

# BioMinE

## Biotechnological research for European mining operations

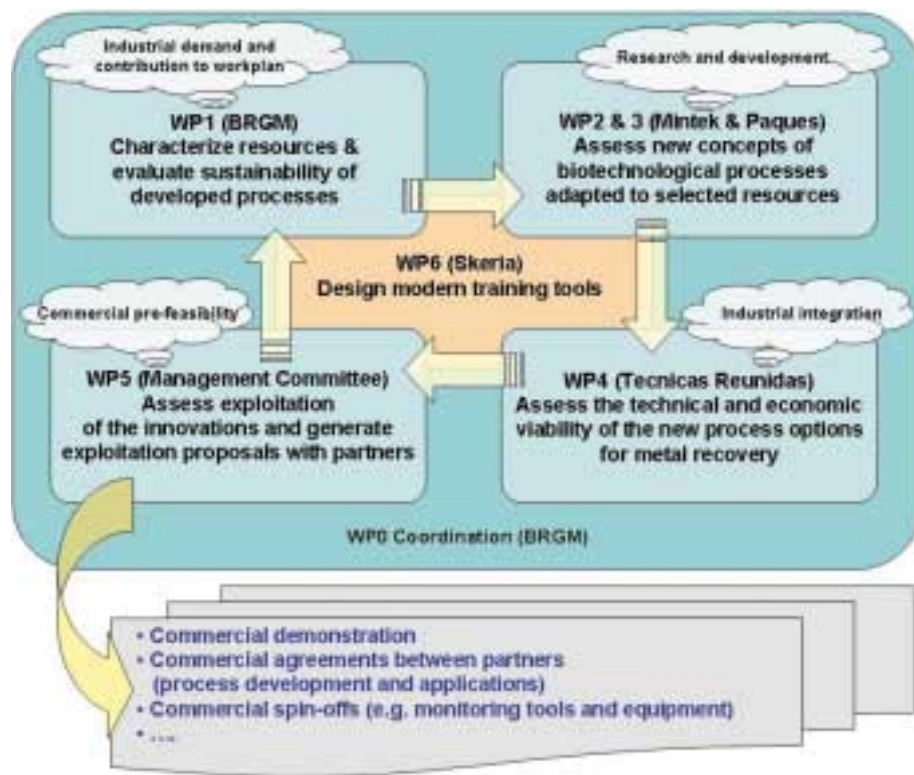
Since 2004 and going until 2008, a consortium of industry, research organisations, and universities is evaluating the merits of integrated biohydrometallurgical process options for metal recovery from mineral resources in Europe. The structured evaluation procedure in the European FP6 Integrated Project **BioMinE** guides the direction of development, improvement, and customization of biotechnologies to make industrial application economically and environmentally attractive when compared to alternative metal winning processes.

Innovation in biohydrometallurgy provides advantages in treating materials with relatively low metal concentrations, and in the environmental consequences. From its origin as a controlled practice at the industrial scale, it has developed over the last 40 years. Over the last 15 years, the understanding of the biochemical processes involved has been subject to growing investigations resulting in a diversification of the potential industrial targets.

The main application at an industrial scale is bioleaching, consisting of dissolving metal sulphides by the use of microbially assisted reactions. Today only copper and gold are produced in significant quantities in other continents by the use of biohydrometallurgy. Additional industrial operations in the world producing cobalt, and under development for nickel and zinc, confirm the technological potential for different non-ferrous metals.

The BioMinE project is aimed at using European and South African scientific assets to investigate the opportunities to recover metals from primary and secondary mineral resources in Europe. Although various process options for treating metal concentrates are either already well established, the real challenge in BioMinE is to demonstrate the economic feasibility of the biotechnologies when applied to specific European ores, concentrates, and secondary resources of non-ferrous metals that are traditionally considered to be difficult or not feasible to process economically.

BRGM's expert in biotechnology Dominique Morin, General Co-ordinator of the project, expects "a high chance for a technological breakthrough" if the integrated research direction



given by the project can be pursued. "Following resource evaluation and target selection, demonstration of the opportunities for applying biotechnological processes to some representative metal-bearing resources in Europe will be achieved now. The final year of BioMinE includes the demonstration of different technologies that may become commercially developed after the end of the project. For some metal-bearing materials in Europe the existing processes for metal recovery are economically or environmentally inappropriate. The complex mineralogy influences the footprints of processing techniques on the environment imposing the consideration of innovative routes as substitute, add-on, or parallel processing, with significant metal recovery and less impact in terms of water use, energy consumption and pollution dissemination".

BioMinE has succeeded in integrating European expertise to achieve biohydrometallurgical technology breakthroughs. Through amenability test work the project has started to improve and optimally fit biotechnologies suitable for treatment of European resources and has entered the stage of developing and demonstrating technologies that can be commercialized.

Some of the most significant results obtained at laboratory scale have led the way for technology demonstrations planned in the framework of BioMinE. These are in particular:  $\beta$  Direct bioleaching of copper concentrates with thermophilic micro-organisms; with special emphasis on Cu-Ni concentrates. It has been shown that more than 95% copper and 99% nickel could be extracted from Cu-Ni

concentrates of Aguablanca (Spain). Similarly, it turns out that copper from Bor concentrate (Serbia) could be almost totally recovered by bioleaching

- ◆ Direct and indirect bioleaching of zinc polymetallic concentrates; focussing on bulk Zn-Pb concentrates including precious metals from Boliden's mining operations in Sweden and Ireland. The results show that the generation of ferric iron as oxidant of the metal sulphides could be optimised and controlled in such a way that the techno-economic viability of a process weakly sensitive to penalty elements might be feasible

- ◆ Thermophilic microbial leaching of refractory gold concentrate gave excellent results in terms of reduction of the final elemental sulphur content (consumer of cyanide) and soluble arsenic in the solid residue

- ◆ The treatment of secondary resources - byproducts, tailings and slag in Europe is a special objective. A new concept of low-duty bioreactor has been developed to target these resources. Three operating plants have provided access to such substances for testing (KGHM in Poland and Bor in Serbia for copper tailings, and nickel tailings from the Aguablanca mine in Spain).

- ◆ Effluent polishing by biological sulphate reduction techniques dedicated to pregnant solutions and industry effluents, with Umicore's present-day effluent as proxy.

The technology demonstrations will be carried out in the facilities of the main project investors; BRGM (France), Mintek (South Africa), Técnicas Reunidas (Spain), and Paques



Evaluating smelter slags at Bor in Serbia

- Low duty bioreactor. Report on preliminary testing results and modelling
- Metal biorecovery and/or effluent polishing
- Cu and Cu polymetallics. Report on piloting operation and pre-feasibility study
- Zn and Zn polymetallics. Report on piloting operation and pre-feasibility study
- Low duty bioreactor. Report on piloting operation and pre-feasibility study
- Metal biorecovery and/or effluent polishing final evaluation

<http://biomine.brgm.fr>

(The Netherlands), and on the industrial sites of Boliden, KGHM, Rio Narcea, Umicore, and Bor Copper.

The list of deliverables is also available through the project's website (products/deliverables section). Thus far in the areas of bioleaching and biotreatment and resource recovery, achievements have included, amongst others:

- ◆ Bioleaching amenability studies of concentrates and wastes,
- ◆ Information on new and existing microbial consortia and bioleaching mechanisms and performances
- ◆ Biomolecular tools
- ◆ Genetic and proteomic analyses on metal resistance mechanisms
- ◆ Characteristics of microbial communities in AMD-affected areas
- ◆ Studies on alternative electron donors for sulphate reduction
- ◆ Expected mass flows, composition and samples of the solids produced by the effluent treatment techniques
- ◆ Studies on the viability of the bioflotation and bioagglomeration processes
- ◆ Ecotoxicity studies of biotechnological and classical effluent treatment
- ◆ Studies on metal precipitation processes in industrially applied biological processes.

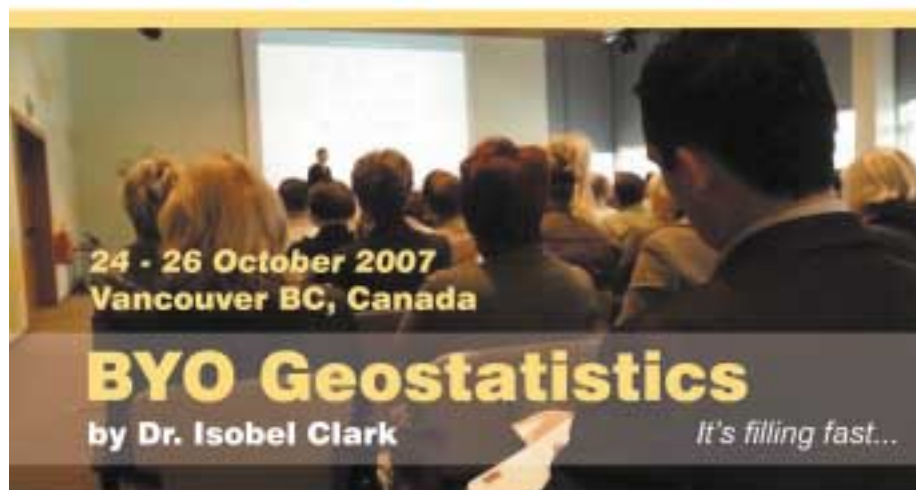
The results of this are further integrated in 'process integration and application':

- ◆ Report on bioreactors and associated equipment design
- ◆ Mineralogical analysis of samples of residues or products from lab tests
- ◆ Conceptual design and evaluation of developed biometallurgical processes
- ◆ Integrated piloting
  - Cu and Cu polymetallics. Report on flowsheet evaluation and downstream product test work
  - Zn and Zn polymetallics. Report on preliminary evaluation of the application



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#### Course Summary

A three-day classroom course based on 28 years of teaching statistics and geostatistics to professionals in the mining industry. Participants are encouraged to analyse their own data using software provided.

#### Who Should Attend?

The course is aimed at geologists, mining engineers, statisticians, environmentalists, surveyors, biologists, agriculturalists and other professionals dealing with spatially related data.

#### About the Author

Dr. Isobel Clark provides consultancy through Geostokos Limited, almost exclusively in the field of mineral resource and reserve estimation, most often at feasibility or even pre-feasibility stage.

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