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Prevention and Remediation Issues in Selected Industrial Sectors: Non-Ferrous Mining

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2003
Annual Report
NATO/CCMS Pilot Study

Prevention and Remediation Issues
in Selected Industrial Sectors:
Non-Ferrous Mining

Baia Mare, Romania
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NOTICE

This Annual Report was prepared under the auspices of the North Atlantic Treaty Organization's Committee on the Challenges of Modern Society (NATO/CCMS) as a service to the technical community by the United States Environmental Protection Agency (U.S. EPA). The report was funded by U.S. EPA's Office of Superfund Remediation and Technology Innovation. The report was produced by Environmental Management Support, Inc., of Silver Spring, Maryland, under U.S. EPA contract 68-W-03-038. Mention of trade names or specific applications does not imply endorsement or acceptance by U.S. EPA.

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INTRODUCTION

The Council of the North Atlantic Treaty Organization (NATO) established the Committee on the Challenges of Modern Society (CCMS) in 1969. CCMS was charged with developing meaningful programs to share information among countries on environmental and societal issues that complement other international endeavors and to provide leadership in solving specific problems of the human environment. A fundamental precept of CCMS involves the transfer of technological and scientific solutions among nations with similar environmental challenges.

This document reports on the first meeting of the Pilot Study on Prevention and Remediation Issues in Selected Industrial Sectors. The purpose of the pilot study is to define and explore best practices for reducing the health and environmental impact on soil and groundwater from industrial sectors of interest (e.g., metals mining, organic chemical production, gasworks, and fertilizer manufacturing) as well as other unique site "types" (e.g., old landfills, privatization sites [i.e., facilities transitioning from former state ownership in certain categories], mega sites [i.e., large scale former industrial and mining facilities], and shoreline sediment sites). The pilot study will explore the techniques and technologies for preventing and avoiding discharge to soil and groundwater as well as measurement and remediation for that industry sector or site type. It seeks to engage industry and other private sector organizations at the transnational level in sharing and evaluating technical information. In reviewing case studies as well as experience from the previous CCMS pilot study on contaminated land and other sources, the proposed pilot study may be able to assess or benchmark "what is easy to clean," "what is difficult to clean," and "what is impossible, at reasonable cost, to clean." The unique contribution of the pilot study would be measured by its ability to synthesize information regarding best practices, successes and failures, and uncertainties for the sectors of interest

The first meeting of the study was held Baia Mare, Romania on Sept. 7 – 10, 2003. The United States is the lead country for the Pilot Study, and nine other countries participated in the meeting along with representatives of the World Bank and Joint Research Center of the EU. This report is a set of abstracts (annotated with significant web sites) of the presentations at the meeting along. In addition, a CD is available with copies of all the detailed presentations.

This report is available online at http://www.nato.int/ccms/ and http://www.clu-in.org/intup.htm. CD ordering information can be found at the latter web site. General information on the NATO/CCMS Pilot Study may be obtained from the country representatives listed at the end of the report. Further information on the presentations in this document should be obtained from the identified presenters.

Stephen C. James
Walter W. Kovalick, Jr., Ph.D.
Co-Directors

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ABSTRACTS INCLUDED IN NATO/CCMS PILOT STUDY

USE OF ALKALINE ADDITIVES AND A SOIL COVER FOR PREVENTION OF ACID MINE DRAINAGE FROM SULPHIDIC TAILINGS IN LAVRION

Anthimos Xenidis
Greece

1. ABSTRACT

The methodology for the design and application at full scale of a simple, innovative and cost-effective rehabilitation scheme on the Tailings Dam in Lavrion, Greece, using alkaline additives and a soil cover for Acid Mine Drainage prevention is presented. This spoil contains sulphidic flotation tailings and was characterized as hazardous since it exhibited high acid generation potential, poor pore water quality, high EPA TCLP toxicity and high bioavailable and phytoavailable fractions of heavy metals. Experiments at both laboratory and field scale proved that it is possible to inhibit acid generation by thorough mixing of ground limestone with pyritic tailings and by carefully controlling the conditions in such a way that the oxidation products precipitate around the pyrite grains, hindering further oxidation of the pyrite; this localized dissolution - precipitation action will ultimately result in cementing the particles and forming a low-permeability layer (hard pan) acting as a barrier to oxygen and water infiltration. The entire rehabilitation scheme applied to the Lavrion Tailings Dam involves mixing of the top 0.80 m of the tailings with limestone and application of a dry cover consisting of sand-gravel, protective and vegetation soil layers. The principal functions of this scheme are: to reduce water and oxygen infiltration within the tailings; to avoid transportation of the fine toxic particles by the wind; to avoid contact of humans, animals and plants with the tailings; to encourage the development of a plant community and produce an aesthetically pleasing vegetated surface and finally to serve as a long-lived and maintenance-free cover system. In order to monitor the overall performance of the scheme, drillholes were placed on and around the rehabilitated area and piezometers were installed for regular monitoring of the pore water level and quality. It has been proven that 8 years after the construction, pore water quality was substantially improved and it still remains neutral.

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REMEDIATION STRATEGIES OVERVIEW: REMEDIATION OF METAL CONTAMINATED SITES

Ludo Diels
Belgium

1. ABSTRACT

Former mining activities, non-ferrous metals processing, surface treatment and electronic industries lead to the contamination of soils and groundwater with heavy metals. In function of the industrial activities these metals are sometimes accompanied by organics like BTEX or chloro-aliphatics (VOCLs). Also the presence of natural iron (or even arsenic) can play a role in this contamination. After long periods of exposure the heavy metal plumes became very large and are threatening groundwater reserves. This paper will deal with the use of immobilisation techniques for the reduction of risks related to the presence of heavy metals.

The addition of soil additives (as silicates, phosphates, carbonates, iron oxides, etc) can reduce the bioavailability of metals in the soil and allow normal plant growth. Such an immobilisation process will reduce the spreading of metals to the groundwater and to the air. Examples will be presented.

In case of groundwater pollution, the metals can be treated in situ in the aquifer in a way that they become immobilised. This immobilisation can be done by inducing Sulphate Reducing Bacteria (SRBs) to reduce sulphates into sulphides which will precipitate the heavy metals as metal sulphides. In order to induce the bacteria a carbon source (electron donor) must be provided to grow these bacteria and to remove the oxygen. It is important to make good evaluations about the feasibility of this technology as a quite low ORP is necessary and methanogenic activity must be avoided. Good chemical analysis of the inorganic and organic content are necessary (evaluations will be presented).

Batch test systems and column test systems will be presented. Evaluations of the in situ precipitates will be discussed. Special attention will be paid to the addition of ORP reducing compounds.

The upscaling of the process towards injection and diffusion of carbon sources will be discussed in detail. The influence of the carbon source and concentration on the microbial ecology of sulphate reducing bacteria versus methanogenic bacteria will be presented. Also the treatment design will probably consist of some kind of virtual barrier or treatment curtain at the border of the industrial site to avoid the high costs for complete remediation of the whole site. Feasibility tests and the results of a pilot study work for in situ bioprecipitation and sorption will be presented and compared. All the results will be accompanied by molecular biological results concerning the identification of specific groups of Sulphate Reducing Bacteria in the process.

The results will be compared with another in situ technology being immobilisation by sorption to zeolites, silicates, compost and other materials in Permeable Reactive Barriers. Also results will be presented on an alkalinity producing barrier system.

The results will also be compared with pump and treat technology and a general approach for mining sites, non-ferrous sites or surface treatment sites will be presented. Special attention will be paid to prevent possible disasters and to remediate large areas of contaminated groundwater and even surface water. The approach will be presented by applying an Integrated Management System, under development for megasites or risk-management zones in Europe.

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REMEDIATION SCHEMES TO MITIGATE THE IMPACT OF ABANDONED MINES

Brian D. Bone
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1. ABSTRACT

Mining in Britain has a long history, dating back to the Bronze Age and with widespread production from Roman times through to a general decline following its peak in the 19th and early 20th centuries. The exploitation of our mineral resource, however, has not been without cost, and an environmental legacy has arisen from mine abandonment.

The main problems arising from abandoned mines in England and Wales relate to historical pollution of surface waters, recent abandonment and groundwater rebound, and the impact of mining wastes, both as diffuse sources of pollution and potential harm to health. Legislative changes in the UK and Europe in the last decade have provided significant drivers for the remediation of abandoned mines and are likely to increase the need for remediation when the EC Water Framework Directive is fully implemented.

It is important that remedial strategies to deal with pollution from abandoned mines are based on sound science having regard to site conditions and remedial options. A strategy may involve one or a combination of active treatment, passive treatment or preventative measures and can require a multi-disciplinary approach utilising engineering, chemical, geological and biological expertise.

Case studies are presented to reflect the range of technologies that have been piloted and used in England and Wales to deal with minewater and mine waste impacts and three remediation schemes carried out at two former non-ferrous metal mine sites in England are discussed in this paper:

- an active oxidation and neutralisation treatment system to deal with the discharge from a tin mine following abandonment and groundwater rebound;
- a pilot passive system to assess the feasibility of such technologies to offer a long-term solution to metal mine discharges; and
- civil engineering methods to prevent collapse of a tailings dam at an abandoned lead mine.

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TOXIC MINING WASTE IN THE PRE-ACCESSION COUNTRIES: THE PECOMINES PROJECT

Marco D'Alessandro
Italy

1. ABSTRACT

Mining waste is known to be amongst the largest waste streams in the EU and it is ranked first in the relative contribution of wastes in many Central and Eastern European Countries.. There is a substantial gap in consistent information on European level, how mining wastes in EU Member States and Candidate Countries are managed, of which nature their major hazard are and where the sites generating largest hazards are precisely located, including those that have been abandoned. In order to fill effectively such a gap, three components are crucial: A) Inventory; B) Impact assessment and C) Regulations.

Tackling the problem associated to mining waste from this perspective facilitates the outline of tight interactions among legal, technical, and scientific aspects of the problem, helping the scientific community and policy makers to face the problem in a rational manner.

On this background the Pecomines Project aimed to conceptualize and demonstrate a standard regional inventory of waste sites from mineral mining in Pre-accession Countries in relation to catchment areas. Thus it becomes possible to develop a concept of regional impact assessment allowing to link the site/source related indicators with spatial information at catchment scale. The Pecomines inventory combines site specific information coming from existing data bases in the Candidates Countries, which is harmonized through the Pecomines questionnaire, and put into a relational data base.

The environmental impact assessment work package develops the links between pressure identified by the inventory, and possible actions to reduce impacts and risks to acceptable level. Although different negative environmental impacts are known, (dust and gas emission, subsidence,.. etc) the primary concerns are still related to emissions from the sites, contaminated water and land, and the risk of accidental release from tailings ponds.

The third component of Pecomines Project is the detailed review of regulations in force in Candidate Countries. In fact the ecosystem protection from toxic mining waste management requires a comprehensive legislation and technical standards, which take full account of the vulnerability of the environment within the catchment area downstream of mining sites. As a matter of fact differences exist between Pre-Accession Countries: this review makes easier the comparison of existing guidelines exploiting the opportunities offered by relevant measures from Community environmental legislation. This should contribute to the development of criteria for safe disposal of waste, and for remediation and environmental rehabilitation measures at active or abandoned mines.

The described approach to collect standardized information on mining sites and related waste from existing data base is also an important step to fulfill the needs for a consistent development of EU policies related to waste management, protection of water and soils resources, and health.

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3. FOR MORE INFORMATION

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- www.eugris.info
- www.viso.ei.jrc.it/pecomines_ext/main.html

REMEDIATION CASE STUDY: THE DELORO MINE REMEDIATION PROJECT

Konstantin Volchek
Canada

1. ABSTRACT

The Deloro Mine site is a 202 hectare parcel of property that was the site of mining, refining and manufacturing activities for over 100 years.

This report describes results of a field demonstration of an innovative arsenic removal process that incorporates coagulation and microfiltration. Given the increasing importance of the arsenic contamination issue in drinking water, the Coagulation-Enhanced Microfiltration (CEMF) was studied with respect to drinking water treatment.

CEMF includes the addition of some metal salts that hydrolyze once they contact with water in neutral or basic conditions. Freshly formed metal hydroxides react with arsenic ions and produce insoluble colloidal particles. The water is then filtered through a membrane that rejects arsenic-bearing particles.

SAIC Canada previously performed a preliminary experimental investigation of CEMF and found it highly effective in removing arsenic from water. The focus of this study was to demonstrate CEMF on a pilot scale using actual arsenic-contaminated water.

A series of in-house tests were carried out on the actual water samples prior to field demonstration. This was done to assess process parameters, such as operating pressure, system throughput, and reagent consumption.

The field demonstration took place at the Deloro Arsenic Treatment Plant operated by the Ontario Clean Water Agency (OCWA) in Deloro, Ontario. The Plant uses the ferric precipitation process to reduce the level of arsenic in the groundwater and enable its discharge into the environment. Treated effluent generated in this process was used as feed water in CEMF tests. Results of the field tests confirmed the effectiveness of CEMF. The process reduced the level of arsenic in the discharge effluent from an average 80 µg/L to as low as 10 µg/L. It was demonstrated that CEMF could be incorporated into the existing water treatment schemes with only minor modifications to the existing process.

This report provides recommendations for further studies and the trial implementation of CEMF at existing arsenic treatment plants.

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ALMADÉN: REMEDIATION TECHNIQUES IN THE LARGEST MERCURY MINING DISTRICT OF THE WORLD

Pablo L. Higueras
Spain

1. ABSTRACT

Almadén, located in south-central Spain, contains the largest mercury mines of the world, having produced one third of total mercury used by mankind in more than 2,000 years of uninterrupted mining activity. The area contains 5 mines that have produced each more than 100,000 flasks (5,263 tons) of metallic mercury, and over 50 points in which cinnabar can be found, and have been object of mining research to greater or lesser extend. All these sites distribute in an area some 100 km2 wide, and of course, constitute the source of a general distribution of the element in the regional environment.

In this presentation we will know the main characteristics of the area, including a brief presentation about the geology, mining and metallurgy of the mercury deposits, and the environmental questions arising from the generalized presence of mercury in the area. After that, we will analyze the corresponding risks and hazards for the inhabitants of the region in relation with this question, to end with the presentation of the results of the remediation techniques applied in the area, and the work that it rests to do to minimize the risks detected.

The remediation techniques applied up to date in the area are phytoextraction and the study of a crandallitic compound that can be used as a mercury immobilizator, on fluids, and on natural sites. The results coming from these studies show that phytoremediation using agricultural plants (wheat, barley and lupine) does not offer good results, on the basis of the low capacity of these plants for mercury uptake. On the other hand, the crandallitic immobilizator has proven to be cheap to synthesize, and with high capacity of mercury sorption.

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SELECTION OF REMEDIATION MEASURES FOR CONTAMINATED MINE SITES

Michael Nahir
Canada

1. ABSTRACT

The selection of remediation measures for contaminated mine sites requires a process that is very different from the approaches used at contaminated sites from other industries. The huge volume of waste materials produced by mining and ore processing, the delayed reactivity of some of those wastes, the long-term contamination of mine water, and the presence of significant physical hazards are examples of factors that argue for a different approach. This paper describes case histories from Northern Canada where the authors have been involved in the selection and implementation of mine closure measures, and presents a methodology that can be applied to efficiently select closure measures for other mine sites.

The first case history describes the assessments of several remote mining sites in the Yukon, and the simple method used to prioritize remedial measures. The second case history describes the closure of an abandoned tailings facility in the southern Yukon, and the method used to select the appropriate level of closure measures. The third case history describes ongoing efforts to select remediation measures for the 270,000 tons of arsenic trioxide dust that was left underground when the Giant Mine, near Yellowknife NWT, was closed. The fourth case history describes closure planning for the Colomac Mine, an abandoned gold mine faced with long-term environmetal concerns as well as immediate concerns related to cyanide-contaminmated water and tailings dam safety.

The four case histories differ significantly in the levels of complexity and cost. Nonetheless, the authors found that a common approach was effective. The “top down” approach is described, and its implementation through various decision analysis methods is demonstrated. The “top-down” approach is contrasted with approaches commonly applied at non-mining contaminated sites.

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SAFETY AND RISK ASSESSMENT FOR AURUL TAILINGS POND

Dan Stematiu
Romania

1. ABSTRACT

The case study dedicated to Aurul tailings pond illustrates the use of risk analysis for developing a proper risk management program after a severe technical accident. In the presentation below, the characteristics of the pond, the design elements and the operating conditions required by the project are presented, followed then by the description of the technical accident from January 2000, its causes and the first measures taken immediately afterwards. A preliminary risk evaluation based on numerical indices allows for a rational rating of constructive measures required to restart the pond operation. A complete quantitative risk assessment renders evident the efficiency and the benefits of the structural and non-structural measures in terms of risk management. The process starts with the identification of potential failure modes and effects. The probability of breaching is then quantified on the basis of event trees. The consequences of a potential failure are evaluated with respect to environmental and socio-economic factors on a gravity scale.

2. CONTACT

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ISSUES IN UNITED STATES MINING

George R. Bockosh
United States

1. ABSTRACT

The National Institute for Occupational Safety and Health (NIOSH) is a part of the United States Department of Health and Human Service's Centers for Disease control. NIOSH is the sole U. S. Agency who's role is to improve occupational safety and health through research and education. Its Pittsburgh Research Laboratory occupies over 100 acres and employees over 200 people. Beginning in 1910, It has a long history of producing practical solution to some of the most vexing safety and health issues in mining. It continues that proud history today with a world class staff representing a wide range of disciplines, including engineering, epidemiology, industrial hygiene, chemistry, physics, geology, psychology and sociology, and world class facilities that enable it to address complex safety and health problems. The PRL executes a wide range of research topics including expertise in dust, and diesel particle monitoring and control, explosives, fire and explosion prevention and response, ergonomics and machine safety, electrical safety, ground control, mine ventilation and training. It also tracks injury and illness in mines via a surveillance activity and actively addresses the issue of the possible positive or negative impact of emerging technologies on occupational safety and health.

This presentation will provide brief overviews of PRL and the U.S. mining industry. It will then report in some depth on a NIOSH/PRL – Department of Energy funded study of critical technologies in the mining industry. The study, New Forces at Work in Mining – Industry views of Critical Technologies study "that was completed by the RAND Corporation. Critical developments that are expected in the industry were derived from the views of leading representatives of 58 mining firms, equipment manufacturers, research organizations and other entities. These critical technologies will be discussed as four priority areas: 1) Information and communications technologies for process optimization, 2) Remote control and automation, 3) Operations and maintenance, and 4) Unit operations capabilities.

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- www.Rand.org/publiations/MR/MR1324/
- www.cdc.gov/niosh/

THE DISTRICT OF GOSLAR: ONE THE WORLD'S MOST IMPORTANT MINING AREAS IN FORMER TIMES AND A SEVERE ECOLOGICAL BURDEN TODAY; HOW CAN THE COMPETENT AUTHORITY COPE WITH SUCH A HERITAGE?

Juergen Bauer
Germany

1. ABSTRACT

The district of Goslar is an area of 965 km² in the state of Lower Saxony, Germany. The development of the mining and smelting industry began 1,000 years ago. Altogether approximately 68 million tons of ores were extracted. At the beginning of the 20th century 1 to 2 % of the world's production of lead and zinc came from this area. About 6 % of the residential area is now dangerous waste area. They are contaminated with lead, cadmium, arsenic, and zinc. Because of the continual emission, within 36 % of the residential areas, the topsoil is polluted at levels of 1,000 mg of lead or 150 mg of arsenic per 1 kg of soil.

The groundwater in the District of Goslar is contaminated in some areas. The severity of the environmental problems have forced those responsible for the soil damage or contaminated sites to cooperate together with land and lease owners and the environmental authority. The authority institute practical and innovative ways to eliminate pollution.

2. EXAMPLES OF ACTIONS TAKEN

Evaluate whole areas of former industrial locations that are highly contaminated. The result would be to negotiate a binding "Public Law Contract", within the obligatory steps of investigation and planning for remediation and the goals would be defined.

3. COLLABORATIONS WITH TECHNICAL UNIVERSITIES, COLLEGES, AND OTHER INSTITUTIONS

Combine remediation projects with the development of new areas. To insure a healthy standard of living and continued use of the contaminated soil, the authority has passed the ordinance "Plans for Soil Areas ". It´s the first in Germany, in which standardized rules and measures of use are established for the landowner. Work together with general puplic, the regional parliaments, the local councils, and media in order to achieve the goals for remediation.

4. CONTACT

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RISK REDUCTION OF MINING ACCIDENTS IN THE TISA BASIN

Adriana Eftimie
Romania

1. ABSTRACT

The 2000 tailing disposal facilities accidents in the Baia Mare region heightened concern in the international community that tailing facilities represent a major risk to the environment, both in the short- and long-term. They have increased public awareness of the environmental and safety hazards of the mining industry and have shown that the risk assessment and prevention of tailing dams pollution accidents have to improve. While the catastrophic releases provide heightened awareness, the continuous erosion of mine tailings and unprotected mining and spoil disposal areas during high precipitation events and flows could have a far greater impact on the environment and also raises concern.

After the two accidents in the Maramures region, the Government decided to amend its legislation to address the safety of tailings storage facilities and is committed to improve the environmental performance of the mining sector. A comprehensive Mining Sector Environmental Assessment (MSEA) has been recently completed, and provides a baseline evaluation of the mines throughout the country. The MSEA has identified that a large number of operating mining sites require urgent environmental rehabilitation of their tailings and waste storage facilities to avoid catastrophic and continued releases of highly persistent toxins, thus reducing the risk of mining accidents with long-term environmental consequences.

The presentation refers to the upcoming “Hazards Risk Mitigation and Emergency Preparedness” Project, co-financed by the World Bank, GEF and Romanian Government. One of its component is “Risk Reduction of Mining Accidents in the Tisa Basin”, which will support the implementation of pilot projects for improving the safety and management of tailing and waste facilities, thus reducing the risk for catastrophic release introduction of contaminants into surface waters contributing to the Tisa and Danube.

2. CONTACT

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Director PIU
National Agency for Mineral Resources

MINING REMEDIATION TECHNOLOGY DEVELOPMENTS AND INFORMATION RESOURCES

Walt Kovalick
United States

1. ABSTRACT

This presentation examines the Environmental Protection Agency's (EPA) programs and related efforts to develop new remediation technologies for treating the environmental problems created by abandoned mines. Abandoned mines pose an environmental threat that goes beyond pure aesthetics. Acid mine drainage (AMD) and heavy metal releases contaminate the run off water from such sites. These releases can result in contamination of surface and ground water, disruption of ecosystems, and changes to groundwater regimes.

The EPA/DOE Mine Waste Technology Program is the principal agency program designed to find an effective solutions to the problems caused by abandoned mines in the environment. **Since 1991 the program has been funded by the two federal agencies at levels of $2.5 – $7.5 per year and managed by Montana State University.** The focus is on development and demonstration of innovative technologies at the bench and pilot scale stages in three priority areas: source controls, including in-situ, "end of pipe" treatment technologies, and source recovery.

Two of the more promising case studies from the program are presented: The first was a two-stage bioreactor able to neutralize the AMD without clogging the reactor with metal precipitants. The second was a permeable reactive barrier designed to treat arsenic contamination using passive treatment; this approach would be ideal for remote mine locations.

The presentation also provides information on one of the five Hazardous Substance Research Centers (HSRC) in the U.S; this center includes a consortium of participants working towards improving the technology and cost effectiveness for treatment of AMD and heavy metal runoff. The presentation also details the results of a 10 week research project on the abandoned mine issue developed by an EPA NNEMS intern. To receive more information on EPA's efforts on developing a viable treatment of AMD and links to other helpful resources, visit EPA's Technology Innovation Program's website at http://www.cluin.org.

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3. FOR MORE INFORMATION

For more information, visit these links:

- www.epa.gov/ORD/NRMRL/std/mtb/mwtphome.html
- www.engr.colostate.edu/hsrc
- www.cluin.org

THE ROSIA MONTANA PROJECT: HOW A GOLD MINING INVESTMENT GIVES HOPE TO THE ENVIRONMENT

John Aston
Romania

1. ABSTRACT

The Rosia Montana gold and silver epithermal ore deposit is situated towards the top of the Rosia Montana valley in the Apuseni Mountains in west-central Romania. The Rosia Montana gold and silver ore deposit has been mined for over 2000 years. This was a jewel in the crown of both the Roman and the Austrian-Hungarian Empires. More recently the site has gone through over 40 years of state-owned underground and open-pit mining, with few environmental controls. Together these activities have created a network of underground workings totalling more than 140 kilometres of tunnels, and are now an extensive source of Acid Rock Drainage (ARD) in the region. The name “Rosia Montana” meaning “Red Mountain” is partly due to the colour of the exposed leached rocks of the mountain but mainly due to the red streams flowing down its valleys.

With the recent period of economically and environmentally non-sustainable operation drawing to a close, the Rosia Montana mine is being privatised and redeveloped. The management of the new mine is faced with the dual task of remediating two thousand years of aquatic pollution and complying with current or foreseen Romanian, EU and World Bank environmental standards.

This paper identifies the major sources of pollution and shows how the project will manage this environment in such a way as to not only remediate the years of historical pollution but also to meet or exceed the requirements of all Romanian and EU environmental regulations.

2. CONTACT

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OBSERVATIONS ON MINE LIFE CYCLE ISSUES AND ACID DRAINAGE

Dirk Van Zyl
United States

1. ABSTRACT

The stages of the mine life cycle are: exploration, development (including baseline studies, environmental impact assessment, financing, final design and construction), operations, closure, and post-closure. Modern mines are designed to protect or enhance the environmental and community wellbeing at the post-closure stage. Until the 1960's it was common to consider the end of operations as the end of the mine life cycle and many mines were abandoned without any reclamation. Mine reclamation became standard practice in the 1970's and 1980's and the philosophy of "designing for closure" has been actively practiced since the 1990's. Designing for post-closure place certain expectations on the mining company and the engineers and scientists involved in the enterprise. Much will be learned about this approach in the upcoming decades. The results of a number of heap leach closure workshops are available on www.unr.edu/mines/mlc.

Acid drainage is by far the largest environmental issue that faces the mining industry. Site characterization and identification of the problem is extremely important during the exploration and development stages of the mine life cycle. Unfortunately many operating mines are faced with this problem without having identified it earlier in the life cycle. Mitigation strategies must then be developed to limit the environmental impacts. These may often have significant economic impacts on the operations. Mitigation strategies for acid drainage are divided into three categories: source control (controlling the availability of one of air, sulfur or water), migration control and treatment. The latter two strategies have received much attention through the design and construction of cover systems, water management systems and active and passive treatment systems. Source control in the form of passivation of the sulfides is a promising area of future acid drainage controls. DuPont donated a patent for permanganate passivation to the University of Nevada, Reno. Since 1999 laboratory research and field scale tests have shown the effectiveness of this technology. Water quality results of effluent from a pilot scale test at the Gilt Edge Superfund site in South Dakota, that was partly sponsored by Region 8 of the USEPA, show that discharge from the passivated materials satisfy effluent standards for pH, sulfates, and metals. The effectiveness of the treatment is better than 99 percent when compared to the controls.

International cooperation on acid drainage issues is developing. The International Network on Acid Prevention (INAP) has established a network for cooperation with the Acid Drainage Technology Initiative (ADTI) in the USA, the Mine Environmental Neutral Drainage (MEND) program in Canada and the Australian Centre for Mining Environmental Research (ACMER). Links to these activities can be found at www.unr.edu/mine/adti.

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- www.unr.edu/mines/adti
- www.unr.edu/mines/mlc
- http://ecorestoration.montana.edu
- http://eippcb.jrc.es-activities-public

ROMANIAN MINING INDUSTRY AND ENVIRONMENT PROTECTION: NON-FERROUS MINING INDUSTRY

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Romania

1. ABSTRACT

Romania has a surface of 237.500 km2 and a population of 21,5 million inhabitants.
The mining industry in Romania has been practiced for more than 2000 years. The first written document dates from the year 132 ad, and it was found in Rosia Montana (Alburnus Major), Alba county. In the Romanian mining industry work in present 96 economics agents, out of which:

- 3 national companies for coal which have 40 mining branches;
- 2 national companies for polymetalic, gold and silver ores which have 44 mining branches;
- 7 societies for non-metal ores;
- 10 societies for geological research; and
- 5 research institutes.

The general legal framework that regulates the environmental protection in the mining sector consists in:

- Waters Law nr.107/1996;
- Environmental Protection Law nr.137/1995 including modifications and additions, and subsequent regulations;
- Safety Dams Law nr. 466/2001 and subsequent regulations;
- Prevention and Integration Control of Pollution Law nr.645/2002 and subsequent regulations; and
- Seveso Governmental Decision nr.95/2003.

The mining industry impact on the environment refers to the following aspects:

- Emission of pollutants in air (NOx ;CO; SiO2 ;SO2);
- Emission of pollutants on surface and ground waters (heavy metals, sulfates, chlorites, carbonates and others);
- Soil pollution;
- Hydrological changes in the area;
- Landscape changes in the area;
- Occupation of a large area of terrain for the exploitation activity, industrial facility, waste deposits and tailing dam;
- Disturbing of natural habitats;
- Affects cultural and historical sites;
- Vibration effects caused by explosions; and
- Long term effects over the environment during activity and after the closure of the mining activity.

The main treatment method of the flotation wastewater is based on the chemical neutralization and sedimentation of the tailing within large tailing ponds. The first tailing dam was built in 1961 and now there are 109 tailing dams out of which 50 are operational.
The Tailing disposal site types are:

- Valley disposal sites – 40 tailing dams;
- Slope disposal sites – 45 tailing dams; and
- Flat disposal sites – 24 tailing dams.

In the last period of time, the closure of inefficient mines and rehabilitation of mining sites starts to become an important activity with regard to the environmental protection. In the period of 1990-2002 more than 200 mining sites were proposed for closure.

The costs for the closure of these mining sites are over 300 million USD, this closure operation being financed by the state budget and by the loan from the World Bank.

The World Bank financed the elaboration of a Manual for the closure of the mining sites; M.E.C., M.A.F.W.E. and N.A.M.R approved this manual.

2. CONCLUSIONS

- The mining activity has a strong impact on the environment;
- The environmental problems have been accumulated in time;
- The financial efforts for the closure of the mining sites and rehabilitation are high;
- Every year it's necessary to assure the operational costs for the treatment plant for the acid drainage from the budget;
- The state has to assure the necessary funds for the safety of the tailing dams and waste deposits; and
- It's necessary to monitor the acid drainage and to mitigate this phenomenon.

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4. FOR MORE INFORMATION

For more information, visit this link:
www.mappm.ro

NATO/CCMS OVERVIEW

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Belgium

1. STRUCTURE OF PUBLIC DIPLOMACY DIVISION, THREATS AND CHALLENGES SECTION

2. MAIN ISSUES

3. CHARACTERISTICS

CCMS established in 1969 as a complementary committee with the Science Committee and to give a new "Social and Environmental" dimension for Alliance:

- Intergovernmental and open-ended cooperation (governments decide nature of their representation, including institutes and universities)
- Work is carried out on decentralized basis (bottom-up approach)
- It provides a forum for exchange of views in social, health and environment (in particular defense-related environmental problems)
- Nationally funded
- Voluntary participation
- Suggestions and recommendations to North Atlantic Council
- Regular Committee of the Council (Chairman is Assistant Secretary General for Public Diplomacy), which meets twice a year in plenary session

4. MECHANISMS

- Pilot Studies (3-5 years)
- Short Term Projects (12-18 months)
- International Conferences, workshops, seminars, round tables
- Funded by the Pilot Country
- Participating NATO Countries cover the expenses of their experts
- Participation of experts from Partner Countries partially covered by NATO/CCMS

5. KEY OBJECTIVES

- Reducing the environmental impact of military activities
- PS on "Forms of Environmental Education in the Armed Forces and their Impact on Creation of Pro-environmental Studies" (Poland/Canada)
- Conducing regional studies including cross-border activities
- PS on "Assessment of Natural Hazards" (Canada)
- PS on "Clean Products and Processes" (USA)
- Addressing emerging risks to the environment and society
- PS on "Environmental Decision-Making for Sustainable Development in Central Asia" (USA)
- Preventing conflicts in relation to scarcity of resources
- PS on "Integrated Water Management" (Belgium)
- Addressing non traditional threats to security
    - PS on "Security of narrow waterways"
    - PS on "Food Chain Security"
    - PS on "Effective risk response strategies"

6. FRAMEWORK FOR INTERNATIONAL CO-OPERATION IN NATO/CCMS

- EAPC Action Plan
- NATO-Russia Founding Act
- NATO Ukraine Charter
- Mediterranean Dialogue

7. NEAR FUTURE

Two important workshops will be held in 2003 and 2004 in the framework of CCMS:
Mediterranean Dialogue: “Desertification, a security issue”
(2-5 December, Valencia, Spain)

Mongolia: “Rehabilitation of former military sites”
(Spring 2004, Ulaanbataar)

6. FOR MORE INFORMATION

For more information, visit this link:
www.nato.int/ccms

NON-FERROUS MINING IN CANADA

Lisa Keller
Canada

1. ABSTRACT

Mining is a principal economic resource in Canada. Potash and uranium are primary products, followed by nickel, zinc, cadmium, aluminum, silver, titanium, copper, gold, molybdenum and salt. Today Canada is the world's largest producer of nickel and potash and fifth-largest producer of diamonds. However, more than a century and a half of mining has left a legacy of mine sites and environmental challenges with a variety of contaminants and Acid Mine Drainage (AMD). Canada is making efforts to address the legacy of the past and to ensure that similar contamination does not occur in the future.

2. CHALLENGES

As a nation, Canada is challenged by long distances, climate and governance issues. With over 9 million square kilometers of land, we are second in size to Russia. Provinces of Ontario and Quebec are each larger than most European countries. As well, the remote locations of many of our sites often limit the application of conventional remediation technologies. Our extreme climatic conditions also hinder cleanup programs. The northern regions of Canada experience inhospitably cold weather during the winter months, with average temperatures in the range of -25C to -35C. These extreme temperatures also limit the construction season to only a few months in the year and often require the construction of ice roads to transfer site remediation equipment and supplies. Most contaminated sites in these remote areas are the result of uncontrolled activities of former military sites, and abandoned or insolvent mines. Negotiated treaty rights with Aboriginal peoples have placed the environmental management of contaminated lands north of the 60^{th} parallel, or, "North of 60", under the responsibility of the federal government. Most of the land south of the 60 falls under the jurisdiction of the provinces.

3. RESPONDING TO THESE CHALLENGES

Mining effluent in the North is currently one of Canada's important challenges. Contaminant quantities are very large and extend over large areas. Communities living close to these mine sites often rely on surface or ground water resources and on fish and wildlife for food, such as Aboriginal people who traditionally live off the land.

In the past, mining companies in Canada were not required to set sufficient funds aside to cover the costs for the eventual cleanup and closure on mine sites. Prior to 1993, financial security for environmental restoration relating to mine closures in the North was limited. However, these limits have since been lifted and the federal government now requires all mine operators in the north to establish a reclamation bond.

4. FEDERAL REGULATIONS ON CONTAMINATED SITES

Although there are no federal laws in place that specifically address the designation and remediation of contaminated sites, the *Fisheries Act* and the *Canadian Environmental Protection Act* protect the environment from further damage and the Canadian Council of Ministers of the Environment (CCME) have established guidelines for the identification and management of contaminated sites. Most provinces and territories adopt many of the CCME guidelines although many have developed their own specific policies or regulations according to their needs.

5. METAL MINING EFFLUENT REGULATIONS

Metal mining effluent is regulated in Canada under the *Fisheries Act* (1985). In 2002, these regulations were revised in cooperation with the Mining industry; Aboriginal peoples, environmental non-governmental organizations; and provincial and territorial governments, as a further step to establishing guiding principles and promoting best practices in maintaining sites and protecting human health and the environment. The Metal Mine Effluent Regulations (MMER) apply to all metal mines in Canada. Under the new regulations, "effluent" is defined as mine waters, milling facilities, tailings impoundment areas, treatment ponds, or treatment facilities with seepage and surface drainage as a toxic substance. When the revised guidelines came into force a year ago, the limits for metal and cyanide releases were modified to prevent the discharge of effluent that is acutely lethal to fish and limits were modified for Total Suspended Solids (TSS) and pH. The revised regulations also require mines to conduct Environmental Effects Monitoring (EEM) Programs.

The modified MMER uses an ecosystem approach to environmental management and promotes the concept of sustainable development. These regulations will create comprehensive and inflexible national environmental standards that all Canadian metal mines must adhere to, including those mines opened prior to the date that the new laws came into effect.

6. MINES MINISTERS CONFERENCE

In 2000, various governmental and non-governmental organizations and the mining industry recommended that a workshop on abandoned and orphaned mines be held to review and identify key concerns and priorities for action on this issue. This workshop has now become an annual conference for Mines Ministers from federal and provincial governments. Priority issues in 2002 included the development of a national inventory; the setting of standards and rational expectations; formation of Aboriginal-Industry Partnerships, documentation of funding approaches; and, encouraging research and development in identifying new industrial uses for gold and to promote its use.

As a result of the 2002 conference, a database of abandoned mine sites across the country is also being developed. There are an estimated 10,000 abandoned mine sites in Canada. These sites, however, are not well documented with respect to their numbers or risks to human health and the environment. This inventory, once completed, will enhance our knowledge base which is imperative for the effective management of these lands.

7. SUMMARY

Canada has made significant progress in the prevention of future contamination at mine sites. However, continued development and application of innovative approaches along with long-term commitments are essential to ensuring the management of human health and environmental risks at these sites.

8. FOR MORE INFORMATION

For more information, visit these links:

Federal Government

Department of Justice (Canada): Metal Mining Effluent Regulations
http://laws.justice.gc.ca/en/F-14/SOR-2002-222/120314.html

Mines Ministers of Canada: Action Plan 2002
http://www.nrcan.gc.ca/mms/mmc/2002/aplan02_e.PDF

Abandoned Mine Sites of Canada
www.abandoned-mines.org

Contaminated Sites Management Work Group: Risk management Information and definition
http://www.ec.gc.ca/etad/csmwg/pub/risk_mgmt/en/toc_e.htm

Natural Resources Canada (NRCan): minerals and metals sector index and links for more information
http://www. nrcan.gc.ca/mms/mmi/l_e.htm#bp

(NRCan) summary of Canada's position in today's global mining industry
http://www.nrcan.gc.ca/communications/facts/factsnat_e.html

(NRCan) Canadian mining FAQ's and other information resources
http://www.nrcan.gc.ca/mms/topi-suje/min_e.htm

Office of the Auditor General (OAG): Links to reports regarding contaminated sites issues and other environmental concerns
http://www.oag-bvg.gc.ca/domino/reports.nsf/html/c20021000aae.html

Chapter 3 of the Report of the Commissioner of the Environment
http://www.oag-bvg.gc.ca/domino/reports.nsf/html/c20021003ce.html

Non-Governmental Organization

Mining Watch Canada
http://www.miningwatch.ca/

Mining Association of Canada: state of Canadian Mining and other information
http://www.mining.ca/english/publications/denver.pdf

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PILOT STUDY MISSION

NATO/CCMS Pilot Study: Prevention and Remediation Issues in Selected Industrial Sectors

1. BACKGROUND TO PROPOSED STUDY

The current NATO Pilot Study on technologies for cleanup of contaminated land was completed in 2002. The pilot study was concluded for several reasons. The primary reason is that general information on technologies, processes, and methodologies for the cleanup of contaminated land and groundwater has been discussed and distributed by the pilot study in its meetings and annual reports. Thus, the goal of the pilot study has been accomplished. There is ongoing interest by participating countries and countries with developing contaminated land programs to continue a dialogue, to focus on specific industrial sectors, and to maintain technical contacts and information flow provided by the current "network" of pilot study participants. Thus, a new pilot study is proposed to allow this long-standing global network on contaminated land to continue.

2. PURPOSE AND OBJECTIVES: NEW PILOT STUDY - SECTORAL APPROACH

Much of the work of the past pilot study on contaminated land has drawn on case studies of technologies applied to a wide variety of industrial and land contamination settings. While useful for explaining the basis for the technology, its costs, and applicability, the information available is not focused on certain problems or site types at a variety of scales, contaminant concentrations, geological conditions, etc. Thus, the current pilot study is a "technologist's" view of characterization and remediation approaches.

Of more relevance to governments, industry, and the remediation services industry is interpretive information about the measurement and clean up of certain contaminants in specific industrial sectors in a variety of hydrogeological settings and levels of severity of risk. In addition, environmental protection has embraced more holistic concepts of preventing problems as a first priority. Thus, methods for preventing pollution (both by process changes and by land use and planning initiatives) coupled with remediation efforts are a priority for new and existing industrial development and for newly industrializing countries. This "integrated" approach can positively affect land and groundwater contamination as well.

Thus, a new CCMS Pilot Study entitled **Prevention and Remediation Issues in Selected Industrial Sectors** is proposed. The purpose of the proposed pilot study would be to define and explore best practices for reducing the health and environmental impact on soil and groundwater from industrial sectors of interest (e.g., metals mining, organic chemical production, gasworks, and fertilizer manufacturing) as well as other unique site "types" (e.g., old landfills, privatization sites [i.e., facilities transitioning from former state ownership in certain categories], mega sites [i.e., large-scale former industrial and mining facilities], and shoreline sediment sites). In reviewing case studies as well as experience from the current pilot study on contaminated land and other sources, the proposed pilot study may be able to assess or benchmark "what is easy to clean," "what is difficult to clean," and "what is impossible, at reasonable cost, to clean."

3. SCOPE OF WORK

The duration of the proposed pilot study is three (3) years. The study would commence by selecting industrial sectors. The pilot study meetings would be devoted to the techniques and technologies for preventing and avoiding discharge to soil and groundwater as well as measurement and remediation for that industry sector or site type. Countries would nominate expert speakers on such topics as industrial operations; problem definition and risk assessment; measurement and monitoring strategies; and remediation approaches for both soil and ground water. These speakers could represent many stakeholders - including industry, government, technologists, and consultants. The pilot study would seek to engage industry and other private sector organizations at the transnational level in sharing and

evaluating technical information. The unique contribution of the pilot study would be measured by its ability to synthesize information regarding best practices, successes and failures, and uncertainties for the sectors of interest.

A typical pilot study meeting would explore topics such as:

- Industry overview and assessment including typical waste stream and contamination issues
- Risk assessment methodologies
- Preparedness and planning issues
- Site characterization and monitoring approaches
- Prevention and remediation strategies including technologies and methodologies
- Institutional, financial, and public participation aspects of prevention and remediation

In addition, countries would be given the opportunity to present a general update of prevention and remediation activities via a *Tour de Table* as well as to provide country-specific industrial sector information. A limited number of countries would be selected to provide these detailed updates at each meeting.

It is proposed that the industrial sector of interest would be matched to the special interests to the potential host country for the meeting. Thus, host countries would have primary responsibility for involving industrial sector representatives and, possibly, developing a field visit to the affected sector.

4. ESTIMATED DURATION

Pilot Study Meetings:	September 2003 - September 2005
Completion of Final Report:	Spring 2006

5. PRODUCTS

An industrial sector report will be developed after each meeting. These reports will include invited papers from the industrial sector assessments as well as summary information on the monitoring and evaluation of risks and strategies for prevention and remediation. Country update reports will also be included.

6. NON-NATO PARTICIPATION: BALKANS, CENTRAL ASIA AND OTHER DEVELOPING COUNTRIES

In 2001, NATO/CCMS identified key objectives that would assist developing countries. These objectives include:

1. Reducing the impact of military activities

2. Conducting regional studies including cross-border activities

3. Preventing conflicts in relation to scarcity of resources

4. Addressing emerging risks to the environment and society that could cause economic, cultural and political instability

5. Addressing non-traditional threats to security

The proposed pilot study, *Prevention and Remediation Issues in Selected Industrial Sectors*, specifically addresses #4 and also covers aspects of #'s 1, 3, and 5. The proposed pilot study would target specific industrial sectors based upon interests of countries with newly industrializing and developing economies. The study would provide these countries with a base of technical information and with a network of

experts from whom to obtain advice. This proposal offers the opportunity for current pilot countries to continue networking and information sharing, and also provides a focus for discussions driven by partner country needs.

7. Request for Pilot Study Establishment

It is requested of the Committee on the Challenges of Modern Society that it approve the establishment of the *Prevention and Remediation Issues in Selected Industrial Sectors Pilot Study.*

Pilot Country:	United States
Lead Organization:	U.S. Environmental Protection Agency
Proposed Sector/Schedule:	Sector: Metals/Mining Sector
	Date: September, 2003
	Host Country: Romania
	Location: Baia Mare, Romania