



Environmental characterisation and mine water monitoring

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GTK

Mine Water Management and Treatment

– From Planning of Mine Operations to Mine Closure

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Content

- Need and content of a baseline study
- Characterisation of mining wastes – potential sources of mine drainage
- Water quality monitoring during mining activities
- Post-closure water monitoring
- Focus on mine waters



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Before mining / Baseline study (1)

- Studying the natural state / baseline of the proposed (exploration/) mine site and it's surroundings is needed to:
 - define requirements and pre-conditions set by the environment of the mine site for the implementation and the methods of implementation
 - define the baseline to observe and assess potential environmental impacts of the activities
 - e.g. quality of waters, soils and sediments, biota; water levels



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Baseline study (2)

- Is needed to:
 - plan placement of mining and processing activities
 - Quaternary deposits, groundwater aquifers, catchments
 - to design management actions
 - e.g. detailed mapping of the type and structure of Quaternary deposits, groundwater conditions and bedrock properties in proposed waste disposal areas
 - e.g. carrying capacity of the downstream water bodies – water treatment requirements
 - to define objectives for mine closure



Baseline study (3)

- Should be made latest before any larger changes to the site
 - Smaller scale before exploration
 - More detailed and large scale before initiating preparations for mining
- Is the basis for the EIA
- Should include all parameters
 - on which mining activities may have an impact
 - e.g. complete water chemistry of waters
 - that may be significant with regard to the generation of impacts
 - e.g. hydrogeology properties of the site



Overall content of the baseline study

- Climate
- Landscape, topography, land use
- Socio-economic factors
- Natural landscape, nature, biota
- Conservation areas and sites
- Geology and geochemical baseline
- Waters and their quality
 - Seasonal changes should be included
 - Upstream, downstream of the mine site
 - Complete water geochemistry
- Air quality
- (Characterisation of waste)



Characterisation of mining waste- Requirements in legislation (1)

- Potential waste types:
 - waste rock, tailings, overburden
 - mineral precipitates
 - from water treatment,
 - from mineral processing
- Characterization is needed for the
 - EIA, and
 - the environmental permit application
 - waste management plan
 - during operation as part of emissions monitoring
 - for closure planning of waste facilities
- Waste legislation: requirement to decrease the amount of waste



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Characterisation – Requirements in legislation (2)

- Government Decree on Extractive waste (GD 190/2013)
 - amendments to existing Acts and Decrees
- Characterisation should include/define:
 - background data of the:
 - mining and milling processes
 - exploited ore deposit,
 - the processes generating the waste, the type and amount of the waste material, and the chemicals used in the processing,
 - geotechnical behaviour of the waste, and
 - geochemical properties and behaviour of the waste.



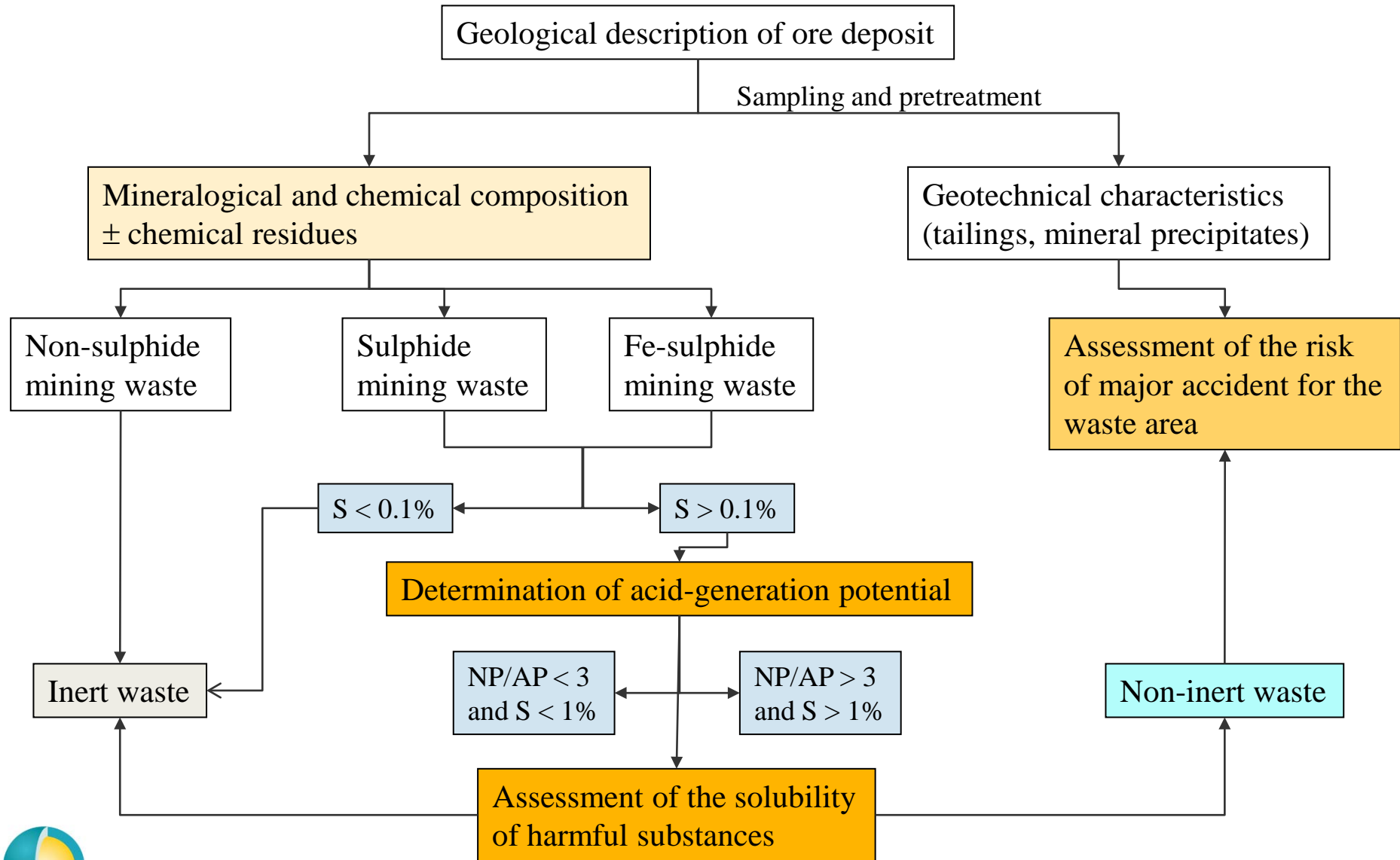
Characterisation of mining wastes

- Why characterisation is needed?
 - During and after mining, wastes are potential sources of mine drainage
 - Properties affecting surface water or groundwater quality are important
 - To evaluate optimal use of mineral materials (ecoefficiency) – decreasing the amount of waste
 - To evaluate future drainage quality
 - Long-term chemical alteration of the waste
 - To design disposal facilities and their closure



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Characterisation of mining wastes



Kauppila et al. 2013: BEP in Metal Ore Mining

Characterisation methods (1)

- Mineralogy
 - Sulphide minerals and other acid producing minerals, neutralising minerals, potential contaminant sources
 - Optical microscopy, SEM + MLA, XRD
- Chemical composition
 - Potential contaminants (including processing chemical residues) and solubility of harmful substances (metals, oxyanions, salts)
 - Total methods: XRF, total extraction method
 - Solubility: e.g. selective extractions, leaching test, percolation test
 - Also: chemical analysis of process water from concentration tests

Characterisation methods (2)

- Potential to produce acid mine drainage (AMD)
 - Acid production potential (i.e. NP vs. AP)
 - Static tests (e.g. CSN EN 15785, NAG-test)
 - Calculation based on carbonate C –content vs. sulphide S -content
 - AMD quality in long-term
 - Kinetic test methods (e.g. Humidity cell tests)
 - Drainage from waste material of similar ore types with similar processing (analogues)



Water quality monitoring during mining activities (1)

- Operational monitoring
 - Performance of the water treatment systems
 - e.g. active systems, overland flow areas, wetlands
- Emissions monitoring
 - Quality of emissions from operations
 - Process water, dewatering water from the mine workings, seepage waters from the waste facilities
 - Main metals, pH, SO_4 , N-emissions
 - Toxicity of waste waters (SFS-standards)
 - Sanitary waters
 - T, O_2 , pH, EC, COD_{Cr} , BOD_7 , TP, TN, NH-N_4 , bacteria, suspended solids



Water quality monitoring during mining activities (2)

- Environmental impact monitoring
 - Impacts of mining on environment
 - Surface waters
 - the physico-chemical conditions,
 - biological monitoring of surface water
 - monitoring of fish populations and fishing
 - and the monitoring of (aquatic) sediment composition
 - Groundwaters
 - Groundwater monitoring wells, household wells and springs at the mine site and in its' surroundings
 - Physico-chemical quality and level of the groundwater table



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Water quality monitoring during mining activities (3)

- Important!
 - Complete water chemical analysis e.g. once a year
 - Site-specific
 - Should include all potential contaminants
 - process chemical residues
 - residues from explosives
 - those from ore deposit / waste material
 - Monitoring points should be located in potential flow routes of mine drainage



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Water quality monitoring during mining activities (4)

- Important!
 - Seepage quality of the waste piles
 - Field measurements + filtration of the samples in the field
 - On-line monitoring
 - Processing and follow-up of the monitoring data
 - actions if negative changes observed



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Post-closure water quality monitoring (1)

- To ensure that the mine site poses no environmental or health risks
- To ensure the performance of the closure structures, and to facilitate rapid detection and response in case of failure
 - Waste facilities
 - Seepage water volume and quality
 - Open pit / underground mine
 - Flooding, water quality, discharge quality
 - Water treatment systems
 - Minimum: Inflowing water, out flowing water



Post-closure water quality monitoring (2)

- To monitor the impact on the environment
 - Surface water and groundwater quality at the mine site and its' surroundings
 - Both upstream and downstream from discharge points
 - Similar parameters to monitoring during active mining
- Site-specific requirements
 - Monitoring programme to be accepted by environmental authorities



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Thank you!



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