Mine waste and site characterisation research at the University of Miskolc, Hungary

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The only one institution in Hungary for higher education in:

- Mining engineering
- Petroleum engineering
- Mineral processing
- Hydrogeological engineering
- Geo-environmental engineering and risk assessment

Engineering Solutions for a Sustainable Planet

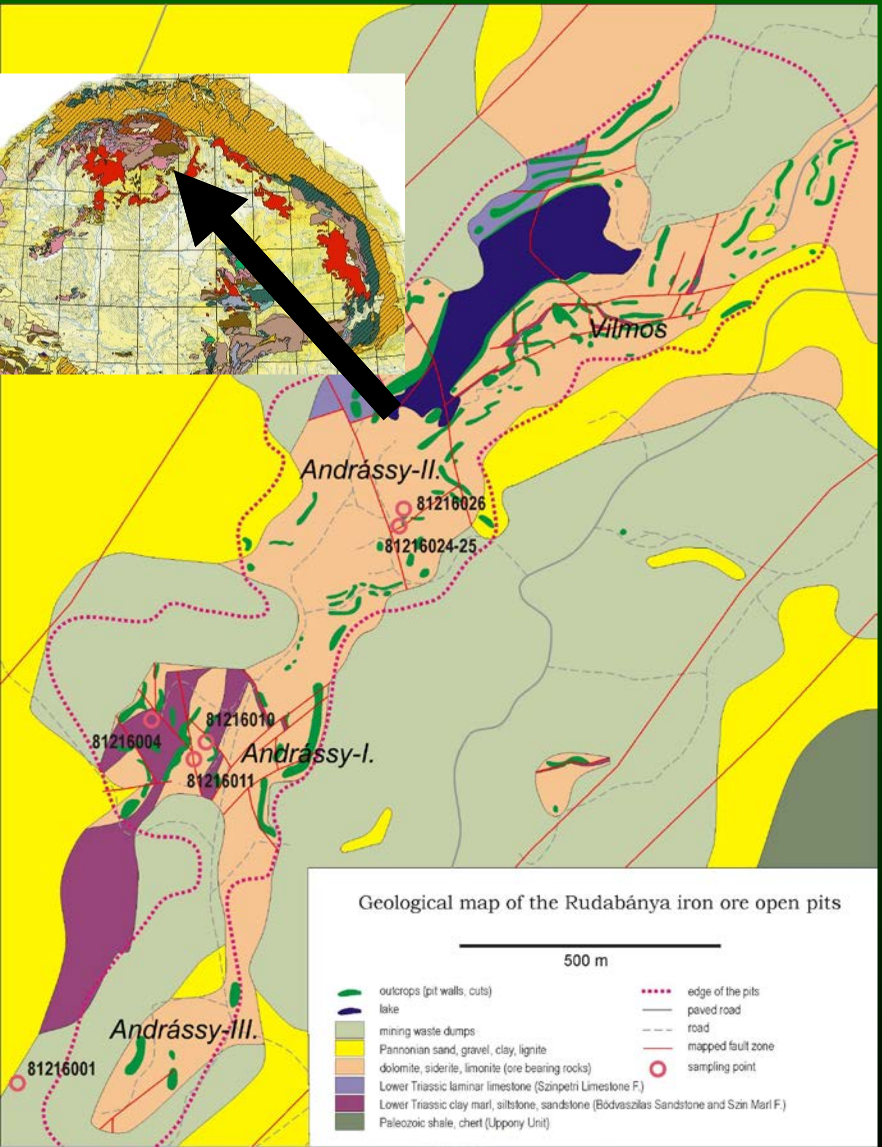
Relevant research projects

- Primary rock geochemistry and AMD effects in the abandoned mines of carbonate-hosted sulphide mineralization in Rudabánya (NE Hungary) and Asturias (Northern Spain)
- ARD characterisation of siderite-hosted base metal deposit Rudabánya
- Kinetic testing and mineralogical characteristics of sulphide mine wastes from the Oruro deposit (Bolivia)
- **TAILSAFE**: Sustainable Improvement in Safety of Tailings Facilities
- **PEREBAR**: Long-term Performance of Permeable Reactive Barriers used for the Remediation of Contaminated Groundwater
- **InSUPeRB**: Innovative solutions in using permeable reactive barriers

Primary rock geochemistry and AMD effects in the abandoned mines of carbonate-hosted sulphide mineralization in Rudabánya and Asturias

- Sapnish-Hungarian Bilateral research 2010 - 2011
- Partners: University of Miskolc, Universidad de Oviedo
- Sites: Rudabánya, Hungary - Asturias, Spain
- To develop geochemical and hydrogeological models of the basins where the abandoned mine operations are located
- To study the possibility to avoid the pollution associated to acidic mine effluents and acidic mine waste heap leachates.
- To design a new exploration model to know the economic suitability of these ore deposits

ARD-screening of site rocks from the Rudabánya base metal mineralization (NE-Hungary)

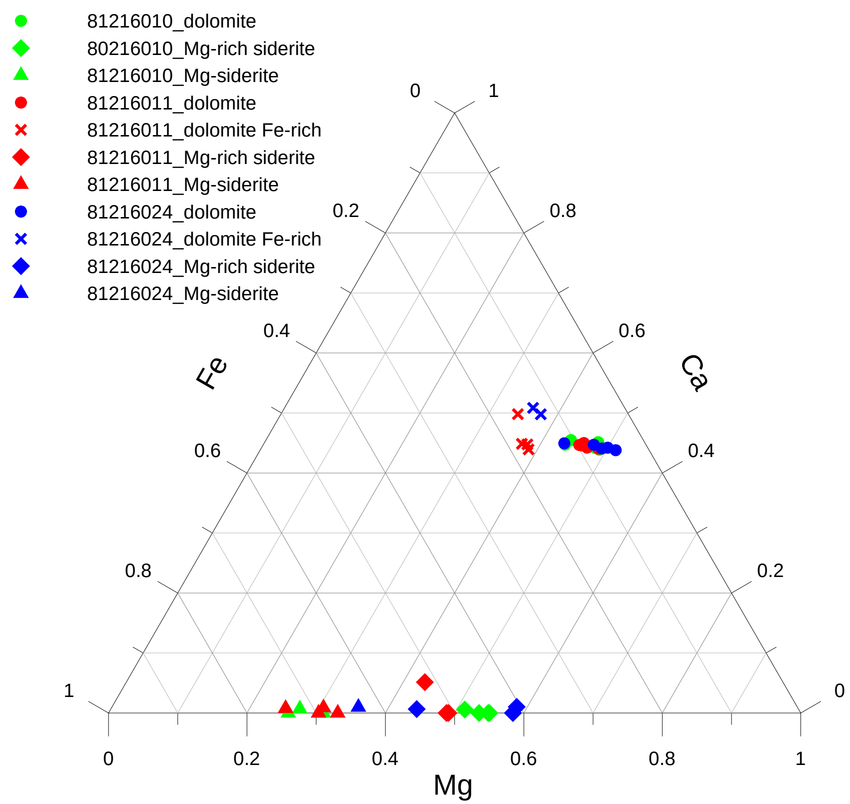


- Check the acid generating potential of 7 sulphide-rich site rock type samples
- Hosting carbonate minerals have significant iron-content
- Check the applicability of the currently formulating European standard on acid generation behaviour to slow-reacting carbonates and especially to iron-bearing carbonate phases.

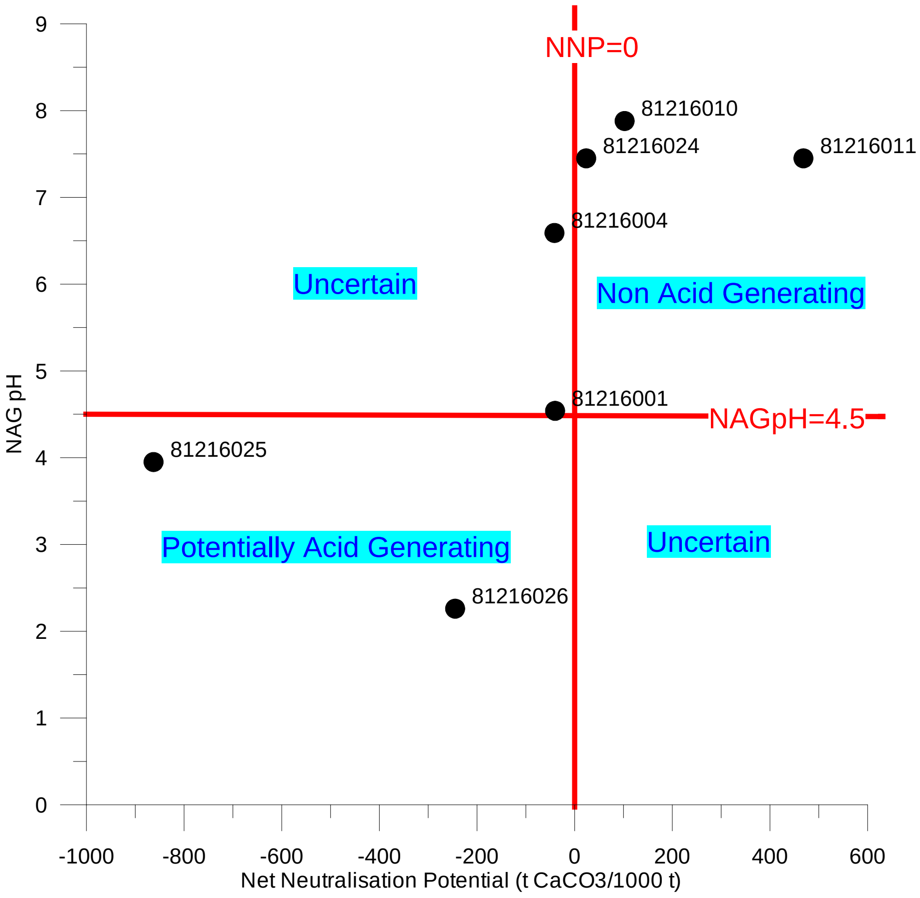
Sample No.	description	CO_3-C (from ISO 10693)	CO_3-C from XRPD	Total S % (ISO 351)	Pyrite S %	Sulphide S %	Sulphate S %
81216001	Mine waste sample. Intensively cemented breccia of the oxidized sparry iron ore. (goethite 9%).	0.10	7.58	2.23	1.83	1.83	0.4
81216004	Gray, slaty, brecciated clay-marl. Zn-Pb sample from the contact zone	7.93	11.94	5.92	2	5.47	0.45
81216010	Dolomitic pyrite-rich sparry iron ore close to contact zone with the marl	5.26	10.71	6.1	6.1	6.1	0
81216011	Dolomite-rich sparry iron ore with vein-fillings of fahlore and pyrite	6.21	8.33	2.81	2.14	2.81	0
81216024	Pyrite-rich sparry iron ore	3.34	4.61	13.21	13.06	13.06	0.15
81216025	Massive pyrite accummulation in the sparry iron ore	1.58	2.99	30.83	29.72	29.72	1.11
81216026	Sample from the „baritic spare edges" with significant barite and pyrite content	0.05	1.17	15.38	6.09	8.45	6.93

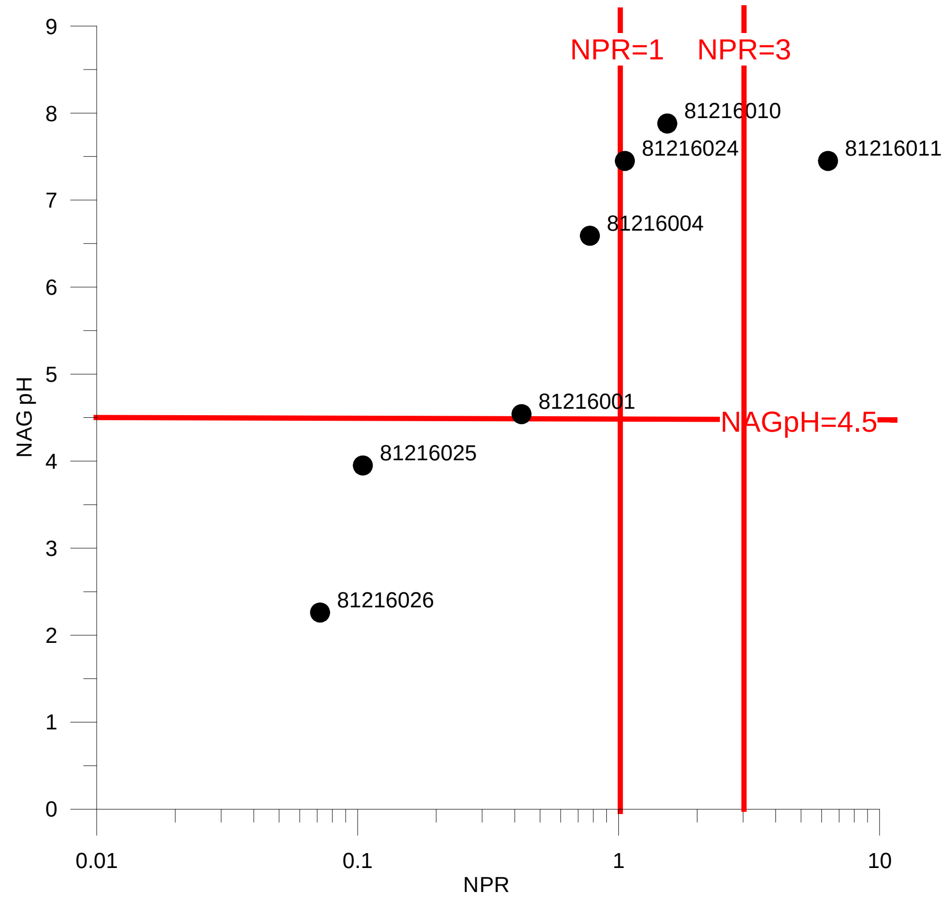
Mineral composition of the samples

Sample No.	81216001	81216011	81216010	81216024	81216004	81216025	81216026
Mg-siderite	66	2	8	5			
dolomite	4	74	52	36	26	23	9
dolomite Fe-rich	2	15	19	27	11		
Magnesite		3	7				
calcite				1			
cerussite					1		
covellite					5		
pyrite	8	3	14	30	5	66	11
sphalerite					9		
tetrahedrite		2					
galena							17
gypsum	5			1	2	7	2
anhydrite					1		
barite							46



Static test results





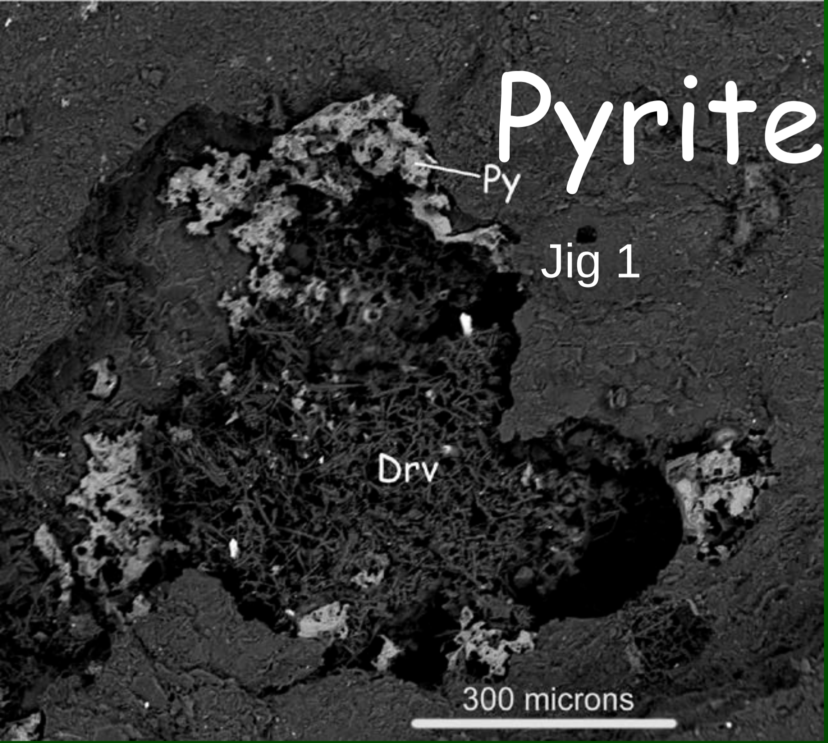
Kinetic testing and mineralogical characterization of sulphide mine wastes from the Oruro deposit (Bolivia) in cooperation with Kjeoy Research and Education Centre, Norway

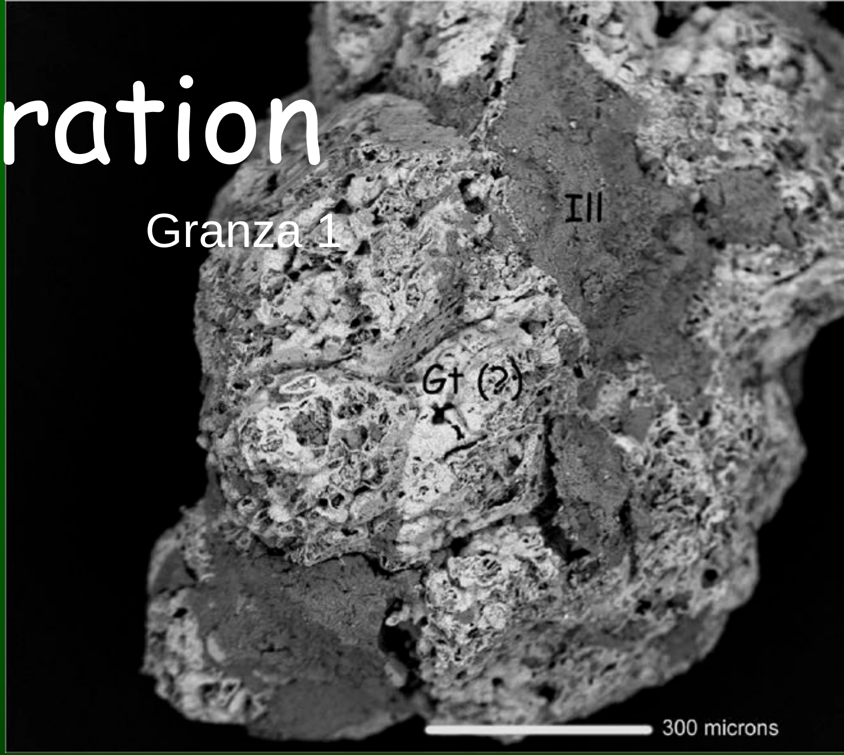
- Mineralogical analysis
  - X-ray diffraction (Rietweld),
  - SEM + EPMA
- Geochemical testing (from kinetic test)
  - pH, Eh, TDS
  - Conductivity, salinity, temperature
  - Anion and cation content
- Sequential extraction

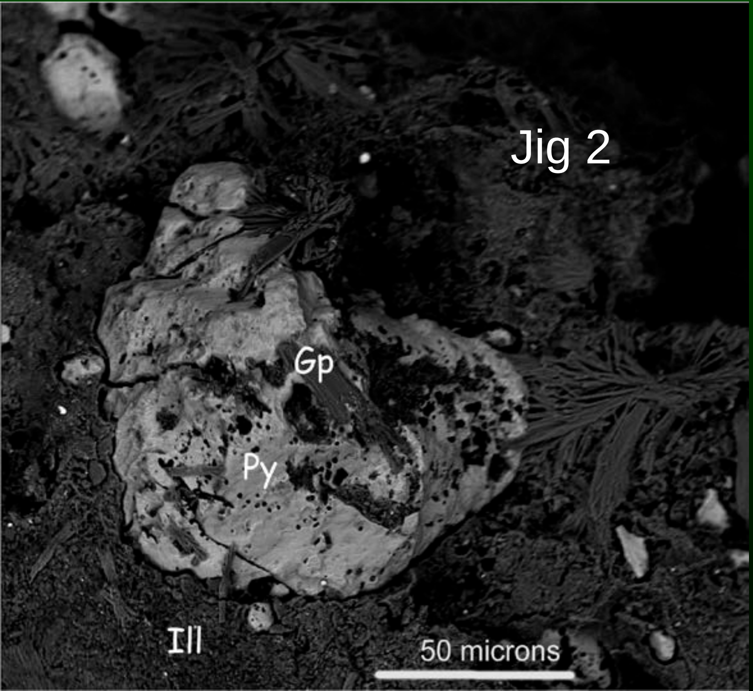
Mineral composition of the samples (XRPD)

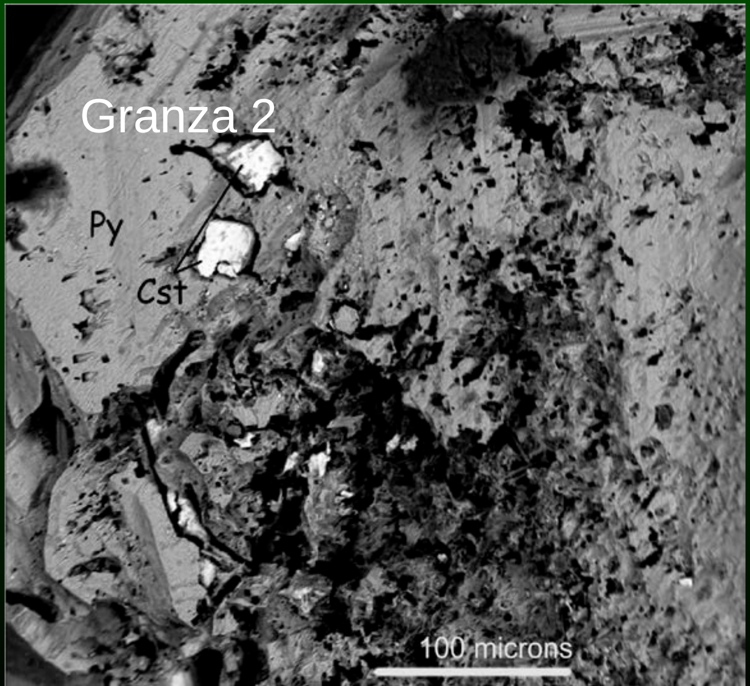
Mineral	Jalpha-01	Playa Irroco-01	Itos jig tailing-01	Itos jig tailing-02	Itos Granza-01	Itos Granza-02
Quartz	59 %	45 %	61 %	59 %	62 %	70 %
Illite	21 %	14 %	25 %	25 %	25 %	19 %
Pyrite	1 %	11 %	6 %	6 %	2 %	1 %
Dravite	-	4 %	2 %	4 %	5 %	3 %
Jarosite	7 %	-	1 %	1 %	2 %	2 %
Alunite	1 %	-	1 %	1 %	-	1 %
Magnesiocopiapite	-	11 %	-	1 %	2 %	3 %
Gypsum	3 %	6 %	-	-	-	-
Kaolinite	3 %	-	1 %	2 %	-	-

Pyrite alteration



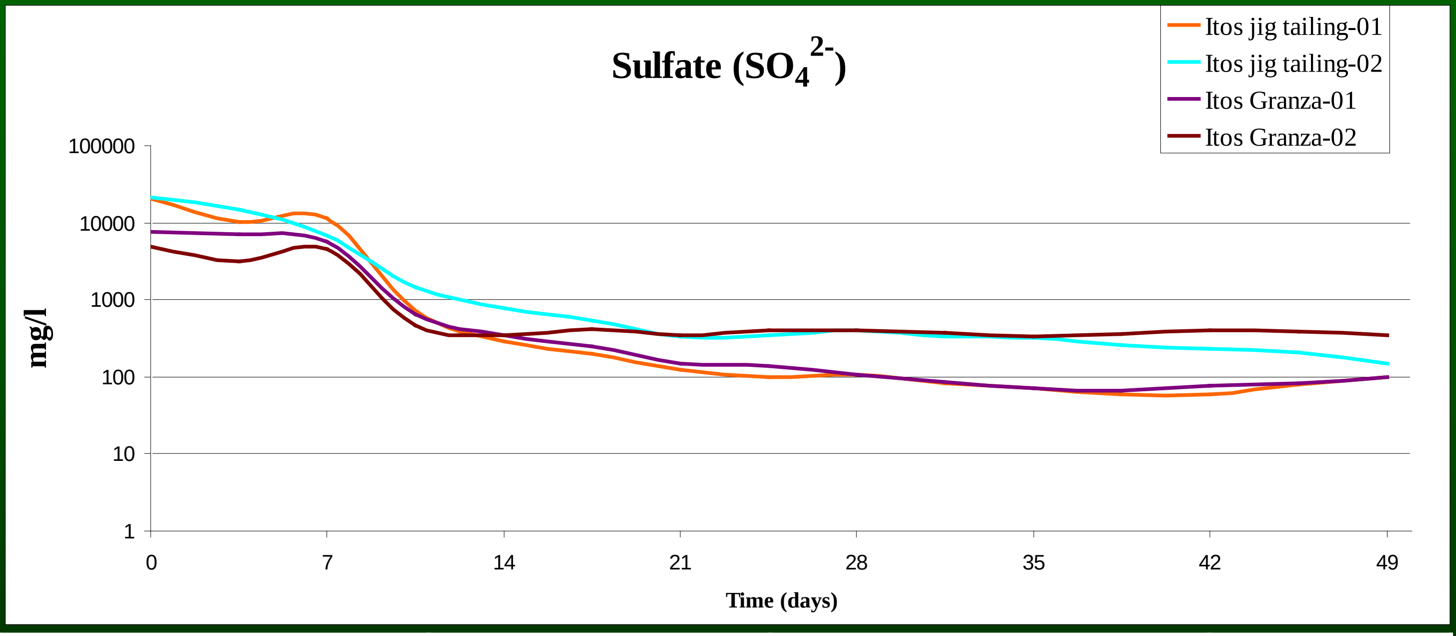






Modelling

- Sulphate release
- Calculated pyrite oxidation
- Estimation of oxidation time span



Sample	Pyrite content * g pyrite / kg sample	Pyrite oxidation rate g pyrite / kg sample / year	Year **
Itos jig tailing-01	60	1.56	38
Itos jig tailing-02	50	5.95	8
Itos Granza-01	20	1.35	15
Itos Granza-02	20	5.72	4

* Based on XRD

** Ideal case

TAILSAFE: Sustainable Improvement in Safety of Tailings Facilities

- EU FP5 project of 10 institutions from 6 countries
- A State-of-the-Art Report, Risks and Reliability and Intervention Actions for Risk Reduction
- Design and Authorisation Procedures for Proposed Tailings Facilities
- Water Management and the Use of Thickened Tailings
- Pilot-scale Hydraulic Transport Test System and Pilot-Scale Slurry Thickener
- Closure and Restoration Plans, Intervention and Remedial Actions and Legislation, Authorisation, Management, Monitoring and Inspection Practices
- Non-Destructive and Minimally Intrusive Methods for the Investigation and Monitoring of Tailings Impoundments
- Catalogue of Site Characterisation Criteria
- An online risk reduction tool implemented on an ASP server and hosted at http://www.tailsafe.net/

PEREBAR Long-term Performance of Permeable Reactive Barriers used for the Remediation of Contaminated Groundwater

http://www.perebar.bam.de/

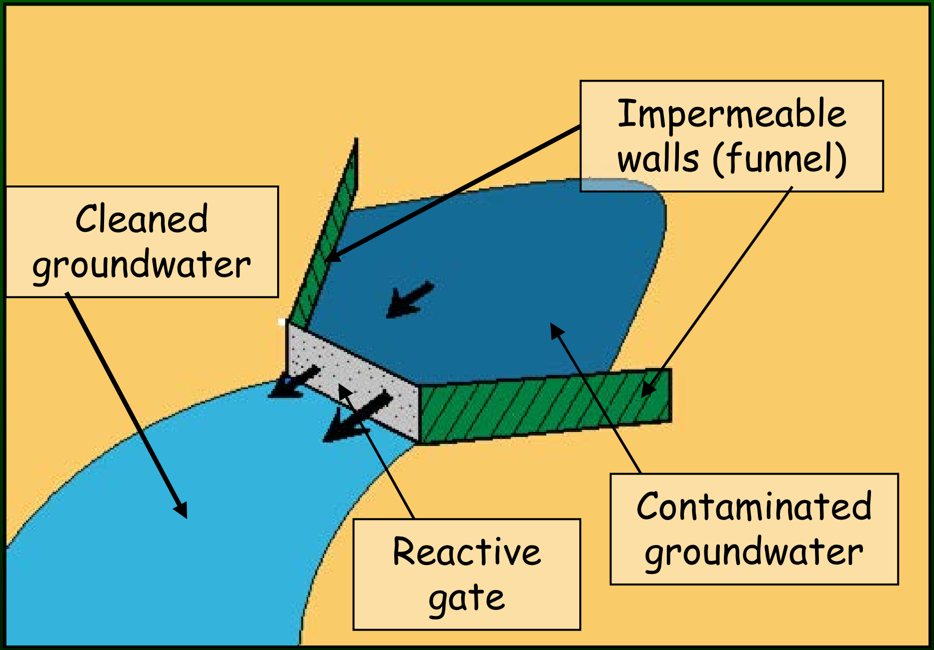
- EU FP5 project of 8 institutions from 4 countries
- Selection and characterization of suitable matrix material
- Characterization of the relevant attenuation processes
- Development of contaminant-binding chemical compounds
- Accelerated testing methods to assess the long-term performance of the attenuation mechanisms.
- Development of a scheme to predict long-term behavior of PRB's
- Evaluation of the influence of site characteristics.
- Monitoring of existing and new field applications
- Field tests: Test Apparatus for Accelerated Testing of Permeable Reactive Material at the former uranium mine tailings at Pécs, Hungary

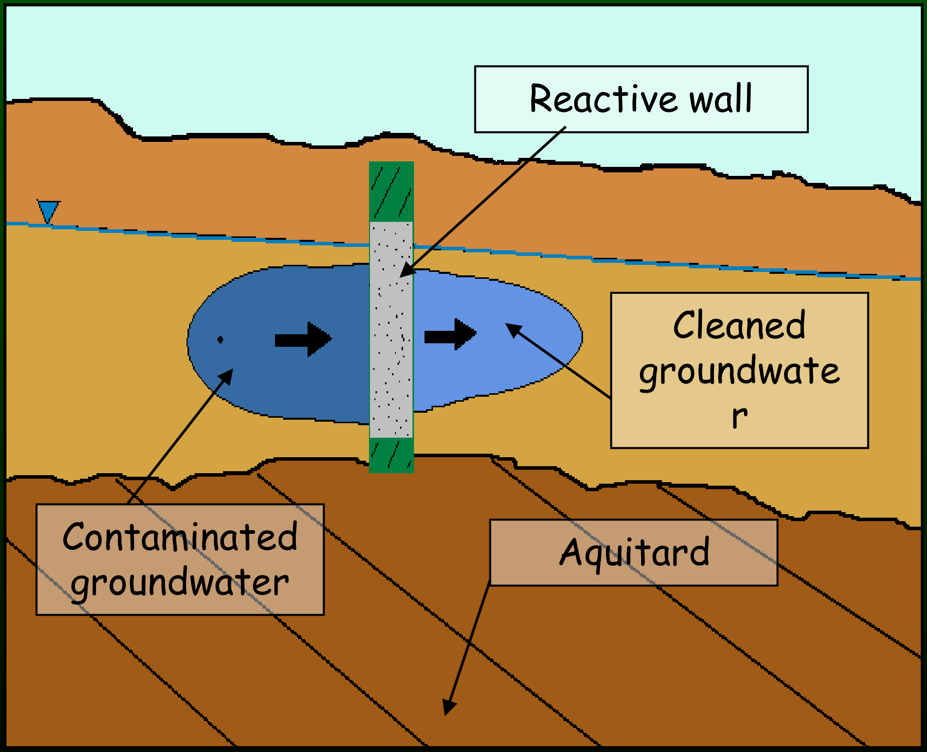
InSUPeRB

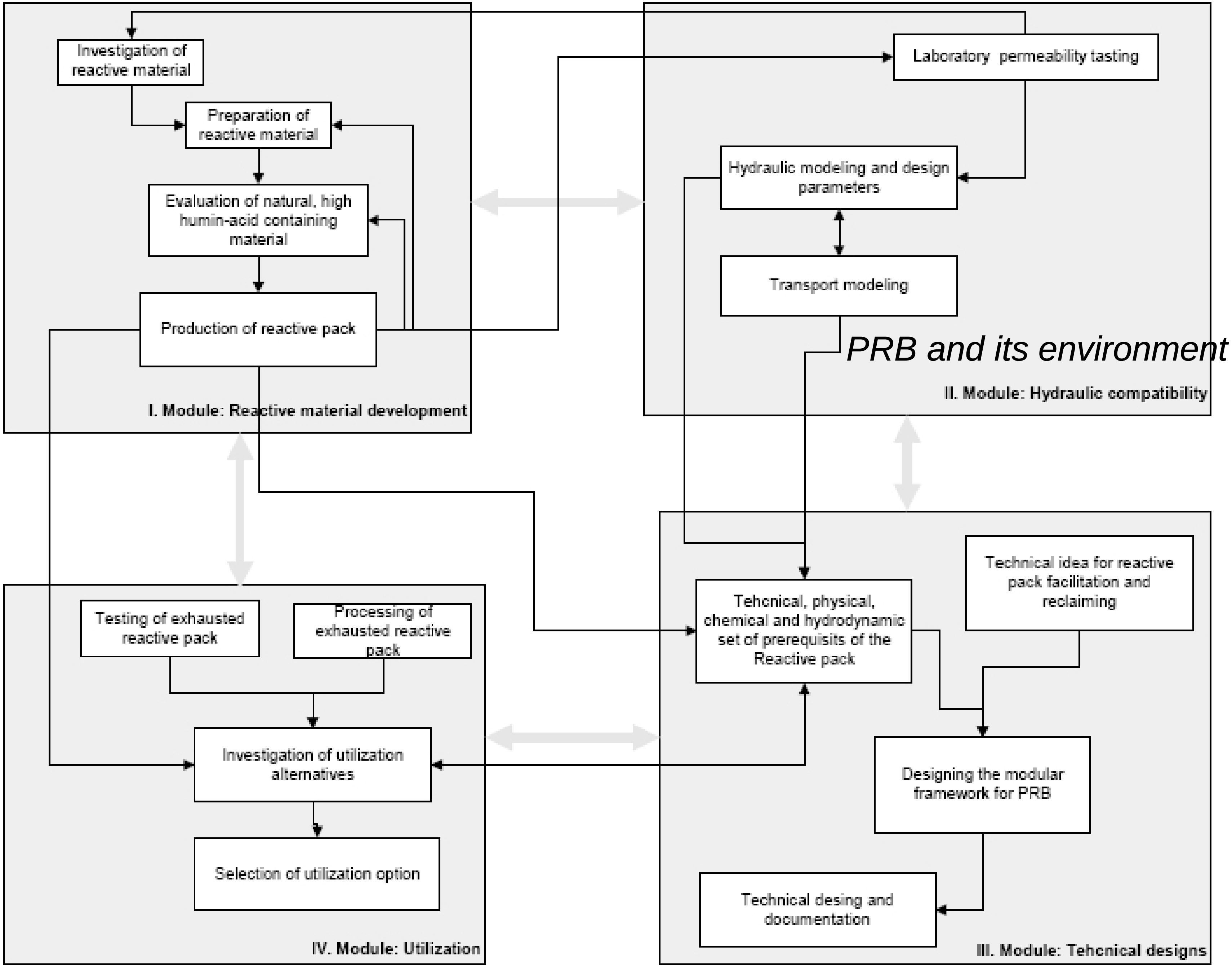
Innovative solutions in using permeable reactive barriers

Bilateral research with the Umea University, Sweden

To lay the technical foundations of an innovative, passive remediation system, which is considerable cheaper and offers faster solutions than the traditional PRB-s.







Investigation of reactive material
Preparation of reactive material
Evaluation of natural, high humin-acid containing material
Production of reactive pack
I. Module: Reactive material development
Laboratory permeability tasting
Hydraulic modeling and design parameters
Transport modeling
PRB and its environment
II. Module: Hydraulic compatibility
Testing of exhausted reactive pack
Processing of exhausted reactive pack
Investigation of utilization alternatives
Selection of utilization option
IV. Module: Utilization
Tehcnical, physical, chemical and hydrodynamic set of prerequisits of the Reactive pack
Technical idea for reactive pack facilitation and reclaiming
Designing the modular framework for PRB
Technical desing and documentation
III. Module: Tehcnical designs