POTENTIAL ENVIRONMENTAL IMPACTS OF MINING

A SHORT ILLUSTRATED REVIEW

BY

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1) INTRODUCTION
nature of mining sources & mining life cycle

2) SET OF EXAMPLES
   MINING METALS
   CONCENTRATING METALS
   REMOVING IMPURITIES

3) OTHERS ASPECTS
   ancient mining & abandoned mines
   socio-economic impacts & public safety
   positive impacts

4) CONCLUSIONS
   how science & technology can help?
INTRODUCTION

Some facts on the nature of mining sources

- Mining has been an integral part of the development of civilization
- Early mining operations have left a historical legacy of negative environmental impacts that affect our perception of mining

- A mine is a waste management project = A new paradigm to meet the global objectives for sustainable development in the 21st century
  - 95% of the material excavated from a mine are waste materials generally left at the surface
  - Some large operations handle more material and generate more waste than many entire industries

- Major impacts are resulting of negative changes in geochemistry over time, when a material’s environment changes (e.g.: from a reducing environment to an oxidizing one...)

INTRODUCTION (2)

Some facts on the nature of mining sources

- This long-term nature of mining impacts requires that predictive tools, design performance, monitoring, be effective for many decades.

- Potential Environmental Impacts are greatly influenced by geological factors:
  - deposit size
  - host rocks lithology & wall rock alteration
  - nature of ore & trace element geochemistry
  - ore & gangue mineralogy and zonation
  - secondary mineralogy
  - topography, physiography & climate
  - hydrology
  - mining & milling methods employed
  - ...
Simplified Mining process and global Impacts on water

Rainfalls
Waste rocks
Leaching
Extraction
Mine water discharge
Ore processing
Smelting
Tailing dams
Seepage
Water wells
Modified pathways
Mining Life Cycle

PROCESS

MINERAL DEPOSIT
- Open pit or underground mining

ORE
- Mining metals

Leaching

Milling

WASTE

NATURAL LEACHING

DISUSED MINES

WASTE ROCKS

DUSTS

EFFLUENTS

TAILINGS LEACHATE PONDS SLAGS

MEDIA AND HAZARD

LAND
- Land degradation
- Land fragmentation
- Soil disruption
- Soil contamination
- Erosion

WATER
- Groundwater table alteration
- Spring and borehole yield
- River or surface water diversion
- Turbidity
- Contamination of rivers
- Acid Rock Drainage (ARD) Tailings

Concentrating metals

METALS IN SOLUTION

CONCENTRATES
Mining Life Cycle (2)

**PROCESS**

- **METALS IN SOLUTION**
  - Solvent extraction
  - Electro-winning

- **CONCENTRATES**
  - Smelting (pyrometallurgy)

- **BLISTER METAL**
  - Refining

- **WIRE BARS**
  - Fabrication

- **METALS IN CATHODES**
  - Fabrication

- **METALS PRODUCTS**
  - Removing impurities

**WASTE**

- **SULPHURIC ACID**
- **AIR EMISSIONS**
  - Carbon oxides
  - Sulphur oxides
  - Nitrogen oxides
  - Methane
  - CFOs
  - Dusts (radioactive, toxic or nuisance)

- **SLAGS**
- **DUSTS**
- **SCRAP METALS**

**MEDIA AND HAZARD**

- **AIR**
  - Heat
  - Noise
  - Vibration

Modified from warhurst 1999
Main Surface Components of a Mine Site in Activity

- Open pit
- Waste dumps
- Overburden dump
- Tailings dams
- Processing plant
- Railway
Mining metals (1)

Physical disturbance to the landscape

Sibai copper mine (Russia)
Mining metals (2)
Waste Rock disposal

Uchaly copper mine (Urals / Russia)
Mining metals (3)

Erosion of waste rocks dumps

Tentative of revegetation

Sibai copper mine (Russia)
Mining metals (4)

Erosion and sedimentation process

Rosia Poieni mine (Rumania)

La Baume Pb / Zn ancient mine (France)
Mining metals (5)

Acidic and metals-bearing soils and water

Assarel copper mine (Bulgaria)

Rosia Montana gold mine (Rumania)
Concentrating Metals (1)
Accumulation of Tailings containing residual chemicals

Pyrite-rich tailings impoundment in Russia
Concentrating Metals (2)

Erosion of Tailing Dumps by Wind and Water

ENGUIALES Tungsten mine ( France )
Concentrating Metals (3)
Production of Acid Mine Drainage

Plant tailings
Acidic water
pH = 2.5

Karabash area (Russia)

Rosia Poieni (Rumania)
Concentrating Metals (4)

Effects of Acid Drainage

Calimani Mine (Rumania)

Rosia Poieni (Rumania)

Overburden dumps

River bed destruction

Surface water quality degradation
Concentrating Metals (5)
Gold Cyanide Heap Leaching

Gold heap leaching Pilot test
Mining and Concentrating Metals (6)

Cumulative Impacts

*Karabash mining area (Russia)*
Removing impurities (1)
Smelter stack emissions and release to air

Karabash copper smelter (Russia)
Removing impurities (2)
Metals and dissolved pollutants from slags disposal and release to water

La Lucette Sb smelter (France)

Metallurgical slags

Precipitation of salts

Drainage ditch

0.8 g/l Cu
1.6 g/l Zn

Zn smelting plant (Russia)
Potential variations of impacts after a mine closure

Potential variations in impacts from hazardous mine waste after a metal mine is closed
Socio-economic impacts and ancient mining
Abandoned facilities at the surface

Sentein Pb,Zn, Ag ancient mine (France)
Socio-economic impacts and old mining sites

Physical stability

Lorraine (France)
Socio-economic impacts and public safety
bioaccumulation in the food chain

Carnoulés (France)

Uchaly (Russia)
Positive impacts: metals empower us
Conclusions (1)

Providing metals and raw materials for the future

The demands for both minerals and metals are expected to increase in the decades ahead (world population growth and rising standards of living…)

New challenges and balanced approaches for mineral supply and environmental protection needed

Society’s expectations and the future of the mining industry require that the long-term environmental impacts of mining be adequately addressed
Conclusions (2)

Protecting the environment and human health

PREVENTION is the key

- dumping sites and tailing dams management and reclamation
- water management and treatment
- reduction of acid rock drainage
- control of dust and gaseous emissions
- recycling
- ...

Conclusions (3)
How Science and technology can help?

The example of MINEO PROJECT

Developing more efficient and cost-effective tools based on Earth Observation Methods for handling mining-related environmental impacts and risks at regional scales

- **identification**, **characterization** and **mapping** of surface physical and chemical disturbances:
  - landscape patterns = surficial indicators of processes

- **detailed mapping** in a risk assessment perspective of sources of pollution, migration pathways, endpoints and population / ecosystems potentially at risk

- **definition** of contamination model and monitoring programme...