling techniques. To reach this goal, the project aims to look into the modeling methodologies in ArcGIS Desktop and web-based platforms.

To support target scale mineral exploration, a public Spatial Data Modeler toolbox is redesigned and recoded into ArcGIS for the use of consulting and exploration companies. To support strategic planning of companies, the project produces an on-line prospectivity modeller for the most prospective areas making land claims for further target scale exploration.

The use of the tool will be demonstrated in a case study with real exploration data. Exploration in Lapland is promoted by distributing a free exploration dataset from northern Finland with the tool. The results of the project will be published in a report of investigation and scientific papers.

The project is solely carried out by GTK and funded by the Tekes-EAKR program Business from digitalization and internationally by exploration industry. Tekes funds 90% and companies 10% of the total of 508,000 euro budget for the years 2016-2017. The MPM project will involve a vast international collaboration network (scientific advisory board, SAB) composed of the top experts in mineral prospectivity mapping. The SAB includes experts from the U.S. Geological Survey, the Geological Survey of Canada and the University of Campinas (Brazil).

While the aim of this project is to focus on challenges faced in Finland, it must be remembered that environmentally neutral technology, mineral exploration and mining are global businesses. Most exploration in Finland is currently conducted by globally operating companies. Thus, there are global applications and a global market for the results achieved in the project. The results of the project will be publicly available and can lead into business models for SME's providing services for mining industry and eventually into new mineral discoveries.

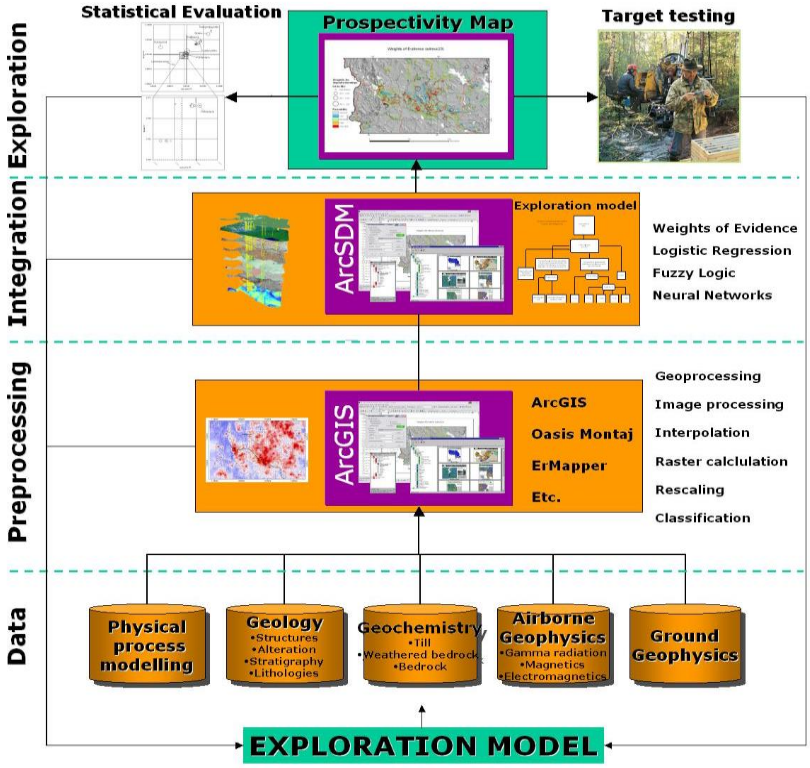


Fig. 1 Methodology and workflow of a dynamic prospectivity mapping project (Nykänen, 2008)

LITERATURE

Bonham-Carter, G.F., 1994: Geographic Information Systems for Geoscientists – Modelling with GIS. Computer Methods in the Geosciences 13. Pergamon, Oxford, 398 p.
Nykänen, Vesa, 2008: Spatial data analysis as a tool for mineral prospectivity mapping. Espoo: Geological Survey of Finland. 27, [92] p.

Research Professor Vesa Nykänen, PhD.
Geological Survey of Finland
P.O. Box 77, 96101 Rovaniemi
Finland
vesa.nykanen@gtk.fi

Senior Scientist Maarit Middleton, D.Sc.
Geological Survey of Finland
P.O. Box 77, 96101 Rovaniemi
Finland
maarit.middleton@gtk.fi

MINING FROM POLYMETALLIC DEPOSITS – CHALLENGES ON THE WAY TO SUSTAINABILITY

Tatsiana Piliptsevich
Supervisor: Prof. Dr. Jan C. Bongaerts

Chair for Resources and Environment Management, Faculty of Economics, TU Bergakademie Freiberg

KEYWORDS
Resources extraction, polymetallic deposits, mining, governmental policy inefficiencies, mining technologies, sustainability.

INTRODUCTION

Nowadays the challenge of secure but at the same time sustainable metals supply becomes urgent, as it has never been before. On one hand, the deposits of metals are not as high-graded as they have been in the past, due to very low possibility to discover new deposits of metals with high-grade of metals in the ore. The latest developments in the technologies still allow to extract minerals economically profitable from the deposits of much lower-grades, then those processed in the past [1]. Thus the mining industry has to adapt to the new situation and be able to process in the future more of lower-grade ores. On the other hand, the demand for metals in different industries, from electronics to renewable energy production, is only growing. For example, the supply of copper is already in the deficit, and zinc is predicted to become soon one of the critical metals in the market [1]. And still, when it comes to the extraction from the polymetallic deposits containing critical metals, many inefficiencies occur. For example, if the extracting company could not receive the permission to extract all the contained in the deposit resources or did not have the technology to do so, the valuable metals stay in the waste rocks or tailings. This becomes one of the main environmental problems, initiated by mining. This paper is aiming to give an overview and analyse the main challenges to the sustainable and optimal extraction from the polymetallic deposits and propose possible directions of their solution or improvement.

MAIN CHALLENGES ON THE WAY TO SUSTAINABILITY IN POLYMETALLIC MINING

The challenges of polymetallic mining on the way to the effective and sustainable extraction of minerals certainly include the common challenges of the mining industry. Among these one should mention the government policies. W. Ascher claims that "poor resources practices typically stem from faulty government policies" [2]. He also have examined several case studies of wasting natural resources and distinguished in the following policy failures:

- underpricing natural resources or products derived from them (which promotes excessive and rapid resources extraction);
- overpricing natural resources (which discourages worthwhile resource exploitation and promotes conversion to less worthwhile resources);
- poor information (diverts decision makers from optimal strategies);
- unclear property rights (promotes rapid resource extraction and discourages resource development because insecurity about receiving future benefits);
- monopoly arrangements (encourage inefficiency due to lack of competition and distort resource prices).

Sometimes the state exploits resources in the following forms [2]:

- direct commands to over- or underexploit the resource base;
- under- or overcapitalisation of state agencies;
- wasteful spending by state agencies that are not held accountable for the waste;
- poor investment decisions by state agencies.

W. Ascher also mentions the pragmatic motives or preferences, which are standing behind the policy failures. Among them are national security, regional development, income redistribution, tax revenues and industrial development. Besides that, I. Kolstad et al. [3] suppose that corruption is the main reason why resource-rich countries perform badly in economic terms and continue to extract their resources in an inefficient way. It is clear that these governmental policies leading to the inefficiencies in resources extraction are also valid for the extraction of the resources from the polymetallic deposits. Since in the case of polymetallic mines the picture is more complex due to, for example, more technologies for the extraction of several minerals or several metals markets, the problems can be even harder to determine and to optimise. For instance, when due to the absence of the permission from the government to extract the metals of interest, some of them stayed in the waste rock or tailings.

Besides governmental policies, as the reasons of unsustainable and inefficient extraction of resources, one can distinguish the technological and management challenges.

The development of technologies for the extraction from the polymetallic deposits is currently probably one of the most burning questions. And still, mining sector is considered to be not the one investing a lot into research and development of new effective and sustainable technologies [4]. Till nowadays many countries and mining sites have to deal with the consequences of inefficient mining technologies of the past. Gold mining from the reef in the Witwatersrand basin (Johannesburg) is a very good example of the extraction dependency on the technologies. Almost a hundred years ago the extraction of gold from the reef reached a recovery between 65 and 80%. As the price for gold dropped and the reef became lower-graded, surface burdens, outcrops, the resulting solid residues and tailings (from the inefficient flotation and concentration processes) were piled up in the tailing dumps. The waste still contained not only gold, but other metals too. Later in the middle of the nineties the company Anglogold developed the technology to extract the residuals from the tailings and the extraction is happening till nowadays.

As it has already been mentioned before, mining companies will have to deal with lower-grade deposits in the future [1] and still will have to provide the metals, the demand for which in increasing, especially in the developed countries. Besides that Mudd [5] states that there is overall tendency of increase in use and scale of open pit mining. These both aspects will lead to the rapid extent of waste rock or overburden. That clearly shows that mining companies should consider the recovery of resources from mining waste to minimise not only environmental consequences and costs for environmental remediation, but also to process less ore. B. Dold [6] notes that “according to the United States Environmental Protection Agency (EPA), water contamination from mining is one of the top three ecological-security threads in the world”. That one more time underlines the significance of the shift of mining, especially technologically, towards the sustainability.

And last but not least, the management in mining should be mentioned. The described above aspects show how the conditions in the mining sector are rapidly changing. That means that the usual strategies might not work anymore or became inefficient and the new strategies should be developed. For example, each mine needs to be economically evaluated. The literature study shows that sufficient literature on the economics of optimal extraction of joint resources from the polymetallic deposits is lacking. The paper of Pindyck [7] discusses the case, but it considers gas and helium extraction, which differs from the solid minerals extraction. Besides that it describes the two-staged extraction of the joint resources, during which at first a composite ore is extracted and afterwards it is processed for the extraction of the separate minerals. Currently engineers are considering the totally new concept of metals extraction from the polymetallic deposits. They are aiming to reduce the extraction processes to only one stage, at which right away the needed minerals will be extracted. As you can see, the development of new strategies and models for the extraction from polymetallic deposits needs to be done in order to optimise the production. In addition, while planning the mines managers should develop the strategies considering long time horizon to direct mining sector into a more sustainable course.

CONCLUSIONS

The discussed challenges in governmental policies, management and technologies in mining from the deposits with multiple minerals inside along with diminishing ore grades and increased demand for most of the resources become the key drivers for the next steps towards the improvents:

- development of the instruments for controlling governmental policies, motivating governments to follow the sound resources policies;
- development of new long-term strategies for the mining industry and economic models of the extraction from the deposits with multiple minerals inside;
- a broader approach to what elements can be extracted, co-extracted, and/or separated from resultant process solutions and a longer-term view of what constitutes the mineral resource;
- the development of new efficient technologies to extract a suite of elements instead of one, the most lucrative element, from complex polymetallic ores, concentrates, tailings and waste rock;
- discarding waste and tailings that are benign, therefore decreasing the expenses of environmental remediation during mine closure;
- development of new separation and purification technologies for the recovery of all elements of interest in the joint production of the minerals [1].

LITERATURE

H.R. Watling, Review of biohydrometallurgical metals extraction from polymetallic mineral resources, Minerals, 2015, 5, pp. 1-60.

W. Asher, Understanding why governments of developing countries waste natural resources, Environment, March, 2000, pp. 8-18.

I. Kolstad, T. Søreide, Corruption in natural resource management: Implications for policy makers, Recources Policy, December 2009, pp. 214-226.
P. Mitchell, J. Steen, Productivity in mining: a case for broad transformation, available online under: http://www.ey.com/gl/en/industries/mining---metals/productivity-in-mining (acceded on 01.10.2016)
G.M. Mudd, Sustainability and Mine Waste Management—A Snapshot of Mining Waste Issues. Available online: http://users.monash.edu.au/~gmudd/files/2007-WasteMment-Sustainability-v-MineWastes.pdf (accessed on 20.10.2016).
B. Dold, Sustainability in metal mining: From exploration, over processing to mine waste management. Rev. Environ. Sci. Biotechnol. 2008, *7*, 275–285.
R.S. Pindyck, Jointly produced exhaustible resources, Journal of Environmental Economics and Management, v. 9, i. 4, 1982, pp. 291-303.

MBA Tatsiana Piliptsevich
TU Bergakademie Freiberg
Faculty of Economics, Chair of Resources and Environment Management
Schloßplatz 1, 09599 Freiberg
Germany
Tatsiana.Piliptsevich@zuv.tu-freiberg.de

RECULTIVATION OF LANDFILLS, BOSNIA AND HERZEGOVINA

Vesna Tunguz[1]–Sladjana Petronic[1]–Mirko Kulina[1]–Ivana Boskovic[1]– Natasa Bratic[1] –Bojana Petrovic[2]

[1]University of East Sarajevo, Faculty of Agriculture, Bosnia and Herzegovina
[2] Mendel University in Brno, Faculty of Horticulture, Czech Republic

KEYWORDS
Agriculture, dump, recultivation, landfills

ABSTRACT

One of the fundamental questions of our time in the management of soil resources is its protection from damage and permanent destruction. Uncontrolled use of land by technical stakeholders in most cases leads to the permanent loss of it. These processes reduce the limited areas for crop production even more which increases the dependence of food and other plant products. The exploitation of lignite coal in surface mines in eastern Herzegovina, has the character of technical pressures on soil which mostly permanently destroys it in the extraction zones and the zones of disposal of mining overburden, ash and slag.
The exploitation of coal in the Gacko coal basin is followed by excavation and disposal of large quantities of land (limestone-dolomite black soil, rendzinas, smonitza, brown soil on limestone and dolomite, fluvial land, fluvial meadow land) of different geological composition and characteristics. In the process of thermal power plants creates a huge amount of slag, ash and tailings that are usually deposited in its vicinity.
Pedological profiles were opened, at the dump Dražljevo. Laboratory testing of physical and chemical properties of the soil were performed at the laboratory of the Faculties of Agriculture in East Sarajevo.
Deposols are characterized by physical properties which are mostly much worse in relation to the properties of autochthonous soils on which the dumps have been formed.
Measurement of microbial communities in the soil would provide answers to important questions such as the success of the restoration of the ecosystem and restore its basic functions and biodiversity of. To this end, microbial communities in the soil criteria to as: the number of microorganisms or their quantity, represented distinct species or functional groups and metabolic activity as measured asimilicaja or breathing.
Possible contamination of landfills can be objectively explain only after determining the content of heavy metals and other pollutants, soil and plants that require further research.

INTRODUCTION

Soil is one of the most important natural resources. It is priceless, irreplaceable, immovable resource for agricultural production which cannot be multiplied and represents the good of humanity, not only of one generation, nation, group or individual.
The exploitation of coal in the Gacko coal basin is followed by excavation and disposal of large quantities of land (limestone-dolomite black soil, rendzinas, smonitza, brown soil on limestone and dolomite, fluvial land, fluvial meadow land) of different geological composition and characteristics (*Tunguz*, 2015). In the process of thermal power plants creates a huge amount of slag, ash and tailings that are usually deposited in its vicinity. These dumps occupy considerable areas of land which it excluded from primary production. The subject of this research is the site of "Dražljevo 'first and oldest deposits of ash, which is deposited the ashes of the first day of the commissioning of the mine and power plant Gacko.
The aim of this study is to determine the characteristics of soil research landfills, to point out the basic principles and management that should be followed in further activities on land reclamation and environmental protection in the area affected by the work of the mine and power plant Gacko.

MATERIAL AND METHODS

The pedological research consisted of field and laboratory work. Two pedological profiles were opened, at the dump Dražljevo. After the profiles were opened, the internal and external morphology of the soil was examined in detail and soil samples were taken for the laboratory testing. Laboratory testing of physical and chemical properties of the soil were performed at the laboratory of the Faculties of Agriculture in East Sarajevo.

Analyzed properties:

- Mechanical composition of the soil, by combined method, the method of sieves and pipetting. Texture-

textured soil group: USA - USDA classification,

- The pH value of soil: (i) in water (H_2O) or an active reaction of soil, (ii) in a solution of 1 M KCl or substitution reaction of soil, electrometrically (inoLab pH 720, 2004),
- Determination of the content of humus, by bichromate method of Tyurin,
- Determination of easily available phosphorus (P_2O_5) by Al method spectrophotometrically (Spectrophotometers, Series 7000, 2004) and potassium (K_2O), photometrically (Sherwood`s Flame photometers, 420/425, 2004),
- Determination of carbonate content in the soil by the method of Scheibler,
- Determination of total nitrogen Kjeldahl, 2004.

RESEARCH RESULTS AND DISCUSSION

On the basis of field and laboratory research it has been determined that on the examined area recultivated dumps of ashes.

Mechanical composition and physical properties of deposols are presented in Table 1.

Deposols are heterogeneous at a small distance because the mass of deposols has been obtained by imperfect mixing and is characterized by insufficient homogeneousness. Deposols are characterized by physical properties which are mostly much worse in relation to the properties of autochthonous soils on which the dumps have been formed *(Tunguz, 2015)*. In profile 1 erodibility was noticed due to change relief conditions and worsening of physical properties of deposol.

Tab. 1 Mechanical composition of deposols

Profile	Profile No.	Profile No.	Coarse sand 2.00-0.2 %	Fine sand 0.2-0.05 %	Dust 0.05-0.002 %	Clay < 0.002 %	Skeleton (%)	Texture class
Profile 1	I	0-9	18.80	17.50	46.58	17.12	3.48	Loam
	II	9-22	6.80	11.90	53.42	27.88	0.00	Powdery clay loam
Profile 2	I	0-10	8.40	13.40	47.64	30.56	0.33	Clay loam
	II	10-33	3.70	5.80	50.58	39.92	0.00	Powdery clay loam
	III	33-42	4.20	8.60	53.32	33.88	0.00	Powdery clay loam
	IV	42-63	46.70	24.20	24.46	4.64	27.67	Sandy loam

The high content of larger particles in the ash, in the absence of real clay minerals and humus, which are binding material and carrier adsorptive capacity, causing a weak attachment ash, relatively little ability to retention of water and nutrients (*Cokic et al.*, 2006).

Tab. 2 Basic chemical properties of deposol

Profile	Horizon	Depth in cm	pH		$CaCO_3$ %	Humus %	N %	mg/100 g of soil	
			1M KCl	H_2O				P_2O_5	K_2O
Profile 1	I	0-9	7.48	8.17	5.72	11.31	0.23	19.20	9.99
	II	9-22	7.13	8.04	4.14	4.70	-	7.07	21.70
Profile 2	I	0-10	7.14	8.20	2.70	3.99	0.22	11.90	17.07
	II	10-30	7.05	8.05	2.41	3.08	-	6.94	22.73
	III	30-42	7.07	8.25	3.55	3.21	-	3.30	23.08
	IV	42-63	7.67	7.94	16.20	4.80	-	14.18	6.88

The chemical properties of the landfill are characterized by a neutral to slightly alkaline reaction in the surface horizon (pH 1 M KCl). Carbonate are from the surface, and the maximum value of $CaCO_3$ in IV horizon other profile (16:20%). Strong carbonate status is expressed in the ashes (*Tunguz*, 2015). In this case, less the value of carbonate due to intermingling with the land. The ashes of thermal power plants as a substrate is significantly different from the land as a substrate for agricultural production. While examining the fresh ash, slag and disposed materials from ash dumps, old more than 11 years, it was found that one of the ways of using these materials is that they mix with the soil, which would solve the problem of their disposal, and also make the corrections of some unfavorable soil properties (*Bisic-Hajro*, 1984).

The ash of all dumps is characterized by low nitrogen content. Humic substances originate from the unburnt coal which is present with 2-3% in the ash of Kostolac power plants. The ashes of the landfill is characterized by low nitrogen content. The percentage of nitrogen is only 0.045% in fresh depositional ash. (*Djordjevic-Miloradovic*, 2002).
The content of available potassium and phosphorus ranges medium provision to. Active acidity of ash ranges from 7.40 to 8.10, which indicates the alkaline reaction of the ash. This reaction is suitable for growing a large number of plants, in particular herbs. Thus, 40 species of plants - weeds, ruderal, rhizome and seedlings of six species of trees has been inhabited on the ash of the dump of TPP Kostolac by spontaneous recolonisation (Djordjevic-*Miloradovic and Vlajkovic*, 2008). After the war it was not to protect the landfill and has been observed spontaneously vegetation.

CONCLUSION

We have carried out soil investigations and found that the landfill is characterized by favorable physical and chemical properties.
In the studied area there was a permanent loss of land due to changes in the land use which is a fourth degree damage to the land, *Basic* (1994).
Based on our research in the area of the landfill can be concluded that the conditions of the natural habitat permanently changed and for this reason this area, to bring it into biologically active state, requires the application of complex measures that include technical and agro biological re-cultivation.
When selecting grass-legume mixture should be taken to ensure that the selected plant species have the ability to bind substrates that are resistant to specific environmental conditions and tolerant to climatic conditions to grow at higher altitudes that are tolerant of pH to grow and develop and the poor and shallow soils that are resistant to drought, and suffer high levels of ground water that are feed mixture of high biological value.
Measurement of microbial communities in the soil would provide answers to important questions such as the success of the restoration of the ecosystem and restore its basic functions and biodiversity of. To this end, microbial communities in the soil criteria to as: the number of microorganisms or their quantity, represented distinct species or functional groups and metabolic activity as measured asimilicaja or breathing.
Possible contamination of landfills can be objectively explain only after determining the content of heavy metals and other pollutants, and access to land reclamation and plants that require further research.

REFERENCES

Basic, F., 1994: Classification of damage to the Croatian Soil, Agronomy journal, 3-4, 291-310, Zagreb.
Bisic-Hajro, J., Jurkovic, M., Velagic-Habul E., 1984: Effect of waste materials from power plants on properties pseudogley and sample the culture, Biological Iugoslavica - Series A: Land and plant, vol. 33, No. 1, Belgrade, p. 39-45.
Djordjevic-Miloradovic, J., 2002: The restoration of ecosystems destroyed by the deposit of ash - the importance of education pioneer communities of plants. - Consultation: Energy complex Kostolac and Environment, Proceedings of the Alliance of engineers and technicians of the Municipality of Pozarevac, pp. 33-37.
Djordjevic-Miloradovic, J., Vlajkovic, M., 2008: Distribution of rare elements in the soil, coal, ash, tailings and plants in Kostolac coal basin (North-eastern Serbia) Advice: The use of ash from thermal power plant Kostolac A and B, the Company chemists, technologists and metallurgists municipality of Pozarevac, 95-104.
Tunguz, V., 2015: Content of heavy metals in dumps of Eastern Herzegovina, IMPEL Soil Conference, “Many Soil Functions, many reasons to protect it”, Milano (IT) 7th, 8th October 2015.
Cokic, Z., Maksimovic, S., Smiljanic, Z. i Kisic, D., 2006: Osobine pepela deponije TE Kostolac i njegova pogodnost za rekultivaciju. In: Tanasijević, Lj. (ed.) Implementation of remediation in environmental quality improvement, Chamber of Commerce, Board of Environmental protection and Sustainble development: 113-117.

Dr Vesna Tunguz, dipl. ing.
Assistant professor
University of East Sarajevo, Faculty of Agriculture
Soil Science
Vuk Karadzica 30
71123 Istocno Sarajevo, **Bosnia and Herzegovina**
Tel./Fax +387 340 401

Dr. Mirko Kulina, dipl. ing.
Associate professor
University of East Sarajevo, Faculty of Agriculture
Vuk Karadzica 30
71123 Istocno Sarajevo, **Bosnia and Herzegovina**
Tel./Fax +387 340 401

Dr. Sladjana Petronic
Associate professor
University of East Sarajevo, Faculty of Agriculture
Vuk Karadzica 30
71123 Istocno Sarajevo, **Bosnia and Herzegovina**
Tel./Fax +387 340 401

Ivana Boskovic, MSc
Assistant
University of East Sarajevo, Faculty of Agriculture
Vuk Karadzica 30
71123 Istocno Sarajevo, **Bosnia and Herzegovina**
Tel./Fax +387 340 401

Natasa Bratic, MSc
Assistant
University of East Sarajevo, Faculty of Agriculture
Vuk Karadzica 30
71123 Istocno Sarajevo, **Bosnia and Herzegovina**
Tel./Fax +387 340 401

MSc Bojana Petrovic, dipl. ing.
Post-graduate student
Faculty of Horticulture, Mendel University in Brno
Valtická 337, 691 44 Lednice, **Czech Republic**
phone: +420 519 367 220

THE TOTAL CONTENT OF CADMIUM IN DUMPS

Vesna Tunguz[1]– Otilija Miseckaitė[2]–Dragana Sunjka[3]

[1]University of East Sarajevo, Faculty of Agriculture, Bosnia and Herzegovina, e-mail: vesna.tunguz@gmail.com
[2] Aleksandras Stulginskis University, Institute of Water Resource Engineering, Lithuania
[3] University of Novi Sad , Faculty of Agriculture, Department for Environmental and Plant protection, Serbia

KEYWORDS
Total content of cadmium, maximally allowable concentration, Eastern Herzegovina

ABSTRACT

One of the fundamental questions of our time in the management of soil resources is its protection from damage and permanent destruction. Uncontrolled use of land by technical stakeholders in most cases leads to the permanent loss of it. These processes reduce the limited areas for crop production even more which increases the dependence of food and other plant products. The exploitation of lignite coal in surface mines in eastern Herzegovina, has the character of technical pressures on soil which mostly permanently destroys it in the extraction zones and the zones of disposal of mining overburden, ash and slag.
The paper presents the results of studies on the total content of cadmium (Cd) in soils, soils of dumps in the process of re-cultivation, slag, ash and mullock dumps mine and thermal power plant in Gacko. The study includes areas that are determined as areas of possible contamination. Extraction of traces of total content of heavy metals, BAS ISO 11047: 2000, was done in laboratory Faculty of Agriculture. In tested samples of the total content of cadmium is below maximally allowable concentration (except in mullock dumps), corrected limit value and well below the remediation values.
The available data in the field of research of soil damage and destroyed farmland by various activities, where the extraction of mineral resources by surface mining leads, date back to the period of 20 or 25 years ago. It is obvious that the lasting conflicts in interests and rights of soil disposal in the technical and in ecological areas are gaining in importance. Research should continue.

INTRODUCTION

Healthy soils are indispensable for life, for food production, for human health and for biodiversity. They reduce our vulnerability to climate change and to floods and droughts. While soil is often perceived to be abundant, it is a non-renewable resource. It takes around 100 years for 1cm of soil to form in temperate climates. Ability of the European soil to deliver ecosystem services is under increasing pressure; the observed rates of soil sealing, erosion, contamination and decline in organic matter all reduce soil capability. The current land take of around 250 hectares per day means that, every year at EU level we lose a surface area larger than the city of Berlin, or, every ten years, a surface area equal to Cyprus. Most of this lost soil comes from agricultural land, with a particular toll on fertile soils surrounding our cities and villages, due to urban sprawl (JRC, 2015).
Among the many damages to soil, contamination of soil with heavy metals draws the most attention. The distribution of heavy metals in the soil, their mobility and solubility depends on the standdard properties of soil (soil reaction, content of colloidal particles in the soil clay content, the content of organic matter of soil). Heavy metals in the soil do not dissolve like many other pollutants, so the decontamination of soil is by rule a long-term process with great investments that lasts even for decades Tunguz et al. (2014).

MATERIALS AND METHODS

Gacko coal basin is located in the Gacko field in the southeastern part of the Republic of Srpska. It covers area of about 40 km^2, at an altitude of about 940 m in a typical karst area. According to the altitude is most elevated mountain part of Herzegovina, with an average altitude above 1,000 meters. Along with Trebinje, Bileca and Nevesinje makes the eastern Herzegovina area known as East Herzegovina.
In the area of Gacko plain there was a disturbance of the land and to its destruction due to changes in land use, or permanent loss of land due to the construction of thermal power plants. Contaminated surfaces of about 750 ha. In the studied dumps were taken average samples at depths of 0-20 cm.
The external and internal morphology is described for all pedological profiles (Munsell Soil Color Charts, 1954), samples in a disturbed state were taken for all genetic horizons. Samples in undisturbed condition were taken from individual genetic horizons, in three repetitions, by cylinders of Kopecký. Extraction of traces of

total content of heavy metals (BAS ISO 11047: 2000, AAnalyst 800, Perkin Elmer (2006), software, WinLab32, version 6.4. Rev. 6).

RESULTS AND DISCUSSION

The surveys covered soils of dumps in the process of re-cultivation, slag, ash and mullock dumps.
FBiH legislation that was used according to the Law on Agricultural Soil (Official Gazette of FBiH, no. 52/09) i.e. Instructions on determining the allowable amount of harmful and dangerous substances in soil and methods for their investigation (Official Gazette of FBiH, no. 72/09) treats pollution i.e. contamination of soil by heavy metals in terms of growing the crop plants, i.e. as agricultural soil, based on textural characteristics.
If the concentration of heavy metals in the soil is significantly higher than normal, it indicates contamination either from anthropogenic sources or their natural geochemical origin. Control of their levels in the soils occurs through comparisons with maksimally allowable concentration (MAC) for unpolluted soils.
In Serbia, the criteria for the assessment of soil contamination with heavy metals (MAC) are given in the Regulations on permitted amounts of dangerous and harmful substances in soil and water for irrigation and methods for their investigation (Official Gazette of RS, no. 23/94) and the Regulation on the program for systematic monitoring of soil quality, indicators for risk assessment of soil degradation and methodology for development of remediation programs (Official Gazette of RS, no. 88/2010).
The limit values for the maximally allowable concentration (MAC) of heavy metals in soils represent a significant foothold in the assessment of soil contamination by these mainly toxic elements.

Fig. 1 External morphology of soils of dumps in the process of re-cultivation

Fig. 2 External morphology of slag dump

Fig. 3 External morphology of ash dump

Fig. 4 External morphology of mulock dump

Limit values, remediation values are value that can point to significant contamination for heavy metals in this case camdium (Cd) and depend on the clay content and / or organic matter in the soil. Data on the total content of cadmium (Cd) are shown in Table 1.

Tab. 1 Mean values of the total content of cadmium (Cd), mg/kg, corrected limit values and remediation values for soils of dumps in the process of re-cultivation, slag, ash and mullock dumps

Dumps	Cadmium (Cd)	Corrected limit value (mg/kg)	Remediation value (mg/kg)
Soils of dumps in the process of re-cultivation	1.85	0.66	9.96
Slag dumps	1.30	0.95	14.28
Ash dumps	1.41	0.45	6.72
Mullock dumps	0.40	0.62	9.36

The maximally allowable amount of cadmium (Cd) in the soil is 3 mg/kg (Official Gazette of RS, no. 88/2010; Scheffer and Schachtschabel, 1998). The average content of cadmium in soils of Central Serbia is 0.805 mg/kg (Report on the state of soil in the Republic of Serbia, 2009).
It is believed that in addition to geochemical origin Cd is often found in soils rich in Zn ore, carbonates, phosphorites, black shales and clays.
High content may be due to anthropogenic pollution (applicable in the industry, it can be found in higher concentrations along roads, and on arable land, as a result of intensive agro techniques (from phosphorus fertilizers and some fungicides) (Adriano 2001; Alloway, 1995).
Cadmium in primary rocks is found in low concentrations, most often in the minerals of zinc sulfate (sphalerite) with about 0.2 to 0.4%. It is much more present in sedimentary rocks, especially in calcium phosphates (<10-980 mg/kg) and in marine black shales (0.30-219.0 mg/kg). In most soils, cadmium is present in concentrations of less than 1.0 mg/kg (Alloway, 1995).

CONCLUSION

Gatačko field is karst field and is certainly the only oasis of arable land.
In tested samples of the total content of cadmium is below maximally allowable concentration (except in mullock dumps), corrected limit value and well below the remediation values.
The available data in the field of research of soil damage and destroyed farmland by various activities, where the extraction of mineral resources by surface mining leads, date back to the period of 20 or 25 years ago. It is obvious that the lasting conflicts in interests and rights of soil disposal in the technical and in ecological areas are gaining in importance. This is one of the important motives for undertaking research activities in Herzegovina, to shed light, as much as possible, on the current situation in the interests of individual land users.

REFERENCES

Adriano, D. C., 2001: Trace elements in terrestrial environments: Biogeochemistry, bioavailability, and risks of metals (2nd edn.), Berlin-Heidelberg-New York: Springer.
Alloway, B. J., 1995: Cadmium. In: B. J. Alloway (Ed.), Heavy metals in soils (2nd edn.) (pp. 368). London, UK: Blackie Academic and Professional.
BAS ISO 11047: 2000, Determination of cadmium, chromium, cobalt, copper, lead, manganese, nickel and zinc in aqua regia extracts of soil - Flame and electrothermal atomic absorption spectrometric methods.
Guidance on determining the allowable amount of hazardous substances in soil and methods of testing, 2009: FBiH Official Gazette No. 72/09.
JRC, 2015. Remediated sites and brownfields. Success stories in Europe; EUR 27530 EN; doi 102788/406096
Law on Agricultural Soil, 2009: Official Gazette Federation of Bosnia and Herzegovina, No. 52/09.
Munsell Soil Color Charts, 1954

Regulation on the application of systematic monitoring of soil quality indicators for the assessment of risk of soil degradation and methodology for development of remediation programs, 2010: Official Gazette of the Republic of Serbia, No. 88/2010.
Regulations on permitted amounts of hazardous and harmful substances in soil and water for irrigation and methods for their testing, 1994: Official Gazette of Republic of Serbia , No. 23/94.
Scheffer, F., Schachtschabel, P., 1998: Bodenkude, Stuttgart.
Tunguz, V., Nešić, Lj., Belić, M., Ćirić, V.: The impact of the thermal power plant in Gacko on land degradation, Book of Proceedings, Agrosym 2014, 23-26 October 2014, Jahorina pp. 682-687.

Dr Vesna Tunguz, dipl. ing.
Assistant professor
University of East Sarajevo
Faculty of Agriculture
71123 Istocno Sarajevo
Bosnia and Herzegovina

Dr Otilija Miseckaitė
Lecturer
Aleksandras Stulginskis University
Faculty of water and land management
Institute of Water Resource Engineering,
Kaunas
Lithuania

Dr Dragana Šunjka
Assistant Professor
University of Novi Sad
Faculty of Agriculture
Department for Environmental and Plant protection
21000 Novi Sad
Serbia