

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

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
### 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 the 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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# Professor Ross Large elected a fellow of the Australian Academy of Technological Science & Engineering

Jessica Tyler

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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. ♦

## SGA News

N.º 8 January 2000

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<http://www.min.tu-clausthal.de/www/sga/sga.html>  
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### Information for contributors

Items for publication may be sent to: SGA News (see address below). Manuscripts should be sent in computer diskette in Macintosh or DOS formats using Microsoft Word or WordPerfect. Please always send a paper copy and indicate the format you are using.

### Deadline for SGA News

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# 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:

	DM old	DM new	Euro new
Regular membership	98	127	65
Senior/Junior membership	68	88	45
Student membership	38	49	25
Corporate membership	294	391	200

### 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 accomodations, 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. Fontboté); 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 für 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: .....

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

-Gold 2000 (November 7-10, 2000, Harare, Zimbabwe, organized by the IMM London, UK and the Geological Society of Zimbabwe).

-6th Biennial SGA Meeting (Krakow, Poland, 26-29 August 2001).

-4th International Archean Symposium (September 24-28, 2001, Perth, Australia)

-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:

*H. J. Stein, K. Sundblad, R. J. Markey, J. W. Morgan and G. Motuza, 1998, 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,*

*published in Mineralium Deposita vol. 33: 329-345.*

On behalf of all authors Dr. H. Stein highly appreciated the award.



SGA

*Society for Geology Applied to Mineral Deposits*

*This is to certify that*

*H.J. Stein, K. Sundblad, R.J. Markey,  
J.W. Morgan and G. Motuza*

*have been awarded the*

*Mineralium 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.*

*published in Mineralium Deposita vol. 33 pp.329-345, 1998*

*witness our hands this 1st day of July 1999*

*H. Papunen*  
President

*David Riek*  
Editor

#### 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.
2. Postponement of the mailing out of the SGA 99 Ballot to November 99 instead of September 99.

#### 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

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## SOCIETY FOR GEOLOGY APPLIED TO MINERAL DEPOSITS

### Report of the Executive Secretary about membership

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)

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Peter NEUMAYR, The University of Western Australia, AUSTRALIA

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Stephen GREEN, Geological Survey of Canada, Ottawa, ON, CANADA

Gerhard JACOB, Jacob Consultancy, Calgary, CANADA

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Larry MACCORMACK, L.Maccormack Associates Ltd., Mississauga, ON, CANADA

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M. McClAREN, Crockite Res. Ltd., North Vancouver, B.C., CANADA

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Greg STOTT, Ontario Geological Survey, Sudbury, ON, CANADA



# from 1: COPPER AND GOLD EXPLORATION IN SOUTHEAST ASIA

## 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, sialic 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 Mesozoic-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 younging eastward, from Early Cretaceous through Paleocene, to late Eocene-early Oligocene and Miocene-Pliocene (Sillitoe and McKee, 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 25 years. The principal deposits are dominantly of Miocene age and chiefly of epithermal and porphyry-type, with some pluton-related veins and a few distal contact metasomatic deposits (Cabello 1992; Ericksen and Cunningham, 1993; Noble and

McKee, 1997). High sulfidation deposits dominate the epithermal category and include a broad spectrum of mineralization styles: vein systems, hydrothermal breccias, stockworks, and disseminated. Low sulfidation deposits are generally smaller than high sulfidation ones and consist mainly of veins. Gold-bearing porphyry-type deposits accompany quartz stockworks (Sillitoe, 1991).

Polymetallic replacements (mainly zinc, lead, and silver rich), skarns and veins are important in northern and central Peru (Cardozo and Cedillo, 1990). They are normally zoned with a core rich in copper-arsenic sulfosalts, an intermediate zone with zinc and lead minerals, and an outer zone with complex sulfosalts (Vidal and Cedillo, 1988).

In the Bolivian Altiplano and Eastern Cordillera the middle and late Miocene magmatic breakout was the most important metallogenic event (Heuschmidt, 1979). Major hydrothermal ore deposits of gold, silver, tin, lead, zinc, bismuth and antimony are related to stocks, domes and volcanic rocks (Redwood and Macintyre, 1989). The best known ore province is the so-called Bolivian Tin Belt which in its central and southern portions is related to near-surface stocks and subvolcanic eruptive centers with a general southward shift with time, generating tin-silver deposits of complex veins and porphyry style orebodies (Sillitoe et al., 1975). These deposit-types have been described in models as Bolivian Polymetallic Vein Deposits (USGS - Geobol, 1992) and Volcanic Dome-Hosted Precious Metals Deposits (Cunningham et al., 1991). Mineralization occurs in veins, fracture swarms, dissemination and breccias. The deposits are telescoped with early high temperature phases and have some affinities with the epithermal low-sulfidation type model.

## EXPLORATION EXPENDITURES AND MAIN DISCOVERIES

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.

Table 1: Central Andes, Mining Production 1998.

	Chile	Argentina	Peru	Bolivia	TOTAL	% of World Production
Copper t	3,843,000	170,000	483,000	---	4,496,000	44.5
Gold t	43.025	19.459	93.570	14.443	170.497	6.1
Silver t	1,344	69	2,025	452.131	3,890.131	22.6
Zinc t	20,000	35,560	868,757	150,709	1,055,046	14.7

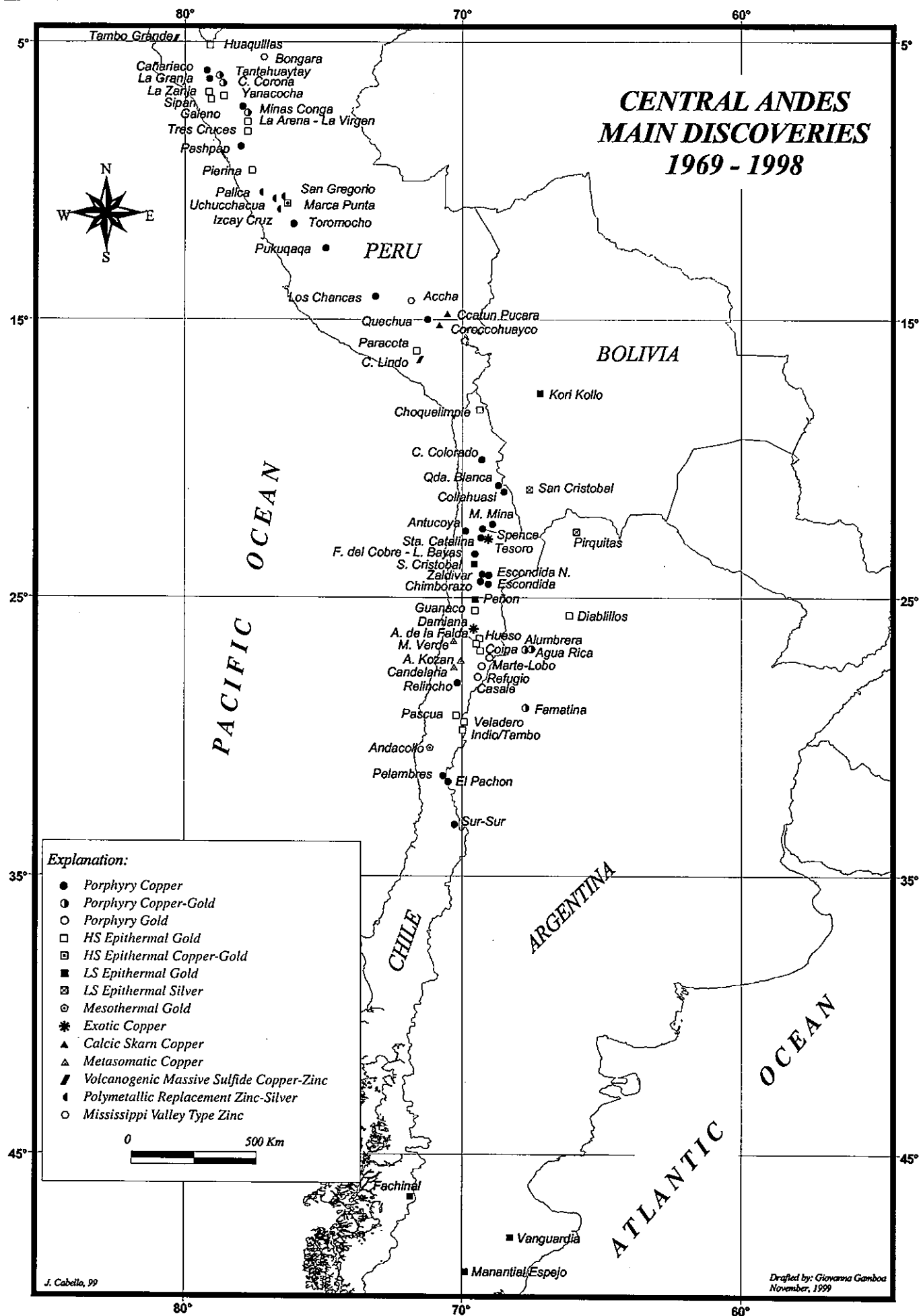


Figure 1: Central Andes main discoveries from 1969 to 1998.

Table 2: Central Andes main discoveries, 1969-1998.

		Resources 10 <sup>6</sup> t	Grades				Discovery Year	Estimated Past Investment	Estimated Future Investment
	Ore Model		Cu%	Au g/t	Ag g/t	Zn%		10 <sup>6</sup> US\$	10 <sup>6</sup> US\$
ARGENTINA									
Gold-Silver									
Pirquitas	LS Epith AgZn	22	---	---	167	0.57	1996		124
Diablillos	HS Epith AuAg	49	---	0.42	68.3	---	1987		
Veladero	HS Epith AuAg	73	---	2.48	30.7	---	1997		450
C° Vanguardia	LS Epith AuAg	9	---	9.7	113	---	1991	270	
Manantial Espejo	LS Epith AuAg	8	---	2.87	181	---	1997		45
Copper									
Alumbrera	Porph CuAu	752	0.51	0.67	2.5	---	1970	1050	
Mi Vida-Agua Rica	Porph CuAu	802	0.61	0.23	3.01	---	1992		767
Famatina	Porph CuAu	300	0.37	0.3	0.6	---	1976		375
Pachón	Porph Cu	879	0.62	0.02	2.4	---	1969		900
BOLIVIA									
Gold-Silver									
Korikollo	LS Epith AuAg	64	---	2.3	13.8	---	1975	150	
San Cristóbal	LS Epith AuAg	240	---	---	62	1.67	1996		413
CHILE									
Gold / Silver									
Choquelimpie	HS Epith AuAg	12	---	2.11	60	---	1985	42	
San Cristóbal	LS Epith AuAg	25	---	0.9	3	---	1985	43	
Guanaco	HS Epith AuAg	11.5	---	1.46	6	---	1980	60	
El Peñón	LS Epith AuAg	8.8	---	6.6	127	---	1994	80	
El Hueso	HS Epith AuAg	16	---	1.68	2	---	1982	20	
Agua de la Falda	HS Epith AuAg	11	---	3.4	3	---	1990	15	
La Coipa	HS Epith AuAg	88	---	0.8	84	---	1980	340	
Marte - Lobo	Porph Au	87	---	1.5	---	---	1983	38	350
Refugio	Porph Au	216	---	0.88	---	---	1985	127	
Cerro Casale	Porph Au	709	0.29	0.8	---	---	1996		1300
Pascua	HS Epith AuAg	219	---	1.8	---	---	1980		1000
El Indio / Tambo	HS Epith AuAgCu	54	2.5	3.43	21	---	1974	440	
Andacollo	MesothAu	130	---	0.7	---	---	1985	100	
Fachinal	LS Epith AuAg	4.5	---	2.2	170	---	1988	85	
Copper									
Cerro Colorado	Porph Cu	221	1.03	---	---	---	1973	331	200
Quebrada Blanca	Porph Cu	836	0.95	---	---	---	1976	360	
Collahuasi District	Porph Cu	3108	0.82	---	---	---	1991	1800	
Mansa Mina	Porph Cu	385	0.96	---	---	---	1989		295
Antucoya	Porph Cu	300	0.45	---	---	---	1996		300
Spence	Porph Cu	400	1	---	---	---	1996		1000
Santa Catalina	Porph Cu	109	0.7	---	---	---	1992		100
Tesoro - Leonor	Exotic Cu	228	0.76	---	---	---	1991		250
Lomas Bayas	Porph Cu	479	0.35	---	---	---	1991	250	
Fortuna del Cobre	Porph Cu	322	0.37	---	---	---	1991		120
Chimborazo	Porph Cu	236	0.6	---	---	---	1986		274
Copper									
Zaldivar	Porph Cu	1000	0.57	---	---	---	1981	600	
Escondida Norte	Porph Cu	1472	0.88	---	---	---	1981		
Escondida	Porph Cu	2118	1.31	---	---	---	1981	2300	1400
Damiana	Exotic Cu	300	0.3	---	---	---	1997		100
Manto Verde	Met-SkarnCu	93	0.82	---	---	---	1969	180	
Kozan	Met-SkarnCu	50	1.6	---	---	---	1989		130
Candelaria	Met-SkarnCu	366	1.29	0.26	0.45	---	1987	870	250
Relincho	Porph Cu	150	0.7	---	---	---	1994		200
Los Pelambres	Porph Cu	300	0.65	---	---	---	1969	70	1300
Sur-Sur	Porph Cu	100M	1	---	---	---	1980	55	
PERU									
Gold-Silver									
Las Huaquillas	HS Epith AuAg	7	---	2.09	25.2	---	1987		
La Zanja	HS Epith Au	38	---	0.64	---	---	1997		
Yanacocha	HS Epith Au	637	---	1	---	---	1985	270	
Sipan	HS Epith AuAg	12	---	1.9	3.6	---	1994	40	



Table 2 (continued)

Minas Conga	Porph CuAu	432	0.3	0.82	---	---	1997		300
La Arena-La Virgen	HS Epith Au	21	---	1.13	---	---	1996		
Tres Cruces	HS Epith Au	31	---	2	---	---	1996		
Pierina	HS Epith AuAg	68	---	2.9	23	---	1993	260	
Paracota	HS Epith Au	15	---	2.26	---	---	1996		
<b>Zinc-Silver</b>									
Bongara	MVT Zn	2	---	---	---	19.3	1996		
Pallca	Replac Zn	15	---	---	---	8	1992		50
Uchucchacua	Replac Zn	9	---	---	400	2.1	1981	35	
Iscaycruz	Replac Zn	10	0.4	---	17.7	17.3	1989	50	
San Gregorio	Replac Zn	70	---	---	17.2	7.3	1994		270
Accha	MVT Zn	9	---	---	---	9	1998		
<b>Copper</b>									
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		2500
Galeno	Porph Cu	405	0.59	0.15	---	---	1998		
Cerro Corona	Porph CuAu	300	0.3	0.5	---	---	1992		300
Tantahuatay	Porph CuAu	375	0.79	0.33	---	---	1995		50
Pashpap	Porph Cu	110	0.64	---	---	---	1969		
Marca Punta	HS Epith CuAu	49	1.89	0.35	---	---	1994		
Toromocho	Porph Cu	1,178	0.51	---	7	0.4	1974		800
Pukaqaqa	Porph Cu	100	0.6	---	---	---	1998		
Los Chancas	Porph Cu	200	1	---	---	---	1999		
Cerro Lindo	VMS CuZn	70	1	---	---	2.4	1995		60
Ccatun Pucara	Skarn Cu	24	1.44	---	---	---	1999		
Corocohuayco	Skarn Cu	155	1.57	0.33	---	---	1973		
Quechua	Porph Cu	100	0.84	---	---	---	1970		300
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 Alumbreira, 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 coppers or porphyry copper-gold (34) and high and low sulfidation epithermal precious metals deposits (26). Also discovered were four polymetallic 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.

	Copper 10 <sup>6</sup> t	Gold kg	Silver kg	Zinc t	Production Period	Investment 10 <sup>6</sup> US\$
<b>Argentina</b>						
Alumbrera	0.21	22 685	---	---	97-98	1 050
C° Vanguardia	---	1 800	20 340	---	98	270
<b>Bolivia</b>						
Korikollo	---	60 103	238 290	---	92-96	150
<b>Chile</b>						
Choquelimpie	---	12 441	82 113	---	88-92	42
Cerro Colorado	000'	---	---	---	94-98	331
Collahuasi	000'	---	---	---	98	1 880
Quebrada Blanca	0.29	---	---	---	95-98	360
San Cristóbal	---	16 430	4 080	---	91-98	43
Zaldívar	0.34	---	---	---	95-98	600
Escondida	0'04	27 371	547 421	---	90-98	2 300
Guanaco	---	14 264	52 345	---	93-98	60
El Hueso	---	17 107	13 064	---	88-96	20
La Coipa	---	56 368	3123 002	---	89-98	340
Manto Verde	0.13	---	---	---	96-98	180
Marte	---	1 866	---	---	92-95	38
Candelaria	0.69	11 709	127 354	---	94-98	870
Refugio	---	14 940	---	---	97-98	127
El Indio/Tambo	0.44	162 017	859 864	---	79-98	440
Andacollo Au	---	10 046	---	---	95-98	100
Los Pelambres	0.14	---	---	---	92-98	70
Sur-Sur	0.36	---	---	---	80-98	55
Fachinal	---	3 306	23 142	---	96-98	85
<b>Perú</b>						
Sipán	---	6 606	---	---	97-98	40
Yanacocha	---	154 510	---	---	93-98	240
Pierina	---	1 769	---	---	98	260
Uchucchacua	---	---	1881 662	35 198	80-98	35
Iscay Cruz	---	---	62 823	200 836	96-98	50
<b>Total</b>	<b>6.95</b>	<b>595 338</b>	<b>7035 500</b>	<b>236 034</b>		<b>10 036</b>
<b>Production Value</b> <b>10<sup>6</sup> US\$</b>	<b>11 488</b>	<b>5 627</b>	<b>1 245</b>	<b>241</b>		

## 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.

Exploration Funds:		10 <sup>9</sup> US\$	3.3
Main Discoveries:	75		
Gross <i>in situ</i> value:	Copper	10 <sup>9</sup> US\$	270.2
	Gold	10 <sup>9</sup> US\$	46.2
	Silver	10 <sup>9</sup> US\$	11.2
	Zinc	10 <sup>9</sup> US\$	16.4
<b>TOTAL</b>		10 <sup>9</sup> US\$	345.0
Estimated buy-in expenditures:		10 <sup>9</sup> US\$	3.0
Estimated past investments:		10 <sup>9</sup> US\$	10.3
Estimated future investments:		10 <sup>9</sup> US\$	16.6
Past Production Value:	Copper	10 <sup>9</sup> US\$	11.5
	Gold	10 <sup>9</sup> US\$	5.6
	Silver	10 <sup>9</sup> US\$	1.2
	Zinc	10 <sup>9</sup> US\$	0.2
<b>TOTAL</b>		10 <sup>9</sup> US\$	18.6

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

US\$ 1 (exploration funds) generated	= US\$ 3.1 (Past Investments)
id	= US\$ 5.0 (Future Investments)
id	= US\$ 5.6 (Metals Production)
id	= US\$ 96.3 (Resources Gross <i>in situ</i> 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 (Quicaý, Tarmatambo, Tincyacalla, 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.

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### The Professor Ian Plimer Fighting Fund CHANGE OF BANK ADDRESS (see also SGA News N. 4, November 1997 and N. 6, November 1998)

Prof. I. Plimer, Head of the School of Earth Sciences in the University of Melbourne (Australia), is engaged in a dispute with the Creationist movement since 1988. Creationism is a fundamentalist movement which claims that the Bible is the only correct source of information regarding the evolution of our planet. Accordingly the Earth was created 6,000 years ago and partly devastated by the great flood 2,000 years later. Creationists' efforts are mainly directed at the school system. Being committed to education, Prof. I. Plimer felt that he had "to take a public stand against Creationism". Litigation continued up to the Federal Court of Australia and judgement was handed down in summer 1997. Prof. I. Plimer found he had lost a major part of the case and was likely to face a cost order of \$A 400,000. However, he decided to appeal. In support to the legal battle of Prof. I. Plimer "The Prof. I. R. Plimer Fighting Fund" has been instituted in Broken Hill (Australia) under the administration of the Mayor of Broken Hill, Mr. Peter Black, and the Reverend Brian Nicholls of the Uniting Church of Australia.

In addition to the account at the Broken Hill Credit Union, Broken Hill, NSW (Australia) (see SGA News N. 4, November 1997), donations can now be paid to the bank address reported on the side to facilitate payments from European countries. Please continue to support the Fund: your help is urgently required.

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## 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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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



# ANNOUNCEMENTS

## 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, drilling, processing, 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. B.Sc. 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-(0)4-303211 Ext. 1427; fax: +263-(0)4-336418; e-mail: msc@geology.uz.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-(0)4-303211 Ext. 1106; fax: +263-(0)4-333407.

### IGCP-373 FIELD CONFERENCE IN THE URALS

"The Eroded Urals Paleozoic Ocean to Continent Transition Zone: Granitoids and Related Ore Deposits"

Ekaterinburg, Russia

18-30 July 2000

The next annual field conference of IGCP-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 of this region. The field excursion 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 IGCP-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@igg.uran.ru  
Send **ABSTRACTS** and **FINAL REGISTRATION FORM** with **PAYMENT** to: Dr. R. Seltmann, 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: rs@nhm.ac.uk

### IMPORTANT DATES

01/04/2000	Return of information form to get invitation for your visa application
01/04/2000	Submission of abstracts preferentially by e-mail. Return of final registration form and payment form. Payment of registration fee
30/04/2000	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).
15/06/2000	Sending of your travel schedule (your arrival and departure dates)
18-30/07/2000	International Field Conference

### 31<sup>ST</sup> INTERNATIONAL GEOLOGICAL CONGRESS

Rio de Janeiro, Brazil

**SGA-COSPONSORED**

August 6-17 2000

The 31<sup>st</sup> Session of the International Geological Congress - 31<sup>st</sup> 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 31<sup>st</sup> 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

Participating members	Accompanying members	Students in 2000
US\$ 350	US\$ 150	US\$ 100

#### Scientific Program

The Scientific Program of the 31<sup>st</sup> 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. Fontboté); iii) Mineral Deposits Associated with Black Shales (J. Pasava); iv) Organics in Major Environmental Issues (J. Pasava -IGCP 429).

#### Contact address

Secretariat Bureau - Casa Brazil 2000

31<sup>st</sup> INTERNATIONAL GEOLOGICAL CONGRESS

Av. Pasteur, 404 - Urca - Rio de Janeiro - RJ - Brazil, Cep 22.290-240; phone: +55 21 295 5847; fax: +55 21 295 8094; e-mail: 31igc@31igc.org - web site: <http://www.31igc.org>



### Training Course in Exploration and Environmental Geochemistry

**geo**chim

postgraduate course

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



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

#### Aims of the course

The certificated 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 Duo (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  
fax: +420-2-5818748  
e-mail: pasava@cgu.cz  
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

# **GEOCHIM 99 - POSTGRADUATE CERTIFICATED TRAINING COURSE IN GEOCHEMICAL EXPLORATION METHODS AND THEIR ENVIRONMENTAL APPLICATIONS SUCCESSFULLY LAUNCHED IN THE CZECH REPUBLIC**

Jan Pasava

Czech Geological Survey, Klarov 131/3, 118 21 Praha 1, 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 Stúr 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 Dolní 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 Dolní 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.

The following special textbook was prepared for the purpose of the first GEOCHIM/UNESCO Postgraduate Training Course on the Geochemical Prospecting Methods and Their Environmental Applications:

Pasava, J. and Kríbek, B., (eds.), 1999, *Geochemical prospecting methods and their environmental applications*. Special Publication, 132 p., Czech Geological Survey, Prague, ISBN 80-7075-357-9.

## **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. Kríbek, D. Masck, I. Pisteková, R. Cadská, V. Bláha 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 ⇒⇒⇒

★ marks a new entry

## 2000

### February 21-24

5TH INTERNATIONAL CONFERENCE ON THE GEOLOGY OF THE ARAB WORLD, GAW-5, Cairo, Egypt - Contact address: Prof. El-Sayed A. Youssef, 5th International Conference on the Geology of the Arab World (GAW-5), Geology Department, Faculty of Science, Cairo University, Giza, Egypt; phone: +202 567 6887 and 567 6502; fax: +202 572 7556 and 572 8843; e-mail: eweida@main-scc.cairo.eun.eg

### ★ February 28-March 1

SME (SOCIETY FOR MINING, METALLURGY AND EXPLORATION) ANNUAL MEETING AND EXHIBIT, Salt Lake City, Utah, USA - Contact address: SME Meetings Dept. PO Box 625002; phone: +1 303 973 9550; Fax: +1 303 979 34 61; web-site: <http://www.smenet.org>

### April 16-19

8TH INTERNATIONAL SYMPOSIUM ON EXPERIMENTAL MINERALOGY, PETROLOGY AND GEOCHEMISTRY, Bergamo, Italy - Contact address: EMPG VIII Organizing Committee, Università degli Studi di Milano, Dipartimento di Scienze della Terra, Via Botticelli, 23 20133, Milano, Italy; fax: +39 027 0638681; e-mail: [empg@biko.terra.unimi.it](mailto:empg@biko.terra.unimi.it); web-site: <http://imiucca.csi.unimi.it/~spoli/empg.html>

### ★ April 27-29

17TH ANNUAL CORDILLERAN EXPLORATION ROUNDUP, Gateway to Discoveries, Vancouver, British Columbia, Canada - Contact address: BC & Yukon Chamber of Mines; ph.: +1 604 681 53 28; e-mail: [chamber@chamberofmines.bc.ca](mailto:chamber@chamberofmines.bc.ca); web-site: <http://www.chamberofmines.bc.ca>

### ★ April 27-29

96TH ANNUAL MEETING OF THE GEOLOGICAL SOCIETY OF AMERICA, Robson Square Conference Centre, Vancouver, British Columbia, Canada - Contact address: Peter Mustard, Earth Sciences, Simon Fraser University, Burnaby, BC V5A 1S6, Canada; phone: +1 604 291-5389; [pmustard@sfu.ca](mailto:pmustard@sfu.ca); web-site: <http://www.geosociety.org/profdev/sectdiv/cord/00cdmtg.htm>

### ★ May 2-5

4TH INTERNATIONAL GOLD SYMPOSIUM, Lima, Peru - Contact address: Comité Aurífero, SNMPE, Francisco Graña 671, Magdalena del Mar, Lima, Peru; phone: +511 460 16 00; fax: +511 460 16 16; e-mail: [cmendoza@snmpe.org.pe](mailto:cmendoza@snmpe.org.pe). Registration: Stimulus S.A.; phone: +511 222 87 88 or +511 221 57 04; fax: +511 222 64 84; e-mail: [Prod1@stimulus.com.pe](mailto:Prod1@stimulus.com.pe)

## WISH TO ADVERTISE FORTHCOMING EVENTS?

### Send your announcements to:

SGA News, Département de Minéralogie, Université de Genève,  
Rue des Maraîchers 13, CH-1211 Genève 4, SWITZERLAND  
fax: +41 22 320 57 32  
e-mail: [SGANEWS@sc2a.unige.ch](mailto:SGANEWS@sc2a.unige.ch)

### ★ May 9-13

V INTERNATIONAL CONFERENCE ON CLEAN TECHNOLOGIES FOR THE MINING INDUSTRY, Santiago, Chile, during the World Mining Exhibition EXPOMIN' 2000 - Contact address: Ema Huenchul Cordova, Secretary of the Conference, Dept. of Metallurgical Eng., University of Concepcion, Casilla (P.O. Box) 53-C, Concepcion, Chile; phone: +56 41 204241; fax: +56 41 243418 or +56 41 204202; e-mail: [ctmi@udec.cl](mailto:ctmi@udec.cl); web-site: <http://www.met.udec.cl/eventos.html>

### May 12-14

EUROPE'S MAJOR BASE METAL DEPOSITS: Galway, Ireland - Contact address: Leo Fuscuardi, Irish Association for Economic Geology, c/o Minorco Services Ireland, Ltd., Killoran, Moyne, Thurles Co., Tipperary, Ireland; phone: +353 504 45369; fax: +353 504 45344; e-mail: [lfuscuardi@minorco.ie](mailto:lfuscuardi@minorco.ie); web-site: <http://www.iaeg.org>

### 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: [gsnsymp@nbgm.unr.edu](mailto:gsnsymp@nbgm.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 80162-5002; phone: 800 763 3132 and +1 303 973 9550; fax: +1 303 979 3461

### ★ May 29-June 1

GEOLOGICAL ASSOCIATION OF CANADA - MINERALOGICAL ASSOCIATION OF CANADA, JOINT ANNUAL MEETING, Calgary, AB, Canada - Contact address: web-site: <http://www.geocanada2000.com>

### ★ June 13-21

XIX CURSO DE POSTGRADO EN METALOGENIA, Quito, Ecuador - Contact address: Dr. Jaime Jarrin J., Director de l'ISP, Universidad Central del Ecuador, Facultad de Ingeniería en Geología, Minas y Petróleos, Instituto Superior de Postgrado, CASILLA:17-21-1405, Quito, ECUADOR; phone: +593 2 557 814; fax: +593 2 566 738 or 593 2 500 306; e-mail: [iinvest@uio.telconet.net](mailto:iinvest@uio.telconet.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, Arias 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](mailto:bt15@asturias.geol.uniovi.es); web-site: <http://www.geol.uniovi.es/bt15.html>

### ★ July 3-7

IGCP - 373 Field Conference in Finland, Rapakivi Granites and Associated Mineralization in Finland, Finalnd - Contact address: Prof. Ilmari Haapala / Sari Lukari, Department of Geology, University of Helsinki, Snellmaninkatu 3, SF-00170 Helsinki, Finland; fax: +358 9 191 234 66; e-mail: [ilmari.haapala@utu.fi](mailto:ilmari.haapala@utu.fi) or [sari\\_lukkari@hotmail.com](mailto:sari_lukkari@hotmail.com); web-site: <http://www.helsinki.fi/~elliott/igcp-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](mailto: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 Científicas, Instituto de Ciencias de la Tierra "Jaume Almera", Solé i Sabarís s/n. 08028 Barcelona, Spain; phone: +34 93 409 54 10; fax: +34 93 411 00 12; e-mail: [geofluids@natura.geo.ub.es](mailto:geofluids@natura.geo.ub.es); web-site: <http://www.ub.es/geoquimi/geofluids.htm>

### ★ July 19-22

10TH PERUVIAN GEOLOGICAL CONGRESS, Lima, Peru - Contact address: Alberto Manrique; Soc. Geol. del Perú, Arnaldo Marquez 2277, Lima 11, Peru; fax +51 1 2612362; e-mail: [sgp@inictel.gob.pe](mailto:sgp@inictel.gob.pe)

### ★ July 13-21

ICAM2000, 6TH INTERNATIONAL CONGRESS ON APPLIED MINERALOGY, Göttingen, Germany - Contact address: ICAM 2000 office, BGR/NLFB, P.O. Box 510153, D-30631, Germany; phone: +49 511 643 2298; fax: +49 511 643 3685; e-mail: [icam2000@bgr.de](mailto:icam2000@bgr.de); web-site: <http://www.bgr.de/icam2000>

### ★ July 18-30

IGCP-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; Pochtovy per., 7, Ekaterinburg, 620151, Russia; phone: +7 3432 511785; fax: +7 3432 515252; e-mail: [smirnov@igg.uran.ru](mailto:smirnov@igg.uran.ru)

**August 6-17**

31TH INTERNATIONAL GEOLOGICAL CONGRESS, Rio de Janeiro, Brazil - Contact address: Secretaria Executiva do 31º Congresso Geológico Internacional, Av. Pasteur, 404 - Anexo 31 IGC - Urca - Rio de Janeiro - RJ - CEP 22.290-240; phone: +55 21 295 5847; fax: +55 21 295 8094; e-mail: 31igc@31igc.org - web site: <http://www.31igc.org>

**August 19-22**

GEOLOGY AND EXPLOITATION OF TIN DEPOSITS IN EUROPE FOR THE THIRD MILLENNIUM, Sokolov, Czech Republic - Contact address: Pavel Beran, Okresni muzeum a knihovna Sokolov, Zamecka ul. 1, 356 00 Sokolov, Czech Republic; fax: +420-16822217; e-mail: okmsokolov@mbox.vol.cz

**★ September 13-16**

5TH INTERNATIONAL MINING HISTORY CONGRESS, Milos, Greece - Contact address: Heliotopos Ltd., Terpsihoris 38, GR-175 62 P. Faliro (Athens) Greece; phone: +30 1 988 40 04; fax: +30 1 988 30 59; e-mail: helio@hol.gr; web-site: <http://www.heliotopos.net.conf.imhc>

**September 25-29**

ISECA-2000, INTERNATIONAL EARTH SCIENCES COLLOQUIUM ON THE AEGEAN REGION, Izmir, Turkey - Contact address: Dr. Ismet Özgenç, Organizing Secretary, ISECA-2000, Department of Geological Engineering, Dokuz Eylül University, P.O. Box 37 (E.Ü.Ptt), 35100 Bornova, Izmir, Turkey; phone: +90 232 388 29 19; fax: +90 232 388 78 65; e-mail: iesc2000@izmir.eng.deu.edu.tr; web-site: <http://www.deu.edu.tr>

**November 7-10****SGA-COSPONSORED**

GOLD 2000, "Gold - a driving force for sustainable development in the new millennium", Harare, Zimbabwe - Organized by the IMM London,

UK and the Geological Society of Zimbabwe. Contact address: Dr. R. P. Foster, University of Southampton, Southampton Oceanography Centre, Southampton SO14 3ZH, U.K.; e-mail: [rpf@mail.soc.soton.ac.uk](mailto:rpf@mail.soc.soton.ac.uk)

**★ November 17-19**

VOLCANIC ENVIRONMENTS & MASSIVE SULFIDE DEPOSITS INTERNATIONAL CONFERENCE AND FIELD MEETING, Hobart, Tasmania, Australia - Pre- and post-conference field trips to VHMS deposits of Mt Read Volcanics. Contact address: Secretary, Centre for Ore Deposit Research, University of Tasmania; GPO Box 252-79, Hobart, Tasmania, Australia 7001; phone: +61 3 6226 2472; fax: +61 3 6226 7662; web-site: <http://www.geol.utas.edu.au/codes>

**2001****August 26-29****SGA-COSPONSORED**

6TH SGA BIENNIAL MEETING, Krakow, Poland - Contact address: Secretary - Dr. Adam Piastrzyński, University of Mining and Metallurgy, av. Mickiewicza 30; 30-059 Kraków, Poland; phone: +48-12-6172433; fax: +48-12-6332936; e-mail: [piastrz@geol.agh.edu.pl](mailto:piastrz@geol.agh.edu.pl)

**2002****August**

11TH IAGOD SYMPOSIUM, South Africa - Contact address: Dr. Hammerbeck, Council for Geoscience, P.B. X112, Pretoria 0001, South Africa; phone: +27 12 841 1130; fax: +27 12 841 1140; e-mail: [ehammerb@geoscience.org.za](mailto:ehammerb@geoscience.org.za)

## Society of Economic Geologists Foundation Student Research Grants Available in 1999

Students of mineral resources throughout the world may apply for thesis research grants available in 2000 from the Society of Economic Geologists Foundation and the Society of Economic Geologists. Purpose of the research grants is to provide partial support of master's and doctoral thesis research for graduate students. Grants from the Hugh E. McKinstry Fund are awarded to support research with a substantial field component. The Hickok-Redford Fund awards grants for field projects in arctic, sub-arctic, or other challenging field areas. A third group of student research grants is in part funded by gifts from BHP Minerals. These provide funds for research in economic geology that focuses on new descriptive data on ore deposits, mining districts, and on topical subjects. The 2000 awards total at least \$50,000. Individual grants range from US\$500 to US\$3,000 and are intended to fund specific thesis research expenses.

Application forms may be obtained from the:

Chair, SEG Student Research Grants, 5808 South Rapp Street, Suite 209, Littleton, Colorado 80120 USA; Phone: +1 303 797 0332; Fax: +1 303 797 0417; e-mail: [socecongeol@csn.net](mailto:socecongeol@csn.net). Form also available on the web: <http://www.segweb.org>

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

**ETH** 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 Magmatic-hydrothermal ore deposits

The Fluids and Ore Deposits Group at the Swiss Federal Institute of Technology (ETH Zürich) 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](http://www.erdw.ethz.ch/institutes/iimr/iimr.html) for further information, or contact C. Heinrich at [heinrich@erdw.ethz.ch](mailto:heinrich@erdw.ethz.ch).

## SOCIETY FOR GEOLOGY APPLIED TO MINERAL DEPOSITS

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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*.

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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.

## MINERALIUM 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 non metallic 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.

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Additional information in the  
SGA homepage on Internet:

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# SOCIETY FOR GEOLOGY APPLIED TO MINERAL DEPOSITS (SGA)



*in cooperation with*  
UNIVERSITY OF MINING AND METALLURGY  
STATE GEOLOGICAL INSTITUTE  
KGHM POLISH COPPER Ltd.

August 26-29, 2001  
Kraków (Poland)

## Sixth Biennial SGA Meeting

### Preliminary Information



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.

Deadlines		Contact address
April 30, 2000	Pre-registration	6th Biennial SGA Meeting Secretary - Dr. Adam Piestrzyński, University of Mining and Metallurgy, av. Mickiewicza 30; 30-059 Kraków, Poland telephone: +48 12 617 24 33 fax: +48 12 633 29 36 e-mail: piestrz@geol.agh.edu.pl
July 31, 2000	Second Circular	
January 31, 2001	Abstract submission	
March 15, 2001	Registration & field trip	