Thirty years of Base and Precious Metals Exploration in the Central Andes

José Cabello
Manager Latin America, Discovery Business Development, BHP Minerals Development

INTRODUCTION

The Central Andes (Argentina, Bolivia, Chile and Peru) are one of the key metals mining regions in the world, remaining one of the most important for both current production and future growth in the global mining industry.

Last year the region produced 4,496,611 t of fine copper, 29,344 t of molybdenum, 156 t of gold, 3,834 t of silver and 1,055,026 t of zinc (Table 1). This corresponds to the following share of world production: copper 44.5%, silver 22.6%, zinc 14.7% and gold 6.1%. The Central Andes are also an important producer of antimony, bismuth, cadmium, lead, lithium, molybdenum, tin and tungsten. Over the last decade, mining productions of copper, gold, silver and zinc have all increased by 20% or more. Copper has shown the biggest increase, with output rising by more than 70%. Several facts explain this large increase in metals production, with a key one being the success of exploration over the last thirty years. This resulted in the discovery of several world-class deposits which, once developed into mines, accounted for much of the production increases.

This review summarizes the successes of basic exploration carried out during the last three decades in the Central Andes (Figure 1) and is based on data published in different specialized mining books or magazines (Sillitoe, 1995; Cabello, 1999; Benavides and Vidal, 1999). It mainly includes discoveries important at a world or regional scale (minimum gross in situ value of US$200 million), but not minor discoveries important at a local scale. The economic impact of these discoveries is here presented regarding the value of the mineral resources identified, the investments and metals production generated.

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◆ R. Large elected fellow of the Australian Academy of Technological Sciences & Engineering

◆ News from the Council

◆ P. Herzog receives Leibniz Prize for 2000

◆ 6th Biennial SGA Meeting, Krakow, Poland, 26-29 August 2001
Professor Ross Large elected a fellow of the Australian Academy of Technological Science & Engineering

Jessica Tyler
Public Relations Officer, Centre for Ore Deposit Research, University of Tasmania, GPO Box 252-79, Hobart Tasmania 7001

Professor Ross Large, Director of Tasmania’s Centre for Ore Deposit Research, has been elected a fellow of the prestigious Australian Academy of Technological Sciences & Engineering in recognition of his world-leadership in ore deposit research, at a special ceremony in New South Wales earlier this week. The election also recognises his management of the Centre for Ore Deposit Research, located at the University of Tasmania, described in the citation as “Australia’s pre-eminent group in this field”. Since its creation in 1989 as a National Key Centre, the Centre has grown to become one of the leading forces in minerals exploration research and development for the Australian industry. With a turnover of more than $3.5 million, the Centre is backed by industry through collaborative research projects at many of the major mining districts around the world. Professor Large is the first Tasmanian geologist to be elected to the Academy and Technological Sciences & Engineering, and joins an eminent group of six other Tasmanian scientists from other fields previously elected. The 1999 Oration ceremony for 32 new fellows across a range of scientific disciplines was held in Cooma, New South Wales and was given by Dr. Michael Gore AM, Director of the National Science & Technology Centre during the Academy’s 1999 Symposium and General Meeting.

Professor Ross R Large
Director, Centre for Ore Deposit Research

Brief Biography

Ross Large was born in Hobart, Tasmania in 1948 and graduated with BSc (Hons I) from the University of Tasmania in 1969. He joined Geopeko as an Exploration Geologist at Tennant Creek in 1970 and stayed with that company until 1984, rising to the positions of Senior Geologist (Queensland) in 1975 and Supervising Geologist (Tasmania) in 1979. During his period with Geopeko he undertook a PhD degree at the University of New England on the genesis of the Tennant Creek orebodies. After graduating in 1974, he spent a year on leave at the University of Toronto as a CSIRO Postdoctoral Fellow, studying Archaean massive sulfide deposits. In 1983 he received the Lindgren Award for excellence in research from the International Society of Economic Geologists for his work on the Tennant Creek deposit, as well as Canadian ore deposits. In 1984 he joined the University of Tasmania as Senior Lecturer in Economic Geology and in 1987 was promoted to Reader. During that time he led a team of researchers studying gold and base metal deposits in western Tasmania and northern Australia.

In 1989 he established the National Key Centre for Ore Deposit and Exploration Studies (CODES), at the University of Tasmania, and has been Professor of Geology and Director of CODES since 1990. In 1996 CODES received recognition as the premier research centre in Economic Geology in Australia, gaining the status of an Australian Research Council (ARC) Special Research Centre (SRC). In his current position as Director of the Centre for Ore Deposit Research (CODES SRC), Ross is leading a team of 25 research geoscientists and over 50 postgraduate students, who work on a range of industry-linked projects in Australia and overseas. Professor Large has become internationally recognised for his research on volcanic hosted massive sulfide deposits and Proterozoic ores of copper-gold and zinc-lead-silver.

In 1990 he received the Presidents Award from the Australasian Institute of Mining and Metallurgy, and was the Society of Economic Geologists (SEG) Distinguished Lecturer for 1998. Since 1990 Ross has attracted over $7 million for research from industry, Federal and State Government sources. ♦
NEWS OF THE SOCIETY

News of the Council

Revisions of the SGA Constitution
Following major constitutional changes suggested and approved by the SGA Council in Strasbourg (March 99), only minor corrections have been implemented to the final text of amendments to the SGA Constitution.

1999 SGA election
Jan Pasava presented to the Council a list of officers for 99 election.

Price increase
After keeping membership fees unchanged for more than five years the Council considered an increase of the SGA membership fees in all categories effective from 1.1.2000. There are two major reasons to explain this move: (i) increase in the number of issues of MD from 5 to 8, (ii) introduction of two issues of SGA News per year. The Council finally approved the following figures:

<table>
<thead>
<tr>
<th>Membership Type</th>
<th>DM old</th>
<th>DM new</th>
<th>Euro new</th>
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<tr>
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<td>Senior/Junior membership</td>
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<tr>
<td>Corporate membership</td>
<td>294</td>
<td>391</td>
<td>200</td>
</tr>
</tbody>
</table>

Mineralium Deposita
Eight issues with a total of 801 pages and 17 colour plates were published in the volume 34, 1999. Two more issues are under preparation. The Council once more highly appreciated efforts of D. Rickard and V. Walters which resulted in a significant increase of scientific level of the Society Journal.

R. Goldfarb and B. Lehmann will prepare an article to the issue 1, vol. 35, 2000, promoting MD from various points of view (e.g. emphasizing high citation index - leading scientific journal in mineral deposit, fast publishing etc.)

Promotion
G. Borg informed the Council on the professional SGA booths. Four booths have been finally purchased. Three of them were transported to Perth (Australia), Denver (USA) and Cape Town (South Africa). The last one, which was displayed at the SGA booth in London, will be stored in Halle (Germany).

The Council recommended that better communication between the Regional SGA Vice-Presidents and the Promotion Manager should be developed in the future with the aim to use these portable pannels for promotion of SGA at selected important scientific gatherings worldwide.

5th Biennial SGA-IAGOD Meeting
The Council extended best thanks to Ch. J. Stanley, Chairman of the Organizing Committee of the 5th Biennial SGA-10th IAGOD Quadrennial Meeting, for excellent organization of the meeting and high scientific and technical quality of the Proceedings.

The Meeting was attended by 532 participants (of which 101 students) plus 42 accompanying persons. There were 172 talks and 186 posters. Grants were attributed for a total of 83 days of accommodations, 18 student registration fees and 35 full registration fees. The abstracts were gathered into two volumes of Proceedings of the Meeting for a total of 1468 pages.

Next SGA Biennial Meeting
The 2001 SGA Biennial Meeting will be held in Krakow, Poland, between 26 and 29 August 2001. The candidature of the University of Mining and Metallurgy (Krakow, Poland) has been accepted by the SGA Council at the end of November 1999. The first circular of the Meeting will be distributed in the beginning of 2000. For more information see page 20.

Various
-The Council approved that SGA members will pay reduced registration fee at the future Society Biennial Meetings even if they joined the Society 1 day before the meeting.
-The Executive Secretary wishes to thank all Council members who volunteered at the SGA stand in London. This promotion activity resulted in receipt of 45 new members.

Future SGA Activities
-31st IGC (August 6-17, 2000, Rio de Janeiro, Brazil) - SGA will run 4 symposia: i) Pre-Atlantic Metallogeny of West Africa and Eastern South America (B. Lehmann); ii) Ore Deposits of the Central Andes (L. Fontbote); iii) Mineral Deposits Associated with Black Shales (J. Pasava); iv) Organics in Major Environmental Issues (J. Pasava -IGCP 429).

CHANGE OF ADDRESS FORM

If you have changed (or will change in the near future) your address please fill in this form and send it to:

Peter M. Herzig, SGA Treasurer - Institut fur Mineralogie, TU Bergakademie Freiberg, Brennhausgasse 14 - D-09596 Freiberg, Germany; phone: +49 3731 39-2662/2626; fax: +49 3731 39-2610; e-mail: herzig@mineral.tu-freiberg.de

Name: ________________________________

Old address: ........................................

Complete new address (including phone, fax and e-mail) ........................................

________________________________________
Society for Geology Applied to Mineral Deposits

This is to certify that
H. Stein, K. Sundblad, R. J. Markey, J. W. Morgan, and G. Motuza

have been awarded the

Mineralism Deposita Best Paper Award

for their paper

Re-Os ages for Archean molybdenite and pyrite, Kuittila-Kivisuo, Finland and Proterozoic molybdenite, Kabeliai, Lithuania: testing the chronometer in a metamorphic and metasomatic setting.


Presentation of major SGA Council proposals

The following proposals were separately approved by the General Assembly on a majority vote:

1. Nomination of Prof. Maurice Pagel, the former SGA Executive Secretary, to become a Honorary Member of SGA effective from 1.1.2000.


SGA-IAGOD Joint Meeting, London, 22-25 August 1999

The SGA President and Executive Secretary appreciated the efforts of Ch. J. Stanley, and of the Organizing Committee of the 5th Biennial SGA-10th IAGOD Quadrennial Meeting for the excellent organization of the meeting and the great work of the editors which resulted in the high scientific and technical level of the Proceedings.

Your suggestions and ideas for any topic of interest to SGA are welcome! They can be addressed to any Council member or to

Dr. Jan Pasava
SGA Executive Secretary

Czech Geological Survey
Klárov
CZ-11880 Prague 1
CZECH REPUBLIC

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SGA NEWS

January 2000-Number 8

SGA NEWS MAILBOX

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We expect your letters with comments, news, criticisms, ...

- 6th Biennial SGA Meeting (Krakow, Poland, 26-29 August 2001).
- 11th Quadrennial IAGOD Symposium (July 2002, Windhoek, Namibia).

IMPORTANT NOTICE!!!

Applications to SGA for meeting sponsorship have to be submitted to Jan Pasava, SGA Executive Secretary, on appropriate forms developed and approved by the SGA Council which are available at the SGA home page on Internet:

http://www.min.tu-clausthal.de/www/sga/sga.html

Other requests will not be considered.

SGA General Assembly, London,
24 August 1999

Biennial SGA Award for the best MD paper

H. Papunen, the SGA President, introduced a newly established SGA award for the best MD paper which will be given every two years at the Society Biennial Meetings. The prize consists of a certificate, a sum of DM 3000 and paid travel expenses for one person to the Biennial Meeting where the Prize will be awarded.

Presentation of the SGA 99 MD Best Paper Award

H. Papunen, SGA President and R. Goldfarb, Editor, MD, North American Office, have presented the First SGA Award for the Best MD Paper to Holly Stein (Colorado State University, USA), the first author of the article:

### Executive Committee

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- H. Papanen (Finland)

**Vice-President**
- B. Lehmann (Germany)

**Past President**
- E.F. Stumpf (Australia)

**Executive Secretary**
- J. Pasa (Czech Republic)

**Treasurer**
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**SOCIETY FOR GEOLOGY APPLIED TO MINERAL DEPOSITS (SGA)**

**MINERALIUM DEPOSITA Editors**
- D. Rickard (U.K.)
- R. Golightly (U.S.A.)

### Regional Vice-Presidents

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<th>Region</th>
<th>Member</th>
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<tr>
<td>N. America</td>
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<tr>
<td>S. America</td>
<td>M. Brøndkorb (Argentina)</td>
</tr>
<tr>
<td>Asia</td>
<td>M. Shimizu (Japan)</td>
</tr>
<tr>
<td>Australia</td>
<td>R. Hill (Australia)</td>
</tr>
<tr>
<td>South Africa</td>
<td>H. Frimmel (South Africa)</td>
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### Councillors: term ending on December 31, 1991

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<td>C. Ayont (Spain)</td>
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<tr>
<td>A. Bjørlykke (Norway)</td>
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<tr>
<td>C. Casparini (USA)</td>
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<td>P. Laitanzi (Italy)</td>
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<tr>
<td>C. Marignac (France)</td>
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<td>S. Scott (Canada)</td>
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### Councillors: term ending on December 31, 2001

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<td>F. Barriga (Portugal)</td>
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<td>C. Borg (Germany)</td>
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<tr>
<td>Ch. Heinrich (Switzerland)</td>
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<td>H. Kucha (Poland)</td>
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<td>J. F. Milesi (France)</td>
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<tr>
<td>W. Pair (Austria)</td>
<td></td>
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<tr>
<td>Ch. Stoki (U.K.)</td>
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### Ex officio Members, SEG

**President**
- P. Bethke (U.S.A.)

**Executive Secretary**
- J. A. Thoms (U.S.A.)

### Ex officio Members, IAGOD

**Secretary General**
- J. Aichler (Czech Republic)

**Membership Secretary**
- R. Seilmann (Germany)

**SOCIETY FOR GEOLOGY APPLIED TO MINERAL DEPOSITS (SGA)**

Report of the Executive Secretary about membership

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67 Regular Members, 5 Junior Members, 15 Student Members, 2 Senior and 1 Corporate Member applied for membership from March 29 to August 16, 1999

**LIST OF NEW SGA MEMBERS**

(March 29 - August 17, 99)

#### Regular Members

- Mark BARLE. The University of Western Australia, Nedlands, WA, AUSTRALIA
- Giuseppe LO GRASSO, Mareeba, QUEENSLAND, AUSTRALIA
- Peter A. McNiel, Stoneville, WA, AUSTRALIA
- Peter NEMNY, The University of Western Australia, AUSTRALIA
- Guy FRANCESCHI, CS CURT, Gent, BELGIUM
- Terence J. BOTTRI. Oakville, Ontario, CANADA
- Lise CHÊNARD, Geology and Mining Engineering, DESSAU SOFRING, Albiti-Témisacmangi, Rosny-Nordique, CANADA
- Michael CHUTE, Consulting Geologist, Peterborough, ON, CANADA
- Stephen GREEN, Geological Survey of Canada, Ottawa, ON, CANADA
- Gerhard JACOB, Consultant, Calgary, CANADA
- James LANG, Delta, B.C., CANADA
- Larry MCCORMACK, L.Mccormack Associates Ltd., Mississauga, ON, CANADA
- Allan D. MAC TAVISH, APPRINTE Geological Consulting, Thunder Bay, ON, CANADA
- Alexander E. MARR, Toronto, ON, CANADA
- M. McClaire, Colorado Res. Ltd., Vancouver, B.C., CANADA
- Robert S. MIDDLETON, Robert S. Middleton Exploration Services Inc., Vancouver, B.C., CANADA
- Richard NIEMINEN, Renue-Noranda, QC, CANADA
- Michel J. RUSSEN, Exploration Geologist, Mississauga, ON, CANADA
- Greg STOTT, Ontario Geological Survey, Sudbury, ON, CANADA

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**SGA News**

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Norman RUSSELL, CARIBBEAN MINES INC., Ciudad de la Habana, CUBA
Maurice POUILLAUD, Douin Anzil Mauger, Hudgat, FRANCE
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Gerhard BROWN, Mining Services B.V., Budapest, HUNGARY
Douglass J. KIRWIN, Induced Goldfild Ltd., Jakarta Selatan, INDONESIA
Eibhlin DOYLE, Dublin, IRELAND
Garth EARLS, Crowe Schafftalloy Associates Exploration Mining Services, Dublin, IRELAND
Adrian COOTT, Eiel, ISRAEL
Paulo CONSTANTINI, Rozzatoarchi, ITALY
Jorge BENAVIDES, Empresa Philips Del PERU S.A., Lima, PERU
Miguel CARDODO, South America North Limited, Lima, PERU
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NikolaI EREMIL, Moscow State University, Moscow, RUSSIA
Yuri MALYUTIN, Moscow State University, Moscow, RUSSIA
Valery MALIVIENNIKOV, Institute of Mineralogy, RAS, RUSSIA
Tanja PROCUMOVA, Moscow State University, Moscow, RUSSIA
Lyubka SAKIVA, Moscow State University, Moscow, RUSSIA
Boris SOKOLOV, Moscow State University, Moscow, RUSSIA
Victor STAROSTIN, Moscow State University, Moscow, RUSSIA
Andrei TSYTEKOV, BHP Minerals, Moscow, RUSSIA
Alagay YUTKIN, Moscow State University, Moscow, RUSSIA
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Tony HARWOOD, Placer Dome Exploration Inc., Essoesford, Bedfordview, SOUTH AFRICA
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Ismael OZGUEN, Dogus Etil University, Bursa, Izmir, TURKEY
Tim COLEMAN, British Geological Survey, Keyworth North, UNITED KINGDOM
Graham PHILLIPS, University of Leeds, Leeds, UNITED KINGDOM
Cameron A. ALLEN, Mnd, WA, U.S.A.
Robert W. ALLEN, Bullet Mineral Investments, Danbury CN, U.S.A.
John BALLA, Cascadia Mining, Spokane, WA, U.S.A.
Geoffrey BALLANTINE, Kommetjie Exploration Company, NY, U.S.A.
John FLOREK, Haymarket, VA 22566, U.S.A.
Wayne KEMP, Evergreen, CO, U.S.A.
Steven E. KIESLER, The University of Michigan, Ann Arbor, MI, U.S.A.
Mark A. PETRIEN, MAP Geologic Consulting, Littleton, CO, U.S.A.
David ROYLE, MIM International Exploration, Golden, CO, U.S.A.
Douglas B. SILVER, BALFOUR HOLDINGS, INC., Fergiwold, CO, U.S.A.
David J, SZUMILCA, State of Alaska Department of Natural Resources, Fairbanks, Alaska, U.S.A.
Benjamin MAPANI, University of Zimbabwe, Harare, ZAMBIA
Issa H. NYAMBE, School of Mines, University of Zambia, Lusaka, ZAMBIA
S. SIMDZIKU, School of Mines, Lusaka, ZAMBIA

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**Student Members**

Pablo R. LEAL, Buenos Aires, ARGENTINA
Andrew CONLY, University of Toronto, Toronto, ON, CANADA
Darwin GRIEV, Ottawa, ON, CANADA
Jason KING, University of Victoria, Saaskatoon, SK, CANADA
Kab U. HERULO, London, ON, CANADA
Heather MACDONALD, Toronto, ON, CANADA
Naziem PASTAKIA, University of Toronto, Toronto, ON, CANADA
Craig THEREN, University of Sadburth ofake, SSK, CANADA
Ryoe WESTON, University of Toronto, Toronto, ON, CANADA
Lawrence WINTER, St. John’s, NF, CANADA
Aurakka LIPONEN, Innsbruck, Austria
Muhammad Arar, Gazeli Bakir i.a., Gazeli-Rize, TURKEY

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**Senior Members**

Deb S. SIKKA, Cabinet Conseil en Geologie Miniere Sika Etn., Montreuil, CANADA
O. ALLARD, McKenzie Bay Resources Ltd., Athens, GA, U.S.A.

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**Corporate Members**

PHILLIPS DODGE EXPLORATION, Tucson, Arizona, U.S.A.
METALLOGENESIS

The geological evolution of the Central Andes is characterized by a complex history with a subduction-related record extending back into the Paleozoic. Accretion predominated before the Gondwana supercontinent fragmentation. Calc-alkaline and alkaline magmatism, extension, rifting, subsidence, opening and inversion of basins, extensive back-arc volcanism are all common features of the Andean setting (Megard, 1994; Mpodozis and Ramos, 1990). The Meso-Cenozoic magmatic arcs were formed on a continental, static basement, which is known to include both Paleozoic magmatic and sedimentary rocks generated at earlier subducting margins, and at least two Precambrian complexes (Ramos, 1988).

The long and complex history of the Central Andes has had a decisive role in generating a diverse set of mineral deposits in a variety of geological settings (Petersen, 1989). The Meso-Cenozoic period is, by far, the most productive. In contrast, the pre-Andean cycle stages are much less important (Cabello, 1991; Schalamuk et al., 1992).

Most of the Central Andes copper resources are present in deposits related directly to Meso-Cenozoic intrusive activity (Sillitoe, 1994). This category is dominated by porphyry copper deposits but also includes contact-metasomatic, skarn and enargite-bearing replacement bodies, especially in southern and central Peru (Petersen and Vidal, 1996). As many as seven epochs of porphyry copper mineralization ranging in age from late Carboniferous to Miocene-Pliocene, are recognizable in the Central Andes (Cabello, 1996). Based on available geochronological datings of intrusion and hypogene alteration mineralization the main porphyry orebodies can be assigned to four discrete north-trending belts progressively younger eastward, from Early Cretaceous through Paleocene, to late Eocene-early Oligocene and Miocene-Pliocene (Sillitoe and McKe, 1996). The remaining copper resources are in volcanic and/or sedimentary sequences of upper Paleozoic through upper Tertiary age (Flint, 1989; Fontboté, 1990). This second category includes manto-type deposits as well as red-bed and VMS type copper deposits in western Bolivia and southern Peru, respectively (Vidal, 1987; Cox et al., 1992).

The Central Andes have become a major precious metals province as a result of exploration successes mainly in the last three decades, although an appreciable number was first identified as old mines or prospects during earlier times. Twenty-four are in production, five are being prepared for production, additional five are at or beyond the feasibility stage and one has been mined out.

**Table 1: Central Andes, Mining Production 1998.**

<table>
<thead>
<tr>
<th></th>
<th>Chile</th>
<th>Argentina</th>
<th>Peru</th>
<th>Bolivia</th>
<th>TOTAL</th>
<th>% of World Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper</td>
<td>3,843,000</td>
<td>170,000</td>
<td>483,000</td>
<td>---</td>
<td>4,496,000</td>
<td>44.5</td>
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<td>Gold</td>
<td>43,025</td>
<td>19,459</td>
<td>93,570</td>
<td>14,443</td>
<td>170,497</td>
<td>6.1</td>
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<tr>
<td>Silver</td>
<td>1,344</td>
<td>69</td>
<td>2,025</td>
<td>452,131</td>
<td>3,890,131</td>
<td>22.6</td>
</tr>
<tr>
<td>Zinc</td>
<td>20,000</td>
<td>35,560</td>
<td>868,757</td>
<td>150,709</td>
<td>1,055,046</td>
<td>14.7</td>
</tr>
</tbody>
</table>

During the last 30 years, it can be calculated that some US$ 3.3 billion was invested in basic exploration in the Central Andes. It is estimated that about 45% have been spent in base metals exploration and the remaining 55% has been devoted to the search of precious metals deposits.

The 76 base and precious metal deposits reviewed here (Figure 1 and Table 2) were all mainly explored and discovered during the last three decades, although an appreciable number was first identified as old mines or prospects during earlier times. Twenty-four are in production, five are being prepared for production, additional five are at or beyond the feasibility stage and one has been mined out.
Figure 1: Central Andes main discoveries from 1969 to 1998.
### Table 2: Central Andes main discoveries, 1969–1998.

<table>
<thead>
<tr>
<th>Resources</th>
<th>Grades</th>
<th>Discovery Year</th>
<th>Estimated Past Investment</th>
<th>Estimated Future Investment</th>
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<td>1.9</td>
<td>3.6</td>
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</table>
Table 2 (continued)

| Minas Conga | Porph CuAu | 432 | 0.3 | 0.82 | --- | --- | 1997 | 300 |
| La Arena-La | HS Epith Au | 21 | --- | 1.13 | --- | --- | 1996 |
| Virgen | HS Epith Au | 31 | --- | 2 | --- | --- | 1996 |
| Tres Cruces | HS Epith Au | 68 | --- | 2.9 | 23 | --- | 1993 | 260 |
| Pierina | HS Epith Au | 15 | --- | 2.26 | --- | --- | 1996 |

**Zinc-Silver**

| Bongara | MVT Zn | 2 | --- | --- | 19.3 | 1996 |
| Palica | Replac Zn | 15 | --- | --- | 8 | 1992 |
| Uchucchacua | Replac Zn | 9 | --- | 400 | 2.1 | 1981 | 35 |
| Isacaycruz | Replac Zn | 10 | 0.4 | 17.7 | 17.3 | 1989 | 50 |
| San Gregorio | Replac Zn | 70 | --- | 17.2 | 7.3 | 1994 |
| Accha | MVT Zn | 9 | --- | --- | 9 | 1998 |

**Copper**

| Tambo Grande | VMS CuZn | 42 | 2 | --- | 37 | 1.1 | 1979 | 350 |
| Canariaco | Porph Cu | 380 | 0.6 | --- | --- | --- | 1970 |
| La Granja | Porph Cu | 2000 | 0.61 | 0.04 | 3.9 | 0.12 | 1978 |
| Galeno | Porph Cu | 405 | 0.59 | 0.15 | --- | --- | 1998 |
| Cerro Corona | Porph CuAu | 300 | 0.3 | 0.5 | --- | --- | 1992 |
| Tantahuatay | Porph CuAu | 375 | 0.79 | 0.33 | --- | --- | 1995 |
| Pashpap | Porph Cu | 110 | 0.64 | --- | --- | --- | 1969 |
| Marcia Punta | HS Epith CuAu | 49 | 1.89 | 0.35 | --- | --- | 1994 |
| Toromocho | Porph Cu | 1.178 | 0.51 | 7 | 4 | 1974 |
| Pukapampa | Porph Cu | 100 | 0.6 | --- | --- | --- | 1998 |
| Los Chancas | Porph Cu | 200 | 1 | --- | --- | --- | 1999 |
| Cerro Lindo | VMS CuZn | 70 | 1 | --- | 2.4 | 1995 |
| Ccatac Pucara | Skarn Cu | 24 | 1.44 | --- | --- | --- | 1999 |
| Corococuyaco | Skarn Cu | 155 | 1.57 | 0.33 | --- | --- | 1975 |
| Quechua | Porph Cu | 100 | 0.84 | --- | --- | --- | 1970 |

**TOTAL** | | 10331 | 16623 |

Abbreviations: LS=low sulfidation; HS=high sulfidation; Epith=epithermal; Mesoth=mesothermal; Porph=porphyry; Met=metasomatic; Replac=replacement; MVT=Mississippi Valley type; VMS=volcanogenic massive sulfides.

Forty copper discoveries are included in this review. The main ones are Bajo la Alumbrera, Mi Vida-Agua Rica and Pachon (Argentina); La Escondida, Collahuasi, Los Pelambres, Zaldivar, Escondida Norte and Candelaria (Chile) and La Granja and Toromocho (Peru). This review reports also thirty precious metals discoveries. Of these, the most important and best known are: Veladero and Cerro Vanguardia (Argentina); Korikollo (Bolivia); El Indio District, La Coipa, Pascua and Refugio (Chile) and Yanacocha and Pierina (Peru). Six zinc-lead-silver deposits, all located in central Peru, also appear in the list. The better known are Uchucchacua, Iscaycruz and San Gregorio.

From an ore model point of view, most of the discoveries correspond to porphyry copper or porphyry copper-gold (34) and high and low sulfidation epithermal precious metals deposits. Of these, the most important and best known are: Veladero and Cerro Vanguardia (Argentina); Korikollo (Bolivia); El Indio District, La Coipa, Pascua and Refugio (Chile) and Yanacocha and Pierina (Peru). Six zinc-lead-silver deposits, all located in central Peru, also appear in the list. The better known are Uchucchacua, Iscaycruz and San Gregorio.

From a development point of view, most of the discoveries correspond to porphyry copper or porphyry copper-gold (34) and high and low sulfidation epithermal precious metals deposits (26). Also discovered were four polylmetallic replacements, three contact metasomatic copper, two volcanogenic massive sulfides (VMS), two Mississippi valley type (MVT), two exotic copper, two calcic skarn copper-gold and one mesothermal gold.

**DEVELOPMENT, PRODUCTION AND ECONOMIC RESULTS**

Eleven copper, seventeen precious metals and two polymetallic deposits have been developed and put into production through December 1998 (Table 3). To reach that stage US$10.3 billion were invested. To put the remaining undeveloped deposits into production and to expand the new existing operations an estimated US$16.6 billion will be required (Table 4). Of this group of new mines, the first one to start production was El Indio, Chile, in 1979. The metal production generated by these deposits since 1979 is: 6.95 million t of copper, 595.3 t of gold, 7,035.5 t of silver and some 236,000 t of zinc all together valued at some US$ 18 billion.

The resulting exploration effort has delineated in-ground resources exceeding 162 million t of metallic copper with an estimated gross in situ value of US$ 268 billion, 16 million t of zinc valued at US$ 16.4 billion, 4,941 t of gold US$ 46.2 billion and 63,175 t of silver valued at US$ 11.2 billion. In addition buy-in expenditures totaling some US$ 3 billion were identified.

When putting together all the discoveries (Table 4), the gross in situ value of all the resources identified is US$ 346.2 billion. This is simply a measure of the value of metal in the ground, not taking into account the cost or economic viability of extraction, processing and sales.

A simplified way of measuring the economic productivity of mineral exploration in the Central Andes during the 1969-1998 period can be obtained by comparison of the total exploration funds with the related past and future development investments, as well as with the past production value and the resources in situ value (Table 5). On this basis every dollar spent in basic exploration has generated US$3.1 in past investments and could generate another US$ 5 if the projected future investment is completed. Each exploration dollar return 5.6 times its value in production. Moreover, this same dollar has allowed discovery of and delineated a metal resource with a nominal in-ground resource value of US$ 96.3.

All economic figures were calculated using nominal 1998 US$ dollar and average estimated metals prices valid for the same year: copper US$ 1,653 per t (US$ 0.75 per pound); gold US$ 9,452 per kg (US$ 294 per ounce); silver US$ 177 per kg (US$ 5.5 per ounce) and zinc US$ 1,023 per t (US$ 0.46 per pound).
**Table 3: Central Andes Main Discoveries 1969-1998. Estimated production since start-up.**

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<th></th>
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<th>Gold kg</th>
<th>Silver kg</th>
<th>Zinc t</th>
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**FUTURE TRENDS**

In spite of the current depressed metals market it can be predicted that the Andes of Argentina, Bolivia, Chile and Peru will remain as one of the most important region regarding exploration activities for the foreseeable future. Investments will continue to flow into these countries stimulated by the tremendous success of past exploration and related mining developments. Their appeal is based on several factors: excellent geological prospectivity, permissive size and grade of deposits with respect to critical metal price cycles, balanced environmental laws coupled with gradually improving infrastructure conditions and adequate political-economic stability.

**Table 4: Central Andes Discovery Summary 1969 – 1998. Base and Precious Metals Deposits.**

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</tbody>
</table>

**Table 5: Central Andes Main Discoveries 1969-1998. Exploration Investment Multiplication Effect.**

| US$1 (exploration funds) = US$3.1 (Past Investments) generated | US$5.0 (Future Investments) |
| ---                                                             | US$5.6 (Metals Production)  |
| id                                                              | US$96.3 (Resources Gross in situ Value) |

In conclusion, ongoing exploration drilling of new potential important discoveries keeps yielding favorable results: epithermal prospects in southern Argentina, mesothermal gold in central-northern Bolivia, porphyry coppers in northern Chile (Gaby, Elvira and Opache prospects) and more precious and base metals in Peru (Quicay, Tarmatambo, Tincyaclla, Antapite, Antapaccay, etc.).
As metal prices remain broadly stable or improve, it can be expected that the region discovery record over the next decade will be similar to that presented here.

ACKNOWLEDGEMENTS

The author would like to thank the support given to this research by the BHP Minerals Discovery Group, especially by Chris Blain, Hugo Dummett and Steven Potter. The co-operation of Luis Fava and Cesar Vidal during the stage of data collection is greatly appreciated. The manuscript benefited from reviews by Adriana Espanon and John-Mark Staud.
Dr. Peter M. Herzig receives Leibniz Prize for 2000

Dr. Peter M. Herzig is the recipient of the Leibniz Prize for 2000 from the German Research Foundation (DFG). The prize, named after the German philosopher, mathematician and physicist Gottfried Wilhelm Leibniz (1646-1716), is the highest honor bestowed by the DFG and comes with an award of 3 million German Marks (1.7 million US$) for research in the recipients field. Prof. Herzig is currently the Dean of the Faculty of Geosciences at the Freiberg University of Mining and Technology. He is recognized for his outstanding achievements in the field of mineral deposits research and the study of modern seafloor hydrothermal systems. He has participated on 16 research cruises, including two cruises aboard the JOIDES Resolution drilling ship (co-chief scientist on ODP Leg 158). In recent years, he has worked extensively in the submerged arc environments of the western Pacific, discovering the first known submarine epithermal gold deposit off the island of Lihir in 1994.

Dr. Herzig continues to be a leading figure in German geoscience, serving on numerous scientific advisory boards, and internationally, with ODP and InterRidge. He has been the Treasurer of SGA (Society for Geology Applied to Mineral Deposits) since 1994 and is an associate editor of Mineralium Deposita. The Leibniz Prize will be presented to Dr. Herzig in Bonn on February 10, 2000.

European Metallogenesis Thematic Issue of Mineralium Deposita is dedicated to David Johnstone

The European Metallogenesis Thematic Issue of Mineralium Deposita, Vol. 34/5, has been dedicated to David Johnstone who died whilst on field work. He had submitted a paper for this issue before his death and his family gave permission for his paper to be printed (Johnston, J. D., Regional fluid flow and the genesis of Irish Carboniferous base metal deposits. MD, 34: 571-598). A copy of the Thematic Issue of Mineralium Deposita was sent by the MD Editorial Office of Cardiff to the mother of David Johnston. Here we publish a letter sent to D. Rickard (MD European Office Editor) by Joan Bingley, David Johnston’s sister.

“I recently visited my mother in Dublin and had the opportunity to study the copy of the Thematic Issue on European Metallogenesis which was dedicated to my brother Dave. I found it fascinating and was surprised how much of the content that I, a former mathematician turned businesswoman, could understand. Our mother was delighted to have a copy and has also read some of it with interest.

It is good to know that so much of the thinking that David did in recent years was pulled together and published for the record and to inspire others to pursue his ideas. When clearing his house, we found so many disks and files where he was helping other people with their work that one feared that his own perhaps was not as well recorded. However, your publication would seem to go a long way to completing that record.

Many thanks for the work you put in on editing both the Issue as a whole and also on the piece attributed to David.

With best wishes

Joan Bingley”

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The SGA homepage on Internet has moved to the following new address:

http://www.min.tu-clausthal.de/www/sga/sga.html
Wallrock Alteration and Primary Geochemical Dispersion in Lode-Gold Exploration
by Pasi Eilu, Edward J. Mikucki, and David I. Groves, 65 pages.

The book describes:

- Wallrock alteration of lode-gold deposits
- Lithogeochronal techniques for exploration
- Trace-element variability between deposits
- Recognition of favourable structural sites
- Dispersion aureoles
- Geochemical vectors to ore using case studies

The Golden Mile open-pit at Kalgoorlie, Western Australia, one of the world's largest lode-gold deposits.
MEETINGS, CONFERENCES, FIELD TRIPS AND SHORT-COURSES

RECOMMENCEMENT OF THE M.Sc. PROGRAMME IN EXPLORATION GEOLOGY ON 6TH SEPTEMBER 1999
AT THE DEPARTMENT OF GEOLOGY, UNIVERSITY OF ZIMBABWE

On September 6, 1999, our updated M.Sc. Programme in Exploration Geology has recommenced and the first module on Mineral Discoveries will be presented. The M.Sc. Programme imparts the latest geological concepts in exploration, mining, and management. Courses are given by specialists of recognized national and international acclaim, with a number of talks held by invited professionals in the mining and exploration industry of Zimbabwe. A large variety of laboratory sessions and more than 30 field days assures that the M.Sc. Programme is practical and skills oriented. The M.Sc. Programme is structured on a part-time basis to meet industry requirements.

Registration and Fees
Applicants will normally have obtained a good B.Sc. Honours degree in Geology from the University of Zimbabwe or other approved university or institution, or an equivalent qualification in earth sciences, environmental sciences or mining. General candidates may be considered for entry after completion of three years of relevant work experience. Students may either register and pay fees for single modules, or for the complete M.Sc. Programme. Foreign students are encouraged to apply and will be assisted to obtain an education permit.

Attractive features of the M.Sc. Programme include: Key short courses by international experts, short presentations by company geologists, a large variety of field trips, and time flexibility.

For further information please contact:
Dr. P. Buchholz, M.Sc. Director, Department of Geology, University of Zimbabwe, P.O. Box MP 167, Mount Pleasant, Harare, Zimbabwe; phone: +263-(04)-303211 Ext. 1427; fax: +263-(04)-336418; e-mail: mse@geology.ujz.zw

For registration at the University of Zimbabwe please contact:
Postgraduate Office, Deputy Registrar (Academic), University of Zimbabwe, P.O. Box MP 167, Mount Pleasant, Harare, Zimbabwe; phone: +263-(04)-303211 Ext. 1106; fax: +263-(04)-333407.

ICGP-373 FIELD CONFERENCE IN THE URALS
“Towards the Eroded Uralo-Paleozoic Ocean to Continent Transition Zone: Granitoids and Related Ore Deposits”
Ekaterinburg, Russia
18-30 July 2000

The next annual field conference of ICGP-373 is planned to be held in the Urals, 18-30 July 2000. The field conference will include a 11 day field trip to the most interesting geological areas of the Middle and South Urals (bus excursions with field workshop character) and two scientific conference sessions at the beginning and at the end of the trip. At the first conference session contributions will be presented giving information on the main features of the Urals geology and typical ore deposits. At the end of the field excursion, a scientific conference will consist of a daily introduction lecture, detailed field examination, and final discussion. The participants will be accompanied by local experts who will provide detailed information on the geological situation and give the necessary on site explanations. At the second conference session we shall discuss results and correlation methodology from the major case study regions of ICGP-373.

For general information and to receive the official invitation for visa application contact: Dr. Vladimir Smirnov, Institute of Geology and Geochemistry, UB RAS, Pochtovy per., 7, Ekaterinburg, 620151, Russia; phone: +7(3432) 511785; fax: +7(3432)515252; e-mail: smirnov@iguran.ru

Send ABSTRACTS and FINAL REGISTRATION FORM with PAYMENT to: Dr. R. Selmann, Natural History Museum, Department of Mineralogy, Cronwell Road, London SW7 5BD, United Kingdom; phone: +44(207) 942 5042; fax: +44(207) 942 5537; e-mail: rm@nhm.ac.uk

IMPORTANT DATES

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>01/04/2000</td>
<td>Return of information form to get invitation for your visa application</td>
</tr>
<tr>
<td>01/04/2000</td>
<td>Submission of abstracts preferentially by e-mail</td>
</tr>
<tr>
<td>30/04/2000</td>
<td>Mailing of official invitation for visa application to non-NIS (former Soviet Union) participants. Information on funding to NIS participants who applied for travel grants. Information on receive of payment and abstracts acceptance (as talk or poster).</td>
</tr>
<tr>
<td>15/06/2000</td>
<td>Sending of your travel schedule (your arrival and departure dates)</td>
</tr>
<tr>
<td>18-30/07/2000</td>
<td>International Field Conference</td>
</tr>
</tbody>
</table>

31ST INTERNATIONAL GEOLOGICAL CONGRESS
Rio de Janeiro, Brazil

SGA-COSPONSORED

August 6-17 2000

The 31st Session of the International Geological Congress - 31st IGC - will be held in Rio de Janeiro, Brazil, from August 6 to 17 of the year 2000, in cooperation with and under the scientific sponsorship of the International Union of Geological Sciences - IUGS. The 31st IGC is co-hosted by the Brazilian Geological Society, the Brazilian Ministry of Mines and Energy, Brazilian Ministry of Science and Technology, the Geological Survey of Brazil, Petrobras, the National Department of Mineral Production and important Brazilian government agencies, universities and scientific institutions. Industrial organizations and other South American countries will also be involved in the organization of the Congress. The meeting is designed to create a forum for a broad debate of the most significant advances in the geological sciences and to promote a discussion of the theme: Geology and Sustainable Development: Challenges for the Third Millennium.

Registration Fees
<table>
<thead>
<tr>
<th>Category</th>
<th>Members</th>
<th>Accompanying Members</th>
<th>Students in 2000</th>
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<tbody>
<tr>
<td>Participating</td>
<td>US$ 350</td>
<td>US$ 150</td>
<td>US$ 100</td>
</tr>
</tbody>
</table>

Scientific Program
The Scientific Program of the 31st IGC consists of Colloquia, Special Symposia, General Symposia, Short Courses, Workshops, and Field Trips. SGA will run 3 Symposia: i) Pre-Atlantic Metallogeny of West Africa and Eastern South America (B. Lehmann); ii) Ore Deposits of the Central Andes (L. Fontbolé); iii) Mineral Deposits Associated with Black Shales (J. Pasava); iv) Organics in Major Environmental Issues (J. Pasava - ICGP 429).

Contact address
Secretariat Bureau - Casa Brazil 2000
31st INTERNATIONAL GEOLOGICAL CONGRESS
Av. Pastur, 404 - Urca - Rio de Janeiro - RJ - Brazil, Cep 22.920-240; phone: +55 21 295 8094; e-mail: 31igc@31igc.org - web site: http://www.31igc.org
Training Course in Exploration and Environmental Geochemistry

postgraduate course

Organized by the Czech Geological Survey, Prague and IGCP 429 with the support of UNESCO

Geochim

Prague and Dolní Rozínka, Czech Republic
4 - 18 September 2000

Aims of the course
The certified postgraduate course aims at providing knowledge of important geochemical methods widely used in the prospecting for ore deposits and at showing their applications in the solution of environmental problems. Individual lectures covering various geochemical methods will be accompanied by practical field and also computer training. The course will be followed by a 3 day field trip visiting ongoing open and underground mining operations and processing plants as well as abandoned mining sites with the aim to demonstrate possible ways of effective usage of geochemical methods in both exploration and environmental issues.

Contents of the course
Principles of exploration and environmental geochemistry, exploration and environmental applications of soil geochemistry, stream sediments, heavy minerals, biogeochemical, lithogeochemical, hydrogeochemical, geophysical and radiometric studies with practical field and computer training.

Language of the course
The official language of the course will be English.

Other information considered relevant to the course
For technical reasons, the number of participants has to be restricted to 15 persons.

Tuition fees including the cost of printed handouts is US$ 100 for university postgraduate students, US$ 200 for personnel from state agencies such as geological surveys and US$ 400 for staff members of private companies. Accommodation, travelling and meals during the course will be covered by the organizers. International travelling to Prague is not included. A diploma will be awarded to each successful participant.

Place
Prague (2 days), Dolní Rozínka - Hotel Dou 1 (40 km north of Brno).

Duration
4 - 18 September 2000

Application procedure
Applicants must have a good knowledge of English and the fundamentals of geochemistry. A Bsc degree or equivalent is the minimum requirement. The application form together with a short CV should be sent to organizers not later than March 15, 2000. Letter of acceptance with detailed programme, travel and payment instructions will be sent to selected applicants during May 2000.

Deadline for application: March 15, 2000

Contact address:
GEOCHIM 2000
Dr. Jan Pasava
Czech Geological Survey
Geologická 6
150 00 Prague 5 - Barrandov
phone: +420-2-5817390
e-mail: pasava@cgu.cz
Fax: +420-2-5818748
masek@cgu.cz

Training Course in Geochemical Exploration Methods and their Environmental Applications

Organized by the Czech Geological Survey in Prague and IGCP 429 with the support of UNESCO

Prague and Dolní Rozínka, Czech Republic
4 - 18 September, 2000

APPLICATION FORM

Name: __________________________ Surname: __________________________

Obtained degree: __________________________ Present position: __________________________

Institution: __________________________

Address: __________________________

Phone: __________________________ Fax: __________________________

E-Mail: __________________________

Male/Female (please tick): Male ☐ Female ☐

Date: __________________________ Signature: __________________________

Return by March 15, 2000 to the above address
APPLICATIONS SUCCESSFULLY LAUNCHED IN THE CZECH REPUBLIC

INTRODUCTION
It has been tradition to organize very successful UNESCO Postgraduate Courses on Geochemical Prospecting Methods in the former Czechoslovakia from mid 70's. The first certificated course, GEOCHIM PRAHA UNESCO 1975, was launched on September 5, 1975, and lasted till October 25, 1975. Since that time this course has been organized biannually by the Czech Geological Survey in Prague together with the Dionyz Stür Geological Survey in Bratislava and sponsored by the Division of Earth Sciences (UNESCO/Paris) and the International Association of Geochemistry and Cosmochemistry (IAGS). The course was specialized on both theoretical and practical training in classical geochemical prospecting methods.

The major political and economic changes initiated in 1989 and which led to a split up of the former Czechoslovakia into two independent countries, the Czech and Slovak Republics, have had a significant impact on the evolution of earth sciences and related mining activities. Following decades of extensive exploration programmes and also underground and surface exploitation, new policies have been formed which will result in a more responsible approach to the environment.

A very old and famous prospecting and mining tradition, coupled with a strong emphasis on environmental issues, are reflected in the character of a newly recovered certificated GEOCHIM Postgraduate Training Course. Our new group intends to offer a more complete view, showing how these classical geochemical prospecting methods can be successfully used in the solution of various environmental problems.

GEOCHIM 99
GEOCHIM 99 was held in Prague and Dolni Rozínka (Czech Republic) from September 6-20, 1999 and 12 scientists, representing 8 developing countries were trained both theoretically and practically in the geochemical exploration methods and their environmental applications.

This course was organized by the Czech Geological Survey and IGCP 429 under the auspices of the Ministry of the Environment of the Czech Republic, and the Czech IGCP National Committee and financially sponsored by the Czech Commission for UNESCO, Czech Geological Survey in Prague, Division of Earth Sciences (UNESCO/Paris) through the contract no. SC/RP 205.563.9, and the International Geological Correlation Programme IGCP 429 “Organics in Major Environmental Issues”.

It should be noted that the course was launched on September 7th, 1999 in the building of the Czech Geological Survey in Prague by opening speeches delivered by the Dr. J. Hlaváček, Director, Section of Foreign Relations of the Ministry of the Environment, Czech Republic, Dr. K. Komárek from the Czech Commission for UNESCO, Dr. M. Ruzicka, Director of the Czech Geological Survey and Dr. J. Pasava, Chairman of the Czech IGCP National Committee, Co-leader of the IGCP 429 and Director of the GEOCHIM 99.

Lectures, seminars and practical field training started on September 8th, 1999 in Dolni Rozínka and included the following subjects: (1.) Introduction to the geochemical prospecting methods, (2.) Principles of environmental geochemistry, (3.) Principles of analytical methods, (4.) Heavy minerals prospecting and evaluation of HM concentrates with environmental applications, (5.) Stream sediment prospecting with environmental applications, (6.) Soil prospecting with environmental applications, (7.) Biogeochemical prospecting with environmental applications and up to date results of the IGCP 429, (8.) Lithogeochemical prospecting, (9.) Hydrogeochemical prospecting with environmental applications, (10.) Geophysical prospecting methods with environmental application and radon risk, and (11.) Computer modelling of prospecting and environmental data.

Individual lectures, covering various geochemical methods which were presented during morning sessions, were followed by afternoon practical field and computer training. The course was followed by a field trip visiting active mining operations and processing plants as well as abandoned mining sites with the aim to demonstrate possible ways of effective usage of geochemical methods in both prospecting and environmental fields.


CONCLUSIONS AND FUTURE PLANS
Many participants very highly appreciated both organization and scientific level of the course through their personal letters mailed either directly to the organizers or to Mr. F. Repetto from the Division of Earth Sciences, UNESCO, Paris.

ACKNOWLEDGEMENTS
On behalf of the Organizing Committee, I wish to extend best thanks to the following sponsors – Czech Geological Survey in Prague, Czech Commission for UNESCO, Division of Earth Sciences, UNESCO (Paris), IGCP 429 and Czech IGCP National Committee, for their generous support. It would not have been possible to organize this course without efforts of members of the Organizing Committee (B. Křibek, D. Masck, I. Písteková, R. Čadská, V. Bíhař and J. Tesar from the Czech Geological Survey in Prague) as well as considerable understanding of the management of the DIAMO/GEAM State Enterprise in Dolní Rozínka. Last, but not least, I wish to thank all authors who contributed to the textbook and all lecturers.
**FORTHCOMING EVENTS**

### May 15-18
**GEOLOGY AND ORE DEPOSITS 2000: The Great Basin and Beyond: A Geological Society of Nevada Symposium Reno/Sparks, Nevada, USA**
- Contact address: GSN Symposium Editor, P.O. Box 12021, Reno, NV 89510-2021, USA; phone: +1 775 323 3500; fax: +1 775 323 3599; e-mail: gsn symp@nbmg.unr.edu; web-site: http://www.seismo.unr.edu/GSN

### May 21-24
**5TH INTERNATIONAL CONFERENCE ON ACID ROCK DRAINAGE**
- Denver, CO, USA; Contact address: ICARD SME, PO Box 625002, Littleton, CO 80120-5002; phone: 303 793 9550; fax: +1 303 973 5461

### May 29-June 1
**GEOLOGICAL ASSOCIATION OF CANADA - MINERALOGICAL ASSOCIATION OF CANADA, Jjoint Annual Meeting, Calgary, AB, Canada**
- Contact address: web-site: http://www.geoacanada2000.com

### June 13-21
**XIX CURSO DE POSTGRADO EN METALOGECIA, Quito, Ecuador**
- Contact address: Dr. Jaime Jarrin J., Director del ISP, Universidad Central del Ecuador, Facultad de Ingenieria en Geologia, Minas y Metallogecia, Instituto Superior de Postgando, CASILLA:12-1542, Quito, Ecuador;
- phone: +593 2 557 814; fax: +593 2 566 738 or 593 2 500 306; e-mail: inves@uo.teclotenet.net

### June 29-July 8
**GALICIA 2000, BASEMENT TECTONICS 15: VARISCAN-APPALACHIAN DYNAMICS - THE BUILDING OF THE UPPER PALEOZOIC BASEMENT, A CORUÑA, Spain**
- Contact address: Florentino Díaz García, Departamento de Geología, Universidad de Oviedo, Avda de Velasco s/n, 33005 Oviedo, Spain; phone: +34 98 510 31 14; fax: +34 98 510 31 03; e-mail: bt15@asturias.geol.uniovi.es; web-site: http://www.geol.uniovi.es/bt15.html

### July 3-7
**ICGP - 373 Field Conference in Finland, Rapakivi Granites and Associated Mineralization in Finland, Finalnd**
- Contact address: Prof. Ilmari Haapala / Sari Lukkar, Department of Geology, University of Helsinki, Sennalmiankatu 3, SF-00170 Helsinki, Finland; fax: +358 9 191 234 66; e-mail: ilmari.haapala@helsinki.fi or sari.lukkar@helsinki.fi; web-site: http://www.helsinki.fi/~eillott/icgp-373/

### July 4-6
**GEOCONGRESS 2000, Stellenbosch, South Africa**
- Contact address: The Secretariat, Geocongress 2000, Department of Geology, University of Stellenbosch, Private Bag X1, Matieland 7602, South Africa; phone: +27 021 808 3219; fax: +27 021 808 31 29; e-mail: geologie@maties.sun.ac.za; web-site: http://www.sun.ac.za/geology/

### July 12-14
**GEOFLUIDS III, Barcelona, Spain**
- Contact address: Dr. K. Bitzer, Consejo Superior de Investigaciones Cientificas, Instituto de Ciencias de la Tierra 'Jaume Almera', Solé I Sabarís s/n, 08028 Barcelona, Spain; phone: +34 93 410 54 10; fax: +34 93 411 00 12; e-mail: geofluids@natura.geo.ub.es; web-site: http://www.ub.es/geofluids/geofluids.htm

### July 19-22
**10TH PERUVIAN GEOLOGICAL CONGRESS, Lima, Peru**
- Contact address: Alberto Manrique; Soc. Geol. del Perú, Armando Marquez 2277, Lima 11, Peru; phone: +51 1 2612362; e-mail: sgp@finitel.gob.pe

### July 13-21
**ICAM2000, 6TH INTERNATIONAL CONGRESS ON APPLIED MINERALOGY, Göttinngen, Germany**
- Contact address: ICAM 2000 office, BGR/MLFB, P.O. Box 510153, D-30631, Germany; phone: +49 511 643 2298; fax: +49 511 643 3685; e-mail: icam2000@bgr.de; web-site: http://www.bgr.de/ICAM2000/

### July 18-30
**ICCP-373 FIELD CONFERENCE IN THE URALS, "The Eroded Urals Paleozoic Ocean to Continent Transition Zone: Granitoids and Related Ore Deposits"**
- Ekaterinburg, Russia; Contact address: Dr. Vladimir Smirnov, Institute of Geology and Geochemistry, UB RAS Pochoty per.; Ekaterinburg, 620151, Russia; phone: +7 3432 517865; fax: +7 3432 516520; e-mail: smirnov@ipg.uran.ru
Students of mineral resources throughout the world may apply for thesis research grants available in 2000 from the Society of Economic Geologists. Purpose of the research grants is to provide partial support of research expenses.

Applications must be postmarked by 1 February 2000, and awards will be announced by 15 April 2000.

**Ethi**

Eidgenössische Technische Hochschule Zürich

Ecole polytechnique fédérale de Zurich

Politecnico federale di Zurigo

Swiss Federal Institute of Technology Zurich

**PhD Opportunities**

Fluid-inclusion and isotope geochemistry

Maggmatic-hydrothermal ore deposits

The Fluids and Ore Deposits Group at the Swiss Federal Institute of Technology (ETH Zurich) invites applications for new PhD projects starting in the first quarter of 2000. The PhD projects aim at a well-constrained quantification of mass-transfer processes in selected ore-forming magmatic-hydrothermal systems, combining field and laboratory work. The latter involves application of novel techniques for trace-element and isotope geochemistry, including microanalysis of fluid and melt inclusions by LA-ICP-MS. Enthusiastic young geoscientists with an MSc or equivalent degree are invited to visit our homepage at www.erdw.ethz.ch/institutes/iimr/iimr.html for further information, or contact C. Heinrich at heinrich@erdw.ethz.ch.
SOCIETY FOR GEOLOGY APPLIED TO MINERAL DEPOSITS

SGA Membership Application Form

I would like to become a member of the Society for Geology Applied to Mineral Deposits (SGA) and to receive my personal copy of Mineralium Deposita.

Surname/Corporation
First name
Title
Mailing address
Phone
Fax
E-mail
Date of birth
Nationality
Degrees obtained from Universities or Colleges
Present position
Membership in other scientific societies

Are you a member of the Society of Economic Geologists? (If yes, no sponsors are necessary)  
- Yes  - No

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☐ DM 49 (25EUR)  Student (up to Ph. D., max. 4 years)*
☐ DM 88 (45EUR)  Senior (after retirement)*
☐ DM 391 (200EUR)  Corporate (includes 3 copies of Mineralium Deposita)

*Certificate required

If the application is approved by the SGA Council, I authorize the "Society for Geology Applied to Mineral Deposits" to charge the above amount (please tick)
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Card No. ________________________
Expiry date ________________________

Signature
Place and date

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(Two SGA Sponsors (If you have difficulty in finding sponsors, please send this form to the Executive Secretary who will recommend sponsors)

Name, place, date, signature

Send the Membership Application Form to:
Dr. Jan Pasava
SGA Executive Secretary
Czech Geological Survey
Klárov
CZ-11800 Prague 1
CZECH REPUBLIC

Tel.: +420 2 58 17 390
Fax: +420 2 58 18 748
E-mail: pasava@sgu.cz

Join the SGA now...

The Society of Geology Applied to Mineral Deposits was established in 1965 by an international group of economic geologists. Its Journal Mineralium Deposita is now recognized as a premier international mineral deposits journal.

GOALS
- The promotion of science of mineral deposit geology
- Personal contact of its members in order to exchange knowledge and experience
- Organization of scientific meetings, field trips, workshops. For these events, SGA members have reduced registration fees and in certain cases may apply for travel grants
- Cooperation with other scientific societies, especially with SEG and IAGOD
- Publication of Mineralium Deposita and scientific volumes

MEMBERSHIP
Membership in SGA is open to all persons interested in economic geology, mineral resources, industrial minerals and environmental aspects related to mineral deposits. SGA is an international society with global membership in over 50 countries. Members have reduced registration fees in SGA-sponsored events and in certain cases are eligible for travel grants. Subsidies for publication of color plates in Mineralium Deposita also may be applied. Current membership fees are listed on the left-side column of this page.

MINERALUM DEPOSITA

Editors: David Rickard (Cardiff, UK) and Richard Goldfarb (Denver, CO, USA)

Mineralium Deposita publishes papers on all aspects of the geology of mineral deposits. It includes new observations on metallic and nonmetallic minerals and mineral deposits, mineral deposit descriptions, experimental and applied inorganic, organic and isotope geochemistry as well as genetic and environmental aspects of mineral deposits. Mineralium Deposita is published bimonthly. Fast publication: Mineralium Deposita publishes Mineral Deposita Letters within 3 months and regular papers normally within 4 months after manuscript acceptance and usually 6-9 months after manuscript submission.

..and receive Mineralium Deposita & SGA News!!!

Additional information in the SGA homepage on Internet:
http://www.min.tu-clausthal.de/www/sga/sga.html
The Sixth Biennial SGA Meeting will be held in Kraków, Poland, from August 26 to August 29, 2001. Kraków is a historical capital of Poland and a scientific and cultural center with convenient international travel connections.

The Symposium will be devoted to the essential topics on ore-forming processes and ore types in different environments. There will be an opportunity to have meetings and sessions of ongoing and planned Projects and Working Groups, such as IGCP, GEODE, etc. Proposals for conveners and topics of the sessions are welcome.

Several pre- and post-meeting field trips will be organized and the participants will have an opportunity to visit different metallogenic provinces of Poland, Ukraine, Slovakia, Hungary, Romania, Bulgaria, Lithuania.

The First Circular will be distributed in January 2000.

<table>
<thead>
<tr>
<th>Deadlines</th>
<th>Contact address</th>
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<tr>
<td>April 30, 2000</td>
<td>6th Biennial SGA Meeting</td>
</tr>
<tr>
<td>July 31, 2000</td>
<td>Secretary - Dr. Adam Piestrzyński, University of Mining and Metallurgy, av. Mickiewicza 30; 30-059 Kraków, Poland</td>
</tr>
<tr>
<td>January 31, 2001</td>
<td>telephone: +48 12 617 24 33</td>
</tr>
<tr>
<td>March 15, 2001</td>
<td>fax: +48 12 633 29 36</td>
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<td></td>
<td>e-mail: <a href="mailto:piestrz@geol.agh.edu.pl">piestrz@geol.agh.edu.pl</a></td>
</tr>
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</table>