

# ***HYDROPROCESS2008***

**II INTERNATIONAL WORKSHOP ON  
PROCESS HYDROMETALLURGY**

14-16 May 2008. Santiago, Chile

**Editors** *Jorge Menacho & Jesús Casas*

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## CHAIRMAN'S ADDRESS

Mining industry is now enjoying the economic prosperity times, especially as far as copper is concerned which for rather a long time has been averaging 3-4 US\$/Lb. In spite of the cyclic character of the metal market, high prices are still expected to hold in the middle term, due to the strong international demand, particularly from the Chinese giant. This is not just the case of copper but a generalised tendency in most of the metals and mineral products prices.

Chile has firmly kept the first place among the copper producers and about 5.9 million of tons are expected to be produced during 2008. Expansions in existing plants as well as the emergence of new projects make this figure possible to achieve. Anglo American, Antofagasta Minerals, BHP Billiton, Codelco and Xstrata, among others, are planning strong investment projects with portfolios reaching US\$11,000 million. This dynamics not only involves the big copper producers, but also medium size production projects like Franke of Centenario Copper, Papomono of CMLA-Vale and such exploration projects as Tabaco and Copequire from International PBX.

55,222 billion metric tons are the total reserves of the 166 copper projects to be developed worldwide in 2007-2015. The corresponding investments reach US\$ 65,043 billion and copper production 12,231 million tons. Worldwide average copper grade is 0.71% for concentrate production and 0.66% for EW cathode production. America concentrates 58% of these projects, Asia 15%, Africa 14%, Oceania 9% and Europe 4%. Latin America accounts for 73% of total continental projects and 42% worldwide. Average worldwide specific investment is US\$ 5,318 per ton of fine copper. Chile is the country with the largest number of projects; 12 in concentrate and 14 in SX-EW with 0.74% and 0.55% copper grades, respectively, lower than the worldwide grade average.

During the 2007 copper mining companies spent over US\$ 9,900 million in exploration surveys worldwide, from which about US\$ 360 million were destined to Chile.

Gold producers have also undertaken costly initiatives in our country headed by Barrick's Pascua Lama with US\$ 2,300 million in investments. This project was delayed for several years first due to difficulties in obtaining the environmental permits and now due to problems in tax negotiations between Chile and Argentina.

El Volcán project of Andina Minerals worth US\$1,000 million and Cerro Casale of Barrick Gold are also important gold projects.

The Hierro Atacama project (US\$ 340 million) of Compañía de Acero del Pacífico, CAP, includes the exploitation of the Cerro Negro iron mine which is to produce 4 million tons of iron pellet for the iron steel industry. CAP is also planning the construction of a new galvanised iron plant in Huachipato worth US\$ 300 million in investments.

Another iron producer Minera Santa Bárbara is currently enlarging capacity of La Japonesa mine (US\$ 12 million) to extract ores from the Japonesa Mirador Primavera and Mariposa sectors.

A number of other important projects in the industrial minerals sector are now in progress. White Mountain site is to start rutile and feldspar extraction from the Cerro Blanco orebody with US\$ 200 million in investments. Atacama Minerals is investing US\$100 million in the Aguas Blancas plant to increase iodine production starting from 2008, thus reinforcing the Chilean position as the pioneer producer of this element. In addition, SQM has an important portfolio of projects surpassing US\$ 630 million in nitrates, lithium and iodine products held by the increasing demand and higher international prices.

In February 2008 President George W. Bush announced the 5 times increase in the current US. biofuel production by 2022, which means about 15,000 million gallons resulting from ethanol produced from corn crop. This will probably induce a huge fertiliser demand. Accordingly, SQM will invest US\$ 700 million in the next three years to increase its fertiliser production. SQM currently holds 45% of the world nitrate production followed by TRI Company in the US with 36% and Kemaplo in Jordan with 7%.

The II International Workshop on Processes Hydrometallurgy HYDROPROCESS 2008 is developed within this mining industry prosperity context. The scope of this meeting reminds us that hydrometallurgy moves beyond the copper limits and that cross experience is always a positive one for everyone.

We expect this second HydroProcess meeting to be a valuable contribution to the diffusion of technological innovations and new process developments and practices among all participants.

**Dr. Jorge M. MENACHO**

*Chairman and Head Editor*

II International Workshop on Processes Hydrometallurgy

HYDROPROCESS 2008

## FOREWORD

The II International Workshop on Process Hydrometallurgy HYDROPROCESS 2008 held on 14-16 May 2008 in Santiago, Chile, was produced by GECAMIN Ltd.

HYDROPROCESS 2008 served as an international forum where hydrometallurgical professionals may analyse and discuss recent innovations and developments related to the wet processing of ores and industrial materials. Each Hydroprocess workshop seeks to achieve the following objectives: i) Discuss emerging developments and identify the best practices and methodologies in the hydrometallurgy of metals and industrial minerals, ii) Promote the exchange of knowledge and experience in the design, planning and operations of hydrometallurgical plants, iii) Analyse design and evaluation criteria for industrial plant projects, and iv) Promote development of an interdisciplinary international network for technical collaboration and exchange among hydro-metallurgists.

This Proceedings contains 37 papers written by authors from 14 different countries, including Algeria, Australia, Brazil, Canada, Chile, Cuba, Equator, France, Mexico, Nicaragua, Peru, Spain, Sweden and the United States. Thematic distribution of papers is as follows:

- Cyanidation and Cyanide Treatment (5)
- Leaching and Bioleaching of Ores and Concentrates (6)
- BioHydrometallurgical Studies and Developments (5)
- Electrolytic and Solvent Extraction Processes (5)
- Modelling of Hydrometallurgical Operations and Processes (4)
- Automation, Optimisation and Control of Equipments and Industrial Plants (4)
- Innovations and Developments in the Hydrometallurgical Processes (8).

The Organising Committee acknowledges with gratitude the efforts of all the authors who produced high quality, detailed and innovative technical papers. We also thank the reviewers, GECAMIN Ltd., and all those involved in the creation of this proceedings. The support of the Organising, Advisory and Technical Committees has been greatly appreciated as has been that of the Session Chairmen.

The Organising Committee also wishes to thank the following sponsors (as of 7 April 2008) for their contribution: ABB, GEOBIOTICS, OUTOTEC CHILE LTD., RIEGO SISTEMAS AND MINERÍA CHILENA.

Finally, we thank all the delegates who attended the workshop exchanging their valuable knowledge and expertise, thus contributing to the great success of this second HYDROPROCESS Workshop.

**Dr. Jesús M. CASAS**

*Technical Coordinator and Head Editor*

II International Workshop on Processes Hydrometallurgy

HYDROPROCESS 2008

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## HEAD EDITORS' BIOGRAPHIES

**Jorge MENACHO LLAÑA** is a Dr. in Metallurgical Engineering from the University of Concepción, Chile, and has completed post doctoral studies at Pennsylvania State University, USA. He is Technical Manager of De Re Metallica Ingeniería Ltd., and has over thirty years of experience focused in the fields of copper hydrometallurgy and mineral processing. He has been involved in over 200 studies and projects in R&D, technological innovation, engineering and above all in the optimisation of industrial processes. Co-author of 25 patents, several presently in use, Dr. MENACHO is an active consultant. His Clients include: Codelco Chuquicamata, El Salvador, Andina, El Teniente, Radomiro Tomic, Lomas Bayas, El Abra, Collahuasi, Minera Sur Andes, Andacollo Cobre, Cerro Colorado, Minera Michilla, Mantos Blancos, Manto Verde, Quebrada Blanca, among others.

He used to be a Member of the National Council for Science and Technology, Chairman of the two past International Copper Hydrometallurgy Workshops. Lecturer in Solvent Extraction and Oxide Leaching in the International Short Courses given at the Copper International Conferences of 1995 and 2003, Staff member at the Graduate School of the University of Concepción, as well as Lecturer at many other copper conferences.

**Jesús M. CASAS DE PRADA** is a Dr. in Chemical Engineering Sciences from the University of Chile and has a Post Doctorate from the University of Toronto, Canada. He is an Assistant Professor at the University of Chile and an Independent Consultant. He has eighteen years of experience focused on metallurgy, process design, phenomenological modeling and speciation of aqueous electrolyte solutions. He has been involved in studies and projects in R&D. Author and Co-author of many Congress and ISI Papers as well as Research and Technical Reports.

He had worked for SGS Lakefield Research as Manager of a Hydrometallurgy group in metallurgical test-work and development projects. He has participated in several research projects for universities, PNUD, FONDECYT and FONDEF, and run projects for institutions and mining companies including; Anglo American Chile, BHP Billiton, CMLA-VALE, CODELCO-Chile, CIMM, Collahuasi, ENAMI, Xstrata Copper - Fundición Altonorte, IM2, Minera Florida, Quebrada Blanca, Pucobre, SQM, Zaldívar, Molymet, and engineering companies including; AMEC International, Outokumpu, IDESOL, SNC-Lavalin, among others. He had worked as Technical Coordinator of the International Workshops: HYDROCOPPER 2005 and 2007, and HYDROPROCESS 2006 and 2008. Dr. CASAS is a member of the Chilean Society of Metallurgy and Materials. He is a lecturer in Transport Phenomena in Metallurgy, Physical-Chemistry of Metallurgy and Process Design at the University of Chile.

