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IMAAC COPPER FORUM & JORNADAS CYTED

TECHNICAL REPORT

Sponsored and Organized by

- International Materials Assessment and Application Centre of UNIDO
- Subprograma XIII - Tecnologia Mineral of CYTED
- Ministério da Ciência e Tecnologia da República Portuguesa, Coordenação Nacional CYTED

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Volume II

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Main body

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TECHNICAL REPORT ON THE JOINT UNIDO AND CYTED EVENTS : IMAAC COPPER FORUM AND JORNADAS CYTED - XIII

ORGANIZERS:

UNIVERSIDADE DO PORTO

PAN AMERICAN COMMITTEE ON MINING, METALLURGY AND MATERIALS - COPAM

ESCUELA DE MINAS DE MADRID

COORDINATORS:

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Project Coordinator: Prof. Dr. *Manuel Fonseca Almeida*

Portuguese Coordinator: Prof. Dr. *Manuel Fonseca Almeida*

Spanish Coordinators: Prof. Dr. *Benjamin Calvo*

Prof. Dr. *José Antonio Botin*

PLACES:

Oporto

Neves Corvo

Aznalcollar

Rio Tinto

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THE EXPERTS CONTRIBUTIONS (in Portuguese and Spanish)

- **Comércio Internacional de Produtos Primários e a Transmutação, Francisco Rego Chaves Fernandes**

- **Análise Estratégica de Investimentos e o Desenvolvimento Sustentável: Algumas Reflexões, José M. Coelho, Maria C. A. F. Souza, Saul B. Suslick**

- **Análisis Territorial en el Aprovechamiento Sostenible de las Materias Primas Minerales en España, J. Antonio Espi**

- **A Indústria de Fertilizantes e a Sustentabilidade, Gildo Sá Albuquerque**

- **Santo Antônio de Pádua: um pólo de extracção de Rochas Ornamentais no Estado do Rio de Janeiro, Antônio R. Campos, Gildo A. S. C. Albuquerque, Salvador L. M. Almeida, Marco A. R. Silva, Marçal S. Maia**

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- **Sustainable Industrial Development for Mining Sector (Activity Report for The United Nations Industrial Development Organisation – UNIDO), F. E. Novaes Hegenberg**

- **Informe sobre las Jornadas CYTED XIII y IMACC COPPER FORUM, Agustin Paladines**

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ADDITIONAL DOCUMENTS

- **UNIDO International Technology Centres (ITCs)**

- **Centre for Mineral Technology – CETEM – Brasil**
- **Indústria Extractiva – Informação Estatística, N° 5, Instituto Geológico e Mineiro, Ministério da Economia, 1999**

- **Indústria Extractiva – Uma dinâmica de adaptação ambiental, Instituto Geológico e Mineiro, PEDIP, Ministério da Economia**

- **Guia de Acesso à Actividade Mineira, Instituto Geológico e Mineiro, Ministério da Economia, 1999**

- **The International Copper Study Group´s, World Copper Factbook, 1999**

- **Copper Bulletin, International Copper Study Group, Vol. 6 No. 7, July 1999**

- **Sector Mínero-Metalúrgico Brasileiro e a Tecnologia Industrial Básica: Resultados de uma pesquisa de campo, Gildo A. Sá C. Albuquerque, MCT, CNP_q, CETEM, 1996**

- **A Produção de Fosfato no Brasil: Uma apreciação histórica das condicionantes envolvidas, Gildo A. Sá C. Albuquerque, MCT, CNP_q, CETEM, 1996**

SYNOPSIS

Sustainable Development issues are being discussed worldwide in order to bring consensus among stakeholders regarding the routes and directions that governments and enterprises are to follow aiming to develop codes and procedures that might allow an optimal utilization of the worlds resources.

In such a context, the last Davos Economic World Summit addressed the question of the extraction mineral industries and sustainability, moreover stressing the environmental and decomissioning issues faced by mining and metallurgical operations.

IMAAC and CYTED-XIII, the first having as its goals and objectives the fostering of sustainable practices within the materials industries and, the second, besides, acting upon iberoamericans research entities and enterprises in coordinating clean technologies production principles as well methodological tools in achieving sustainable goals, joined efforts in bringing together a selected group of professionals, meeting at the joint JORNADAS + FORUM, in discussing and proposing concepts, ideas and , why not, eventual solutions for the challenges posed by sustainable development principles upon the extraction mineral industries and using, as a case-study, the copper extraction industry.

Within this scope, a three-day workshop was held in at the Faculdade de Engenharia da Universidade do Porto, in Oporto, Portugal, that introduced the theme and promoted interactive discussions within the invited participants; after such presentations were made and discussions were promoted, technical visits to selected sites for specific objectives were accomplished.

The first of these visits was to SOMINCOR/RTZ mine of Neves Corvo, located in the environmentally sensitive area of Alentejo, in Portugal, in order to discuss the environmental management of such singular enterprise at that location.

The second visit was devoted to BOLIDEN/APIRSA at Los Frailles, Aznalcollar, in Spain, seeking to discuss the collapse of the tailings dam, which affected near 4200 hectars near the Doña Aña's natural preservation area.

The third, and final, visit was performed at RIO TINTO mines in Rio Tinto, Spain, in order to assess the need of decommissioning protocols and measures for mining affected areas.

INTRODUCTION

Materials play a fundamental role in developing a nation and in maintaining or increasing its share in the world's economy.

However, any material to be produced has in its transformation cycle, at least one extracting, processing, fabrication and manufacturing step in which releases of substances say gases, liquids and solids, occur to the environment, affecting people, biota and global resources balances.

Sustainable Development issues are reflected in the materials based industries as the achievement of:

- **minimization of energy** utilization throughout the production process;
- **minimization of mass discards**, from mine to waste;
- **minimization of environmental impacts** associated to land, soil, gases, solids and liquids effluents;
- **maximization of the social satisfaction**, taking into account the needs, desires and goals of the stakeholders;

Planning in a sustainable environment thus means for each of the above mentioned criteria:

- **minimization of energy utilization**: in order to reach the global compromise, a necessary review of the world's energy consumption pattern is needed, regarding:

a) the energetic sources: what are those that mostly impact the environment? What are those that most use huge masses of materials? What are those that most attend the community wills, as jobs, reallocations of cities and villages, etc.
b) the energy dissipation: i.e., the energetic efficiencies of the demanding sectors and their re-distributions and eventual re-dimentionings;
c) the energetic superfluous: disposable products, with quite effemerous life-cycle, demanding energy;
d) the energetic criteria: leading to the conception, definition and implementing of energetic management models that will minimize energy usage;

- **minimization of mass discards**, as:

a) the planning of developing, and uprising, of extraction, processing and manufacturing industries realigned, worldwide, and re-oriented in searching for targets that minimizes energy consumption, environmental impacts and maximizes social satisfaction;
b) industries that are technological capable of recovering by and co-products and promote the re-utilization of recyclable items;
c) the design criteria has to conceive materials that are, or might be, substitutes among themselves; that minimizes the design and production of superfluous materials and that are corrosion resistant;

- **minimization of environmental impacts**: it is understood that the environmental aggression, as promoted by human being, is quite inherent to the industrial production activity in such a way that when utilizing energy to extract, process and manufacture a given material, the environment is being altered. Thus, in order to reach a global compromise regarding minimization of the environmental impact, politicians, planners, economists and scientists have to pay attention to:

a) processes that are all borne within the synergisms between energy, materials and environment;

b) favor through legislation and scientific development, clean technologies (pollution prevention technologies) having low energy and materials inputs;

c) the implicit need to alter the environment aiming "social satisfaction";

- **maximization of social satisfaction**: although quite often not mentioned, this is the central issue of the S.D. concept; i.e., how to conceive, define, and implement an adequate "social satisfaction"? How "adequate" is adequate and what could be visualized as social satisfaction? Therefore thoughts should be given to:

a) social satisfaction as goals to be reached by a particular society, within a given cultural background, although not globally disconnected, defined via stakeholders approaches aiming to achieve problem solutions, via a consensual analysis and methodology;

b) the terms "adequate" should bear the expectations of different and distinct societies, however bearing in mind the equitable balance between the lesser developed and the more developed societies;

In order to tackle all these matters, well recognized world experts were invited to present their ideas and eventual suggestions to a selected audience, also comprising world experts for comments, criticisms and suggestions. These were grouped at the joint event called JORNADAS CYTED-XIII and IMAAC COPPER FORUM.

- **experts contributions**
  - ***on Sustainable Development issues***:
    - Geosciences and Sustainable Development, presented by Eng. Luis José Rodrigues da Costa, Chairman of the Board for IGM, the Instituto Geológico Mineiro of Portugal;
    - The fundaments of S.D. principles and their impacts upon the materials world, presented by Prof. Dr. Eng. Roberto C. Villas Bôas, Chairman of IMAAC Advisory Board and International Coordinator for CYTED-XIII;
    - Materials Policy for minerals and wastes within the context of S.D., by Prof. Dr. Econ. James Randal Kahn, Professor at the Department of Economy of the University of Tennessee at Knoxville, United States;
    - Some issues on mining sustainability for discussion at the Davos meeting, by Prof. Dr. Alyson Warhurst, professor at the University

of Bath (now Professor at Warwick), United Kingdon; the paper was read by Roberto Villas Bôas, in the absence of the author.

- ***on commercial issues and S.D.:***

➢ The international market of ore and minerals and the issues of S.D., by Dr. Econ. Francisco Fernandes, Full Researcher at CETEM/CNPq, Rio de Janeiro, Brasil;

➢ Environmental management: equipment and technology markets, by PhD candidate Flávio Novaes-Hegenberg, University of Leeds, England;

- ***on new mining enterprises:***

➢ A discussion on new mining investment decision making model taking into account sustainable development principles, by Geologist Jose Mario Coelho, of the Companhia de Pesquisas de Recursos Minerais, CPRM, Brasil;

➢ Land and environmental management models and concepts as applied to mining in a S.D. framework, by Prof. Dr. Ing. José Antonio Espi, Professor Titular, Escuela de Minas de Madrid;

- ***on case-studies:***

➢ Life Cycle Analysis (LCA) for the mineral extraction industries: the boron case, by Dr. Adisa Azapagic, Lecturer at the Chemical Engineering Department of the University of Surrey, England;

➢ Design of an integrated resource management system for supplying and processing of metals: the examples of aluminium and copper,

by Dr. Stefan Butenback and co-workers at the BBK-Aachen, Germany;

- The fertilizer's industry and its sustainability, by Eng.MSc. Gildo Sá Cavalcante de Albuquerque, Vice-President of ALAMI, the Latin American Association for Mining, headquarters in Lima,Peru;

- ***on specific copper issues:***

- Copper mining in an environmentally sensitive area: the Neves Corvo Mine, by Eng. Jorge Coelho, Director of SOMINCOR /RTZ;
- Aznalcollar: the catastrophe of the tailings dam, by Prof. Dr. Ing. José Antonio Botin, Professor Titular, Escuela de Minas de Madrid;
- Copper sustainability: discussions in the industry, by Dr. Patrick Hurens, of the International Copper Study Group (ICSG), Lisbon, Portugal;

- ***on decommissioning issues:***

- Environmental sustainability of mine waste facilities in dry climate: challenges to technology and policy to follow, by Geochemist Darren Swanson, of SXDRFTUOO, Golden, Colorado, United States.

- ***on sustainable mining policies:***

- The mineral policy in Argentina: its achievements, by Ing. Hugo Nielson, President of the Servicio Geologico y Minero (SEGEMAR), Buenos Aires, Argentina;

▫ experts attendance:

Name	Affiliation	Country
Adisa Azapagic	Reader at the Chemical Engineering Departement of the University of Surrey, England	Bosnia/UK
Agustin Paladines	Professor at the Universidade Central of Equador, Quito, Equador	Equador
Alyson Warhurst	Professor at the University of Bath (now Professor at Warwick), United Kingdon	United Kingdon
Carlos Fernando Forero	Director General de ASOGRAVAS, Bogota, Colombia	Colombia
Carolyn McCommon	Principal Consultant-Manager, Social Development and Commmunity Affairs, Rio Tinto Technical Services	UK
Cesar Canepa	Professor at the Universidade of San Marcos, Lima	Peru
Darren Swanson	Geochemist of SXDRFTUOO, Golden, Colorado, United States	USA
Eurico Pereira	Geologist of IGM, the Instituto Geológico Mineiro of Portugal	Portugal
F. James Kahn	Professor at the Department of Economy of the University of Tennessee at Knoxville, United States	USA
Fernando Perales Calderon	Professor at the University National Mayor de San Marcos, Lima, Membro do Comité da Organização	Peru
Flavio Novaes Hegenberg	Professor at University of Leeds, England	Brazil/UK
Francisco Fernandes	Full Researcher at CETEM/CNPQ, Rio de Janeiro	Brazil
Gaston Proaño Cadena	Professor at the Escola Politecnica of Litoral, Guayaquil, Equador	Equador
Gildo Sá Cavalcante de Albuquerque	Vice-President of ALAMI, the Latin American Association for Mining, headquarters in Lima, Peru	Brazil
Gina Hernandez	Ministerio da Economia-El Salvador	El Salvador
Isaiah Ruzengwe	General Manager/Chief Executive, the Zimbabwe Mining Development Corporation	Zimbabwe
Jorge Coelho	Director of SOMINCOR/RTZ	Portugal
José Antonio Botin Gonzalez	Sub-Director and Professor Titular at the Escola de Minas, Madrid	Spain
José Antonio Espi	Professor Titular at the Escola de Minas, Madrid	Spain
José Mario Coelho	Geologist of the Companhia de Pesquisas de Recursos Minerais, CPRM-Brasil	Brasil
Julio Cesar Mendes	Professor at the Universidade Federal of Ouro Preto, Brazil	Brazil
Luis José Rodrigues da Costa	Chairman of the Board for IGM, the Instituto Geológico Mineiro of Portugal	Portugal
Manuel Afonso M.F. Almeida	Associate Professor at Metallurgical and Materials Department-FEUP	Portugal
Marcos Tadeu Suita	Professor da Universidade Federal de Ouro Preto-Brasil	Brazil
Mário Machado Leite	Director do Laboratório do IGM	Portugal
Mark Mistry	Geologist-Institute für Bergbaukunde	Germany
Martin Ruhrberg	Environmental Engineer-Institute für Bergbaukunde	Germany
Michael Roehrlich	Mining Engineer-Institute für Bergbaukunde	Germany
Patrick Hurens	Senior-Engineer of the International Copper Study Group (ICSG), Lisbon	Portugal
Roberto Blanco	Professor at the ISMM, Moa, Cuba	Cuba
Roberto C. Villas Bôas	Chairman of IMAAC Advisory Board and International Coordinator for CYTED-XIII	Brazil
Stefan Butenback	Mineral Processing Engineer-Institute für Bergbaukunde	Germany

THE METHODOLOGY

The methodology followed at the said events was:

a) presentations of ideas ad suggestions regarding the S.D. issues as affecting the materials, minerals included, world;

b) thorough discussions of these ideas and suggestions by the audience, in order to emerge real situations among the participants that eventually might be solved, or at least might have a first direction towards solutions (accomplished in at least three real cases);

c) visits to selected mining sites for a more comprehensive approach on mining in an environmentally sensitive area, the problems caused by acid mine drainage and decommissioning issues;

d) discussions at the mine sites with international experts available at the mining sites;

e) lastly, a comprehensive report from the part of each and every participant relating, based on whatever was presented and discussed, his overviews, funded in his professional experiences, in dealing with sustainable issues in geology and mining;

THE CONCLUSIONS

The following main conclusion may be attempted:

- S.D. issues are to be seriously addressed by industry, since they might mean definite market positions;
- within the S.D. issues, the ones that are receiving a greater attention from the part of industry are those related to mining in environmentally sensitive areas, acid waters included, and decommissioning;
- stakeholders are gaining greater freedom of movement in decision making tools and thus the constraints so imposed to new mining activities;
- scientific and technical aspects of S.D., as LCA, sustainability indexes, decision making models, etc., are to be coupled with other social and political aspects of it in order to gain stakeholders credit and approval;
- other several specific conclusions may be found at the specific reports from the participants (see Technical Reports Annex).