# Mining Waste Management in Europe

## An overview of some key aspects on regulation and environmental issues

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Symposium on Mining Waste Management

**ANTALYA, April 20th**

# Scope

- Context and issues in mining in the EU
- The nature of mining waste
- The mining waste facilities issue
- Why the EU Mining Waste Directive had to come !
- Mining waste definition
- Mining waste characterisation
- Rehabilitation programmes for closed mines sites and waste facilities
- Best practices for active mines
- What about reuse and recycling ?

# Context and Issues of Mining in EU

The mining industry still has significant importance for the European economy as well as significant impact on its ecology and regional development.

European consumption of metals depends to a large extent on mines operating outside Europe

- For ex: 60 % of Turkish mining production is exported to EU

Industrial minerals are generally mined and consumed within the European Union

The EU has no competence related to mineral resources and mining. It currently cannot develop a mineral resources policy and/or a European mining code but

It has competences in a number of fields that are of high relevance to the EU mineral resources

- Environment
- Energy
- Research & Development, etc…

# UE dependence on minerals and metals imports (2009)

Data sources: USGS, BGS, BRGM, PGI, WMD

| | | | |
|---|---|---|---|
| Antimony | 100% | Vanadium | 100% |
| Beryllium | 100% | Phosphate | 92% |
| Boron | 100% | Rhenium | 90% |
| Cobalt | 100% | Nickel | 86% |
| Molybdenum | 100% | Iron | 83% |
| Niobium | 100% | Bauxite | 80% |
| Platinum group | 100% | Zinc | 80% |
| Rare Earth | 100% | Tungsten | 76% |
| Tantalum | 100% | Lead | 76% |
| Titanium | 100% | Copper | 74% |
| Germanium | 100% | Chromium | 53% |

Figures shown on a red background show metals of which China is the 1st global producer

# Context and Issues of Mining in EU

There is no EU mineral resources policy but a set of 27 diverse national mineral resources policies and legislations, while the EU, and the rest of the world, is facing the strong and growing competition from China

Green procurement and the transparency of supply-chains is likely to be strongly developed by the EU

ISO 14001 certification of mines and plants, reporting according to GRI and EITI compliance may become compulsory to enter the EU market

Mining Waste accounts for about 28% of the total waste stream in EU

# The nature of Mining Waste

- **Mines generate huge quantities of waste**
  - More than 90 % of the materials excavated are waste materials
  - Main difference with other industries
  - Generally left at the surface for ever !
  - E.g.: uranium production in France has yielded 50 million tons of wastes for only 75 000 t of concentrate
  - Some are **harmless** other are **harmful** for the environment and the public health
- **The issue of mining waste management still perceived differently than the others industries despite vastly larger quantity of solid wastes; reasons:**
  - Perceived benign nature of mine wastes
  - Perceived activity as civil works or earth moving rather than a processing industry
  - Remoteness from population (?)
  - Apparent success in Mine Waste Management
  - Other…

# Some facts on the nature of mining waste

**Major environmental 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…)**

- This is mainly the case when we are removing materials from underground and when they are disposed at the surface through the extraction process

**Ore processing methods introduce new changes within those materials**

- Size reduction and generation of fines (increase of the reactive surface)
- Addition of chemicals reagents (in the case of chemical treatments for ex)

**This implies that the resulting materials ("mining waste") may have direct impact on the receiving environment**

- Water bodies
- Soils
- Air
- Populations

# Some facts on the nature of mining waste

**Potential Environmental Impacts are greatly influenced by geological and industrial 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 & ore processing methods employed

**Summarized in GEOENVIRONMENTAL MODELS (USGS)**

**Used for predicting and managing potential impacts**

- Establishing of **pre-mining baseline conditions (the geochemical background)** during exploration phase
- Mine planning and development - Rehabilitation
- Abandoned mine lands issues

# The Mining Waste Facilities issue

**Most significant liability of a mine**

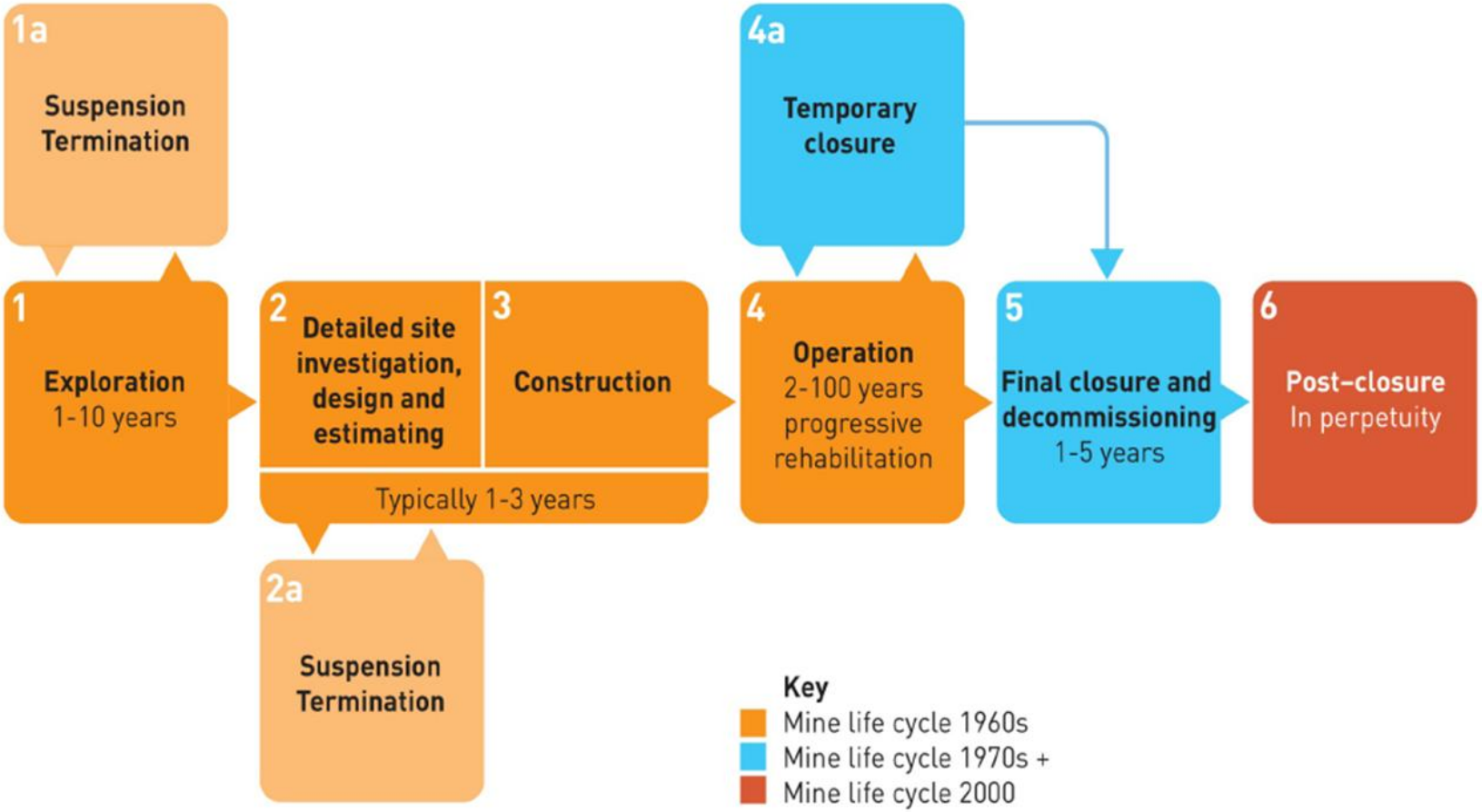
**Costs for governments, communities, industry and environment**

**Mining waste should remain chemically, physically and geographically stable for perpetuity**


# The Mining Waste Facilities issue

- **Significant engineering challenges to meet an ever more complex array of environmental requirements, social expectations, corporate policies and statutory demands**
- **Potential environmental risks depend on:**
  - Waste properties and quantities
  - Waste disposal design and construction techniques
  - Environmental status at the disposal site (land use, hydrogeology etc)
- **How to ensure "long-term" integrity and stability of MWF?**
  - In particular in the context of the **climate change** (by taking into account water availability or more frequent extreme climatic events/floods)
  - Mining waste storage facilities should be investigated and designed to similar levels of care as that of **civil engineering structures**

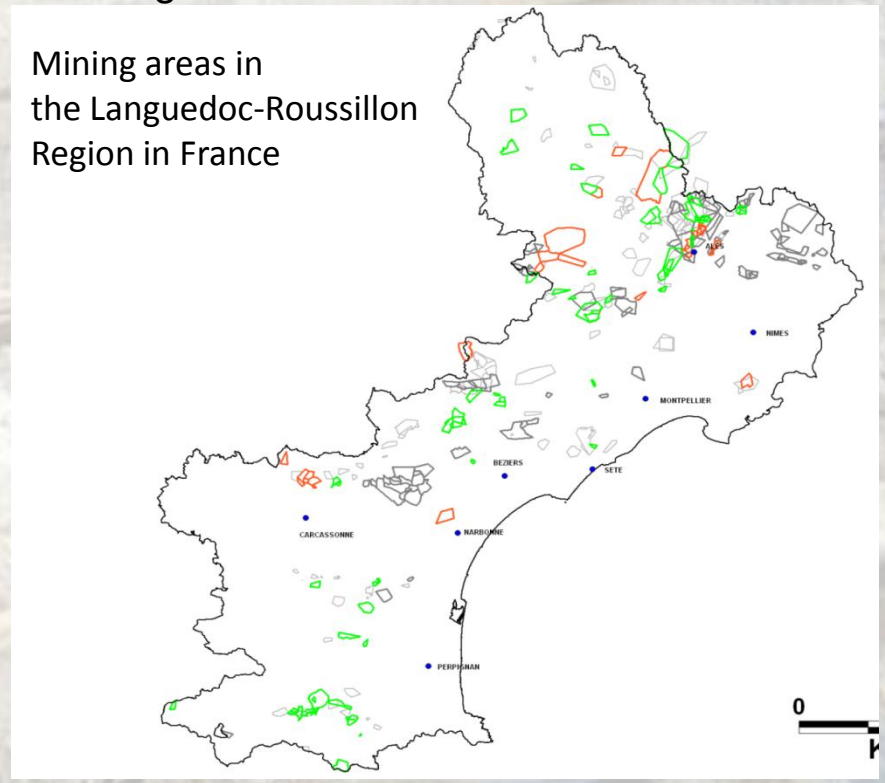
# Changes in the Mine Life Cycle with time



# A unique and simple Mining Waste Legislation

- **EU Mining Waste Directive published in 2006:**
  - Intended to unify the handling of mining waste within the EU
  - Came largely as a consequence of:
    - two major tailings dam failures in Spain and Romania in 1999 and 2000 and recently repeated accident in Hungary
    - accumulation of non-inventoried disseminated waste deposits and facilities = the result of 2 centuries of extensive mining


Mining areas in
the Languedoc-Roussillon
Region in France



# Recurrent catastrophic failures of mining waste facilities

**These events have increased public awareness of the risk for environmental and safety hazards of mining activities**

**They have illustrated the significant environmental and health risks associated with the management of mining waste as a result of their volume and pollution potential**

**One of the main aims of the MWM Directive is to prevent accidents of that type, or at least minimise the consequences of such accidents at (high risk) waste facilities through measures based on Best Available Techniques (BAT).**

# Nature of the Mining Waste Directive

**Specific legal framework (stand-alone directive)**

**Follows doctrine of EU waste policy:**

- Reduce waste production and its harmfulness
- Recycle / reuse as much as possible
- Safe disposal

**Focus on safe management of mining waste facilities**

- Waste rocks heaps & tailing dams
- A shift in thinking towards “Environmental Management” throughout the mine lifecycle

**Provisions proportionate to risks**

# Definition of mining waste

- **The most controversial issue**
- **"Waste" means "any substance or object which the holder discards or intends or is required to discard"**
- **Waste types**
  - **Inert**
  - **Hazardous** : consistent with other Hazardous Waste regulations
  - **Non-hazardous-Non-inert** : a completely new class of waste !
- **The inert waste issue**
  - be in **a physical** and **chemical** form, given local conditions, that limits interaction with the surrounding environment into perpetuity.
- **Importance of the Waste characterisation process**
- **Importance to determine the natural geochemical background**

# Needs of waste characterisation

**Basis for implementing a Waste Management Plan or a waste disposal strategy**

**Objective: establishing and predicting the physical & chemical stability of mining wastes**

- Solids
- Liquids

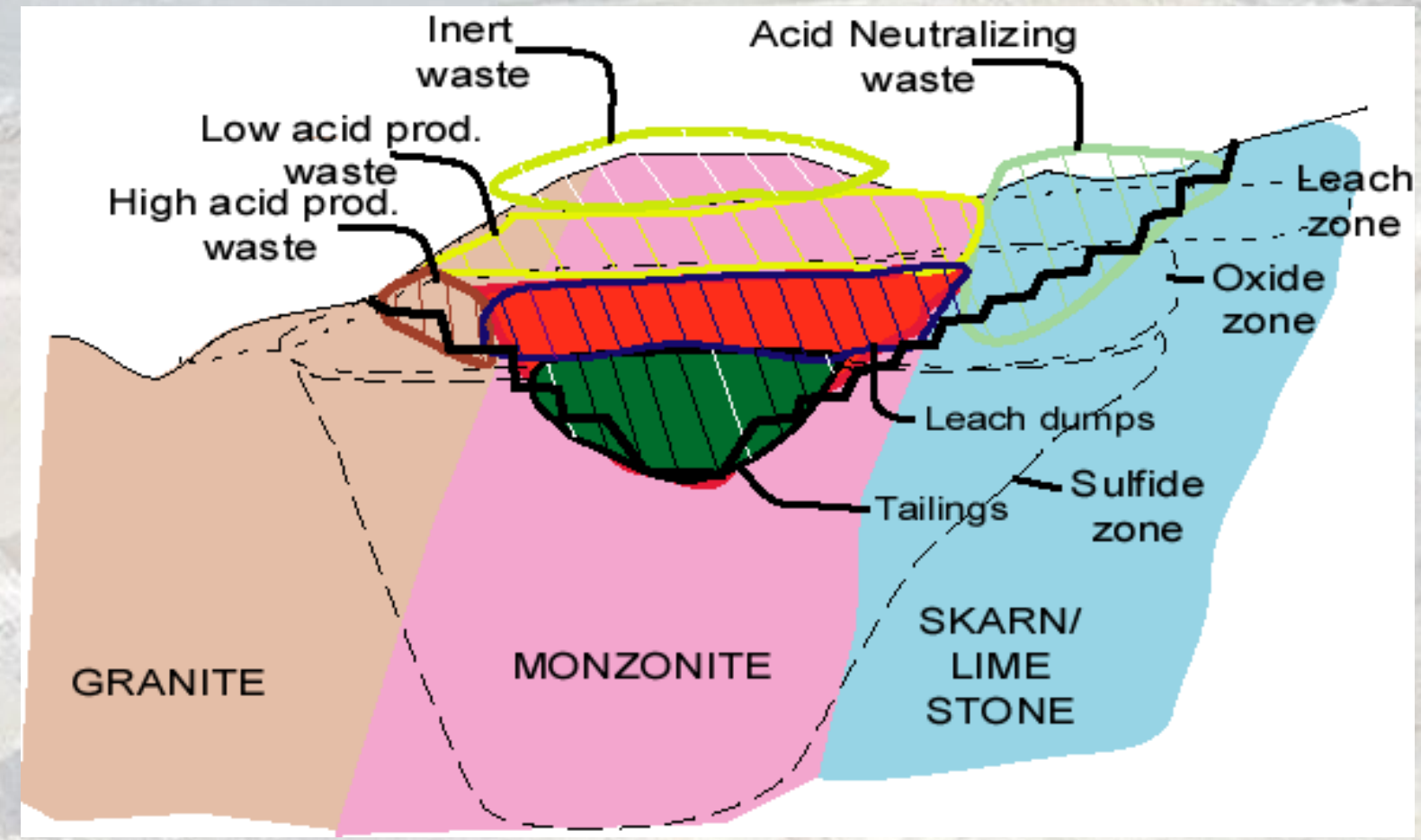
**Starts at exploration stage and continues during exploration, till closure**

**Involves a number of methodologies and standards initiated and developed by the EU**

**Suffers from a number of uncertainties**

- Extent/representativeness of environmental sampling is a key aspect
- Let geologic/mineralogical variability dictate extent of sampling; define geochemical test units

# Implications for mining waste management




- **Waste model linked to geology & waste production types for an hypothetical Porphyry Copper Deposit**

# Extensive rehabilitation programmes through the EU

# Extensive rehabilitation programmes

**A legacy of century old practices**

**"Mining is a relatively short term land use; therefore, it is important that disturbed lands are returned to a safe, stable and productive post mining land form that is both suitable and acceptable to the local community"**

**The cost for remediation are at least 200% higher, if the works are not integrated into the production process (during the mine life cycle)**

**Systematic inventories are needed today to locate and rank tens of thousands of mining waste facilities in the EU**

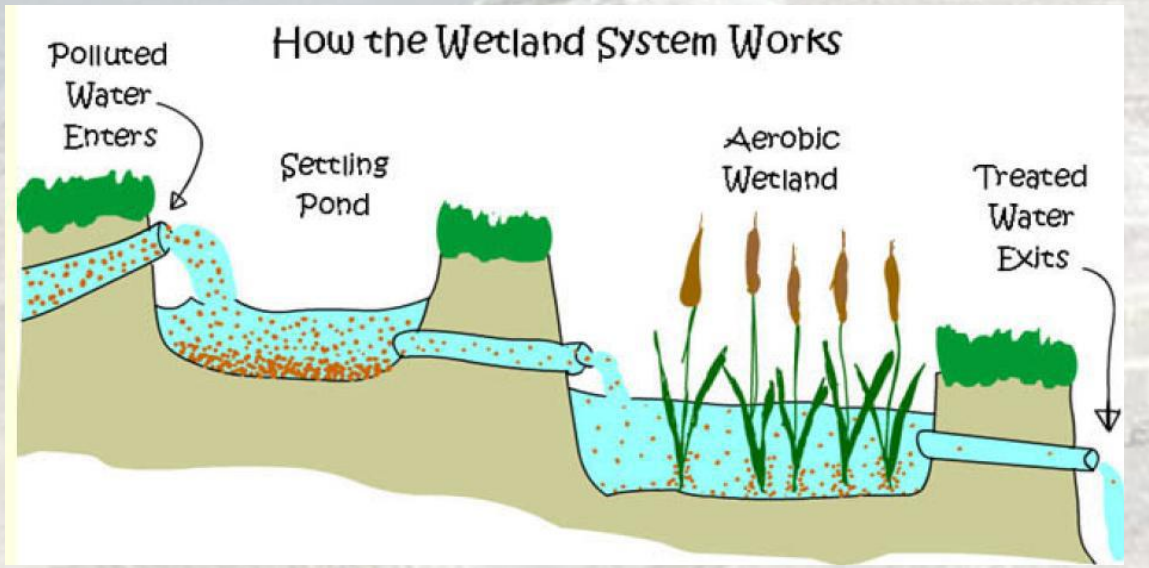
- Risk-based ranking methodology available

# Extensive rehabilitation programmes

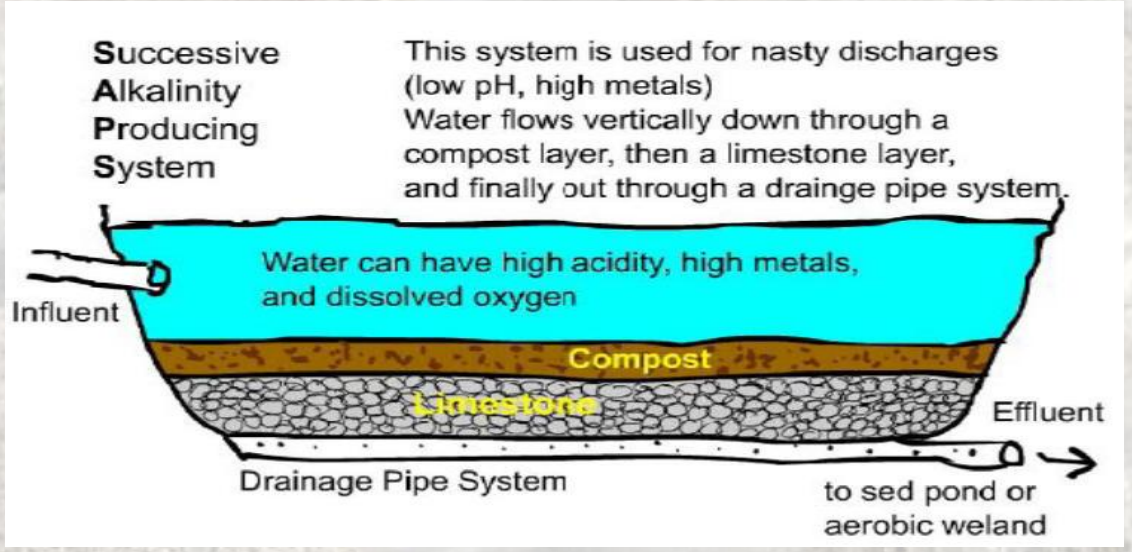
# Extensive rehabilitation programmes

- **Development of low-cost in-situ passive treatments (wetlands) to reduce the contamination related to mine water or mining waste facilities seepage**
  - Organizing what is already existing
  - New artificial constructions (e.g. “Reed beds”)

# Extensive rehabilitation programmes based on the use of passive in-situ treatments








# Best practice for active mines

**Best practice** can simply be explained as **"the best way of doing things"**, but in others words, the term “best practice” describes **a management approach** involving a commitment to achieve outcomes beyond those expected for regulatory compliance

**Best practice** in environmental protection is not **a fixed standard**, it can change with developments in technology and vary with the local environment, and the local economic context

**Best practice** needs to be tailored for the site to ensure that effective environment protection is compatible with efficient production

Reference is made to the **Best Available Technologies** (BAT) Document

# BAT reference document (BREF)

**Reference document on 'Best Available Techniques' for Management of Tailings and Waste-Rock in Mining Activities'**

**Objectives:**

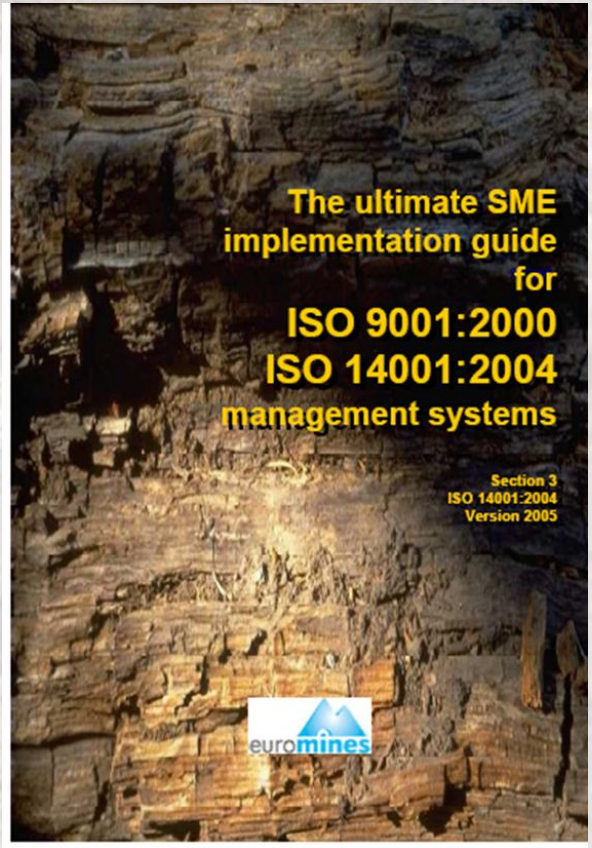
- Help prevent incidents from tailing dams
- Optimise "day to day" performance of tailings and waste rocks management

**A guide for:**

- **Industry**
- **Authorities**
- **Interested public**

**Available on:** http://eippcb.jrc.es/pages/FActivities.htm

# Environmental Management System ISO 14001




Manual part 2

**SYSTEM PROCEDURES**

Policy

Planning

Implementation /operation

Monitoring/corrective action

Review

Manual part 1

**Best practices on**

Water management

Waste rocks management

Tailings management

Hazardous substances

Air/Dust

Acid Mine Drainage

Subsidence

Community

Closure/ Rehabilitation

**Environmental Management System**

**OPERATIONAL PROCEDURES**

Hazardous substances management

Waste management

Land management

Water management

Air & noise management

Flora & fauna management

Closure/rehabilitation

Energy management

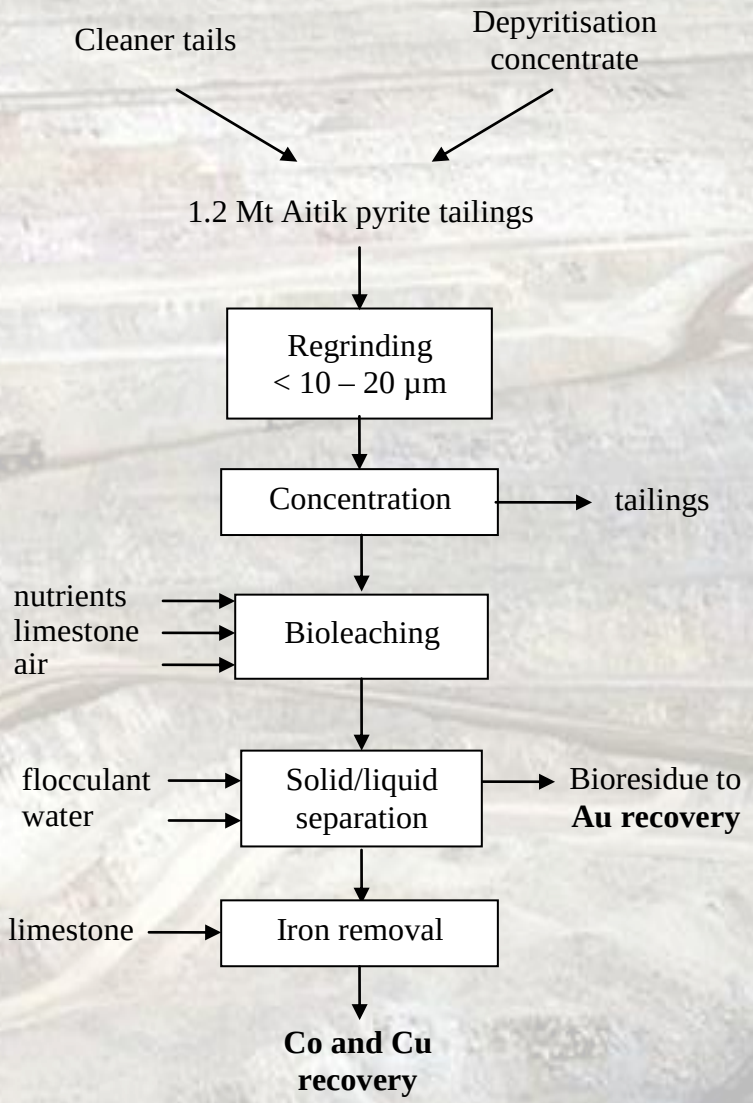
Etc,

# And what about reuse and recycling ?

- **Are mining waste different from ore bodies ?**
- **Benefits:**
  - Optimisation of resource
  - Pollution control
  - Land use improvement
  - Generation of income
  - Improvement of environmental and social conditions at a mine site
- **Minerals waste beneficiation options are case specific, generally no "off-the-shelf" solution**
- **Hence, finding new outlets for specific minerals waste is generally linked in the EU to research and development programs**
- **Contrary to other industrial wastes (fly ash, deconstruction wastes, etc), research has largely focused on the recovery of residual value (metal content, calorific value) of mineral and coal wastes, with little effort expended on their value as construction and industrial minerals**
  - Pyrite is generaly the mineral of interest

# And what about reuse and recycling ?

- **Example of the Aitik pyritic tailings (Sweden)**
  - Mine started in 1968
  - 1,2 Mt of tailings/year
  - Metals of interest: Cu, Co + Gold
    - Co=0,2% in pyrite
    - CU=0,2%
    - Au=0,8 g/t
  - In production in 2012



# TEŞEKKÜR EDERIM