

The "Kola Ecogeochemistry Project": - some lessons for the mineral exploration and processing industry from environmental geochemical mapping of the central Barents Region

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Amongst earth scientists, the Kola Peninsula, NW-Russia (Fig. 1) is well known for the occurrence of rich mineral deposits (e.g., Cu-Ni, Fe, apatite) and many unusual rocks and minerals. Among environmental scientists, the Kola peninsula is famous as the site of severe environmental problems, mostly related to nickel mining and smelting.

Mining and, in general, the mineral industry are the major fields of industrial activity in the central Barents Region. The iron ore deposit near Kirkenes, Norway was opened in 1906 and has since then produced c. 250 mill. tons of iron ore. In the 1920s large nickel deposits were discovered in the Pechenga area (then Petsamo), near Zapoljarnij and a smelter for the local ore was constructed in Nikel in 1932. An even larger Ni-smelter was built in Monchegorsk in 1938 and an ore roasting plant was opened in

Zapoljarnij in 1965 following the discovery of major Ni-orebodies nearby. Since 1971-72 ore from the Noril'sk deposit in Siberia has been shipped via Murmansk for processing mainly in Monchegorsk. The nickel mines and their accompanying concentrating plants and smelters have thus been substantial contributors to the economy of the area for more than 50 years. At the same time they have created a serious pollution problem. Emissions from Nikel, Zapoljarnij and Monchegorsk place these three nickel factories amongst the largest sources of SO₂ and heavy metal pollution in the world. Table 1 summarises emissions of SO₂, Cu, Ni and V for 1994 (MRCENR, 1995).

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◆ *Mineralium Deposita* now N. 1 Journal

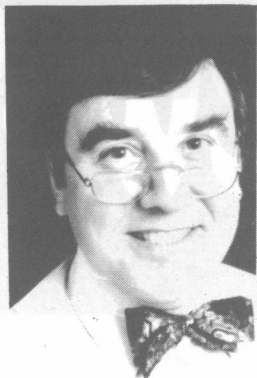
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From the Editors of *Mineralium Deposita*

David Rickard (Cardiff) and Richard Goldfarb (Denver)

Mineralium Deposita now N. 1 Journal

The latest Scientific Citations Index (SCI) Impact Factor listings show that *Mineralium Deposita* is now the world's top journal in the area of economic geology and mineral deposits. A summary listing is shown in Table 1. The SCI listings are widely used as a measure of the quality of scientific output, by scientists worldwide and the research funding agencies of many nations. The Impact Factor measures the number of times papers in the journals are cited.

Thus an Impact Factor of 1 means the average paper has been cited once. For geological journals, the average impact factor is around 0.5. Also listed is the cited half-life. Citations of articles tend to decrease with time so the concept of half-life, analogous to the isotope half-life, is appropriate. The top journals have shorter half-lives since they are reporting cutting edge science of immediate impact. Long publication delays also tend to extend the half-life.

The figures are surprising because of the relative smaller membership of the SGA compared to, for example, the Institution of Mining & Metallurgy or the Society of Economic Geologists. One would expect journals from larger societies with concomitant larger circulations to have more citations. The SGA appears to have succeeded in its policy of emphasising quality for its main journal.

The conclusion is that *Mineralium Deposita* is currently the quality journal for international mineral deposits research. The SCI data independently demonstrates that it reports results at the cutting edge of mineral deposits research. Obviously researchers and professionals in the field of economic geology will need to join the SGA and get *Mineralium Deposita* to keep up with the latest discoveries in this area.

Table 1: Science Citation Index 1998 for leading mineral deposits journals

		Impact Factor	Cited half-life
1.	<i>Mineralium Deposita</i>	0.977	7.2
2.	Ore Geology Reviews	0.969	5.3
3.	Economic Geology	0.943	10.0
4.	Transactions of the Institute of Mining and Metallurgy B	0.667	8.0
5.	Journal of Geochemical Exploration	0.504	7.1
6.	Exploration and Mining Geology	0.323	-
7.	CIM Bulletin	0.170	>10.0
8.	Journal of South African Institute of Mining & Metallurgy	0.073	>10.0

Increased subscriptions and manuscript submissions

Further evidence for this comes from our publishers, Springer-Verlag. They report a large increase in institutional subscription for the journal in 1997. This is not only against the trend of libraries cutting back on journal subscriptions but also against the background of steeply increasing journal costs to institutional purchasers.

In the Editorial Office we have already seen the effect with increased number of manuscript submissions (up 75% in 1997) and also in the enhanced quality of papers received. We are finding that the top ore geologists are now sending their papers to *Mineralium Deposita* by preference. In response we are negotiating with the publishers to increase the number of issues in 1999 from 6 to 8 to keep publication times short and to continue to provide an excellent product for our readers.

New initiatives

Thematic issues continue to be exceptionally popular. The *Iberian Pyrite Belt* issue this year, edited by Marcoux and Leistel, has proven to be a blockbuster. Issues on deposits in Europe, Siberia and China are in the pipeline and should be available through 1999.

The new *Mineralium Deposita Notes* section is also proving successful. These notes are intended to provide brief accounts of new discoveries, mining camps and districts. They are edited by Rich in the Denver office. The format is the simple 4 *Mineralium Deposita* pages and 4 display items. We are also promoting authoritative short review articles (<6 pages) on new findings in minerals deposit research which will facilitate young researchers entering a new area and keep established researchers up to date with new developments in related fields.

David Rickard (Cardiff) and Richard Goldfarb (Denver) ♦



SGA News

N.° 5 May 1998

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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.

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NEWS OF THE SOCIETY

News of the Council

This is a brief summary of relevant points discussed and decisions taken at the SGA Council Meeting held in Heidelberg, c/o Springer-Verlag, on April 24, 1998.

1. Elections 1998

The new Council has been elected in March 1998. The higher number of ballots received than in 1996 (269 vs. 150) reflects the increase of the membership. Prof. Heikki Papunen will take over as President on January 1, 1999. Dr. Jan Pasava, who was acting as Executive Secretary since January 1, 1998, has been confirmed. The list of new Council Members is published on page 4 of this issue.

2. The councillors finishing their term of office (J. Boulègue, L. Fontboté, B. Stribrny, K. Sunblad, J. F. Sureau, O. Thalhammer) were warmly thanked. The President expressed his appreciation to the Society for the important contributions to SGA made by Prof. M. Pagel during his 11 years as Executive Secretary (1987-1997). It was decided unanimously to propose him for Honorary Membership at the next General SGA Meeting in London, 1999.

3. Report of the President

During his recent visit to Australia the President has discussed steps to increase SGA visibility with Prof. R. Large, Director, CODES, University of Tasmania, Prof. D. Groves, Director, Centre for Strategic Mineral Deposits and with Dr. R. Hill, newly elected SGA Vice-President of SGA at the CSIRO, Perth.

4. Report of the Executive Secretary

Since January 1998 Dr. J. Pasava has processed 109 new membership applications of which 71 resulted from the North American Initiative. Dr. D. Leach and Dr. R. Goldfarb were thanked for their efforts in making this initiative successful.

5. Report of the Treasurer

Prof. P. Herzig provided a detailed report showing that the finances of the Society are in good shape.

6. Report of the Editors of *Mineralium Deposita*

The Frank Vokes issue is underway and will be published as Vol. 33/6. Dr. D. Rickard and Dr. R. Goldfarb were congratulated for reaching the highest Impact Factor listed in the 1998 Science Citation Index for mineral deposit-related journals (see page 2). Problems in the distribution system of *Mineralium*

Deposita were discussed with Dr. Engel of Springer-Verlag and steps for improvement of the situation were taken.

7. Report by Dr. D. Leach on North American Initiative

71 new members have been registered in the course of this initiative; similar activities will be arranged in Asia, Australia and South Africa.

8. Prof. G. Borg was appointed SGA Promotion Manager and Dr. D. Rickard SGA Publication Manager.

9. SGA-IAGOD

The IAGOD Secretary General, Ing. J. Aichler, informed the Council about difficulties associated with the preparation of the 10th IAGOD Quadriennial Symposium which should have taken place in 1998 in Australia. On behalf of the IAGOD, he expressed best thanks to the SGA Council for supporting the joint SGA-IAGOD Meeting in 1999 in London (see page 6). It has been agreed that the IAGOD Secretary General and the Membership Secretary will become ex-officio members of the SGA Council and that the SGA President and Executive Secretary will become ex-officio members of the IAGOD Council. Both SGA and IAGOD are open to further co-operation.

10. Future activities. Two SGA-sponsored Symposia have been approved for the 31st IGC (Rio de Janeiro, August 6-17, 2002). Other activities sponsored by SGA are listed on pages 16, 17, 18.

11. Prof. F. Barriga presented information on GEODE, a new European initiative in the field of Mineral Deposits, recently approved by the European Science Foundation (see page 6).

(to page 6)

!!!NEW ADDRESS!!!

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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CZECH REPUBLIC

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!!!NEW ADDRESS!!!

CHANGE OF ADDRESS FORM

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

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

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SOCIETY FOR GEOLOGY APPLIED TO MINERAL DEPOSITS (SGA)

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SOCIETY FOR GEOLOGY APPLIED TO MINERAL DEPOSITS

Report of the Executive Secretary about membership

84 Regular Members, 4 Junior Members, 19 Student Members and 2 Senior Members applied for membership from October 97 to April 98.

List of NEW SGA MEMBERS (October 1997-April 1998)

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Craig J.R. HART, Whitehorse, CANADA

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Stan KENT, Magma Chem Exploration, Bellevue, USA

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David HEDDERLY-SMITH, Park City, USA

Denis LAPOINT, Chapel Hill, USA

Alexandra SKEWES, Boulder, USA

Piorgiorgio ROSSETTI, University of Turin, ITALY

John DREIER, Deloro Minerals, Golden, USA

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Darren ANDERSON, Vancouver, CANADA

Timothy BAKER, MDRU, Vancouver, CANADA

Petr PELZ, Val d'Or, Quebec, CANADA

Gregory GRIFFIN, Barrick Goldstrike, Elko, USA

Steven BUSSEY, Western Mining Corporation, Reno, USA

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

Report on the North American initiative

David Leach

SGA Vice-President for North America

US Geological Survey, Mineral Resource Program, Mail Stop 973, Box 25046 Federal Center, Denver COLORADO 80225

In 1996, Council agreed to a North American Initiative spearheaded by myself and Richard Goldfarb (co-editor of *Mineralium Deposita*). The purpose of the initiative was to increase the profile of the SGA in North America. Here, I present a report on some of our initial activities. The North American Initiative was coincident with the opening of the *Mineralium Deposita* Editorial Office in Denver under Rich Goldfarb.

Summary of the SGA/MD Exhibits

SGA/ *Mineralium Deposita* (MD)/ Springer-Verlag exhibits were present at the Northwest Mining Association annual meeting in Spokane, Washington during the first week of December 1997 and again at the Cordilleran Round-Up held in Vancouver, British Columbia during the last week of January 1998. These exhibits contained information on the SGA, including information for future SGA activities, publication opportunities in MD and highlighted the scientific merits of MD, especially from an industry perspective. In addition, some Springer-Verlag publications were also displayed. The exhibits were staffed by Richard Goldfarb and myself. We also enlisted some volunteer help from Erin Marsh, Craig Hart, Susan Leach, Vic Labson, and Poul Emsbo.

I believe the exhibits were quite successful from several perspectives. The most immediate benefit to SGA was the receipt of 68 new membership applications, 8 of which were from people outside North America. These meetings provided an excellent

opportunity for increasing the visibility of SGA in North America. Hundreds of SGA News and membership applications were handed out to attendees. Many people said that they would consider applying later. In addition, there was much interest in the fact that MD is trying to include more articles, such as the MD Notes, that are especially useful for industry geologists. Some people expressed interest in submitting articles to MD.

What we learned

- 1) The awareness of SGA in North America is remarkably low. However, MD is generally well known. The most important selling point for SGA membership was getting a subscription to MD. Most people expressed the bargain that MD represents, considering the quality of the journal and the reasonable cost of membership. The strength of the US dollar was a help.
- 2) The 15% meeting discount was quite successful in getting people to join - many would have taken the application home and, perhaps, not have sent it in.
- 3) There was very strong interest in our Biennial Meetings and very high interest in obtaining copies of the proceedings. We could have sold many tens of copies, had we been in the publication selling business.
- 4) Most people were interested in books, short course notes, and other publications that SGA had to offer and were surprised that we did not have available a list of SGA publications.



The SGA Exhibit stand at the Northwest Mining Association Annual Meeting in Spokane, Washington (from left: R. Goldfarb, D. Leach and D. Grauch, Treasurer for IAGOD).

GEODE

A new European Research Initiative on Metallogeny

Under the title "Geodynamics and Ore Deposit Evolution (GEODE)" the European Science Foundation has approved a new "Scientific Programme" with the aim of building a quantitative understanding of the geological processes that result in world class ore deposits. In particular the questions of timing and the inter-relationships between geological processes which lead to ore formation will be addressed.

The research programme consists of five sets of projects, each focused on a major metallogenic province within Europe containing world-class ore deposits. They will be complemented by specific projects in South America and in the SW Pacific region. The five provinces are: Alpine-Carpathian belt, Iberian Pyrite belt, Urals, Precambrian of Fennoscandia and Greenland and the sediment-hosted deposits of Ireland and Bohemia. GEODE intends to take a strong coordination role and wants to build a partnership between research institutes across Europe and the mining industry. As other European Science Foundation Scientific Programmes, GEODE has a coordination budget contributed by the member organizations who have agreed to support it. The individual projects within the programme are funded by other sources.

More detailed information on GEODE will appear in the next SGA News issue. A web page is being implemented at <http://www.esf.org> and should be operational by early summer 1998.



L. F.

GEODE information will be available by early summer 1998 from:

Europe Science Foundation, 1 Quai Lezay-Marnésia, 67080 Strasbourg Cedex, France; fax; + 33 388370532; web site: <http://www.esf.org>

MINERALIUM DEPOSITA BEST REFEREE AWARD

The success of *Mineralium Deposita* is due largely to its reviewers, who work for the excellence of the science. Each year the Associate Editors nominate referees whose manuscript reviews have been exceptional. The Editorial Office selects one of these as the *Mineralium Deposita* Reviewer of the Year. This reviewer effectively represents the enormous contribution of all 120 referees who contributed their expertise to the Journal in 1997. The award reflects the esteem in which their contributions are held by the SGA.

 <div style="text-align: center;"> <h3 style="margin: 0;">Best Referee Award</h3> <p style="margin: 0;">for <i>Mineralium Deposita</i> 1997</p> <p style="margin: 0;">is to</p> <h2 style="margin: 0;">Dr. Cornel de Ronde</h2> <p style="margin: 0;">of Lower Hutt, New Zealand</p> <p style="margin: 0;">nominated by Associate Editor Jeff Hedenquist (Tsukuba, Japan)</p> <p style="margin: 0;">"For contributions to the continued progress of international science"</p> </div> 
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from 3: NEWS OF THE SOCIETY

12. The Executive Secretary presented the report and financial statement from the 4th Biennial SGA Meeting (Turku, 1997). The Council appreciated the efforts of Prof. H. Papunen and his co-workers, which resulted in both a high scientific level and a positive financial outturn.

11. Retiring Councillor, Prof. Lluís Fontboté was thanked for introducing SGA News. Dr. Massimo Chiaradia from the University of Geneva replaced Prof. Fontboté as Editor of the SGA News and the Council expressed him good luck for his new job.

5th Biennial SGA Meeting in London

The 5th Biennial SGA Meeting will be held in London, U.K., August 22-25, 1999 at the Imperial College and the Natural

History Museum and will run jointly to the 10th Quadriennial IAGOD Symposium. The Chair is Dr. C. Stanley (Department of Mineralogy, The Natural History Museum, Cromwell Road, LONDON, SW7 5BD, United Kingdom, Fax: +44 171 938 9268, E-mail cjs@nhm.ac.uk). See page 20 for additional information.

Schneiderhoehn Award to Professor Eugen Stumpfl

Prof. Eugen Stumpfl has received the Schneiderhoehn Award on November 20, 1997 in Mainz (Germany) for his outstanding contributions to Economic Geology. The ceremony was attended by about 100 distinguished guests and took place in the Naturhistorische Museum in Mainz.

SGA Special Publications

Strongly reduced prices on SGA Special Publications (see page 13).

from 1: THE "KOLA ECOGEOCHEMISTRY PROJECT"

For an "economic" geologist it may be interesting to note that the metal value of the yearly Ni and Cu emissions alone approaches US\$ 20 million literally going up in smoke. Further pollution sources on the Kola peninsula include the apatite open cast and underground mine at Kirovsk (where the use of nuclear explosives in underground mining was tested in the 1972 and 1984), its processing plant in Apatity, an aluminium smelter in Kandalaksha, iron ore mines and processing plants in Olenegorsk and Kovdor, several large power stations and the town and harbour of Murmansk with probably the world's highest density of nuclear reactors on naval vessels and ice-breakers.

Table 1: Yearly emissions of Monchegorsk, Nikel and Zapoljarnij for 1994 (MRCENR, 1995)

Location	SO ₂ t yr ⁻¹	Co t yr ⁻¹	Cu t yr ⁻¹	Ni t yr ⁻¹	V ₂ O ₅ t yr ⁻¹
Monchegorsk	97,715	81.5	934	1619	60
Nikel	129,160	5.2	82	136	13
Zapoljarnij	69,208	5.4	81	161	21
SUM	296,083	92.1	1097	1916	94

Central Kola Expedition (CKE), Russia, the Geological Survey of Finland (GTK) and the Geological Survey of Norway (NGU) have cooperate since 1991 to produce an ecogeochemical atlas of the central Barents Region. The large scale, severe vegetation damage in the surroundings of the nickel smelters has made the people (especially the native Sami population) living in the neighbouring countries Finland and Norway aware of the severe effects metal mining and smelting can have on the environment. Nickel is situated just 35 km from the Norwegian border and well visible from Norway. This has created a negative opinion about the future use of mineral resources, especially in northern Norway. The Kola ecogeochemistry project is aimed at documenting the regional distribution of a large number of chemical elements and radio-isotopes in a number of sample media, representing different compartments of the ecosystem, to better understand sources, levels and cycling of chemical elements in the environment. The Kola Peninsula in combination with northern Finland and Norway is a unique place for such a study as it combines some of the most pristine areas in Europe with some "world class" point-source emitters.



Figure 1: Map of the Kola peninsula.

Project history and organisation

Field work for the Kola project started in 1992 with a pilot project, covering a 12,000 km² area in the border zone of the three countries, in the surroundings of the towns Kirkenes, Nikel and Zapoljarnij. The main aim of the pilot project was to harmonise field sampling, analytical methods and data processing in the three organisations and to define the sample media, grain size fractions, sample decomposition and analytical techniques best suited for such a large, regional geochemical mapping project. A multitude of different sample media (snow, stream water, stream sediments, overbank sediments, terrestrial moss, humus, topsoil (0-5cm) and the C-horizon of soil profiles) were sampled and analysed. Several publications resulted from this phase of the project (e.g., Niskavaara et al., 1996; Reimann et al. 1996, Äyräs et al., 1997a).

Field work continued in 1994 when eight small catchments (12 - 35 km²) located at different distances from industry and from

the Barents Sea and representing different geological settings, were sampled for detailed investigations. Media sampled included snow (end of winter), rain, stream water, organic stream sediment, overbank sediments, terrestrial moss, topsoil, complete podzol profiles, Quaternary deposits, bedrock and groundwater. The main results of this phase are documented in a number of publications in international journals (e.g., Äyräs et al., 1995; Boyd et al., 1997; Caritat et al. 1996a, b, 1997a; Niskavaara et al., 1997; Reimann et al., 1997a, b).

Regional sampling covered 188,000 km² north of the Arctic Circle, comprising the entire area between 24° and 35.5° E, with the Barents Sea as the northern project border and the Arctic Circle as the southern border (Fig. 1). More than 600 localities (average station density: 1 per 300 km²) were sampled in the summer of 1995, with the highest density close to the industrial centres and along the Norwegian-Russian border. Media collected for regional mapping were:

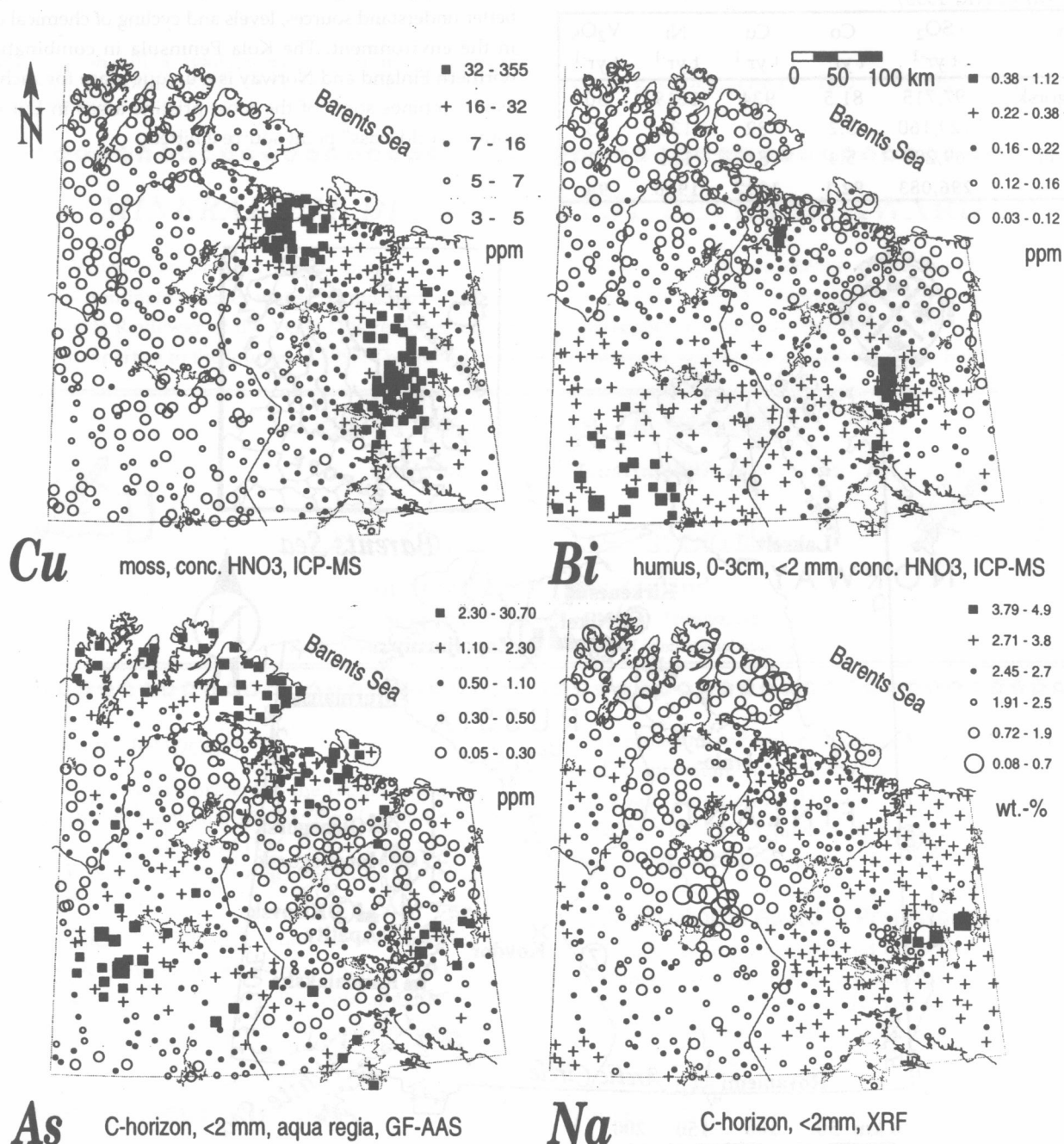


Figure 2: Maps of element distributions (Cu, Bi, As, Na) in the Kola peninsula.

- 1.) Terrestrial moss (*Hylocomium splendens* or *Pleurozium schreberi*) representing primarily element input from the atmosphere;
- 2.) Humus (up to max. 3 cm thickness) representing the interplay between atmosphere, biosphere and pedosphere;
- 3.) Topsoil (0-5cm) (mainly for analysis of radionuclides);
- 4.) Reindeer lichen (*Cladina spp.* - selected places, for analysis of radionuclides - not included in the atlas);
- 5.) Complete Podzol profiles (5 horizons - only B- and C-horizon results included in the atlas), representing the geosphere;
- 6.) Lakewater (Russian project area only), representing the hydrosphere (not included in the atlas).

The atlas presents regional distribution maps for more than 50 elements (^{228}Ac , Ag, Al, ^{241}Am , As, Au, B, Ba, Be, Bi, ^{218}Bi , Br, C, Ca, Cd, Co, Cr, ^{134}Cs , ^{137}Cs , total Cs, Cu, Eu, Fe, H, Hf, Hg, K, ^{40}K , La, Lu, Mg, Mn, Mo, N, Na, Nd, Ni, P, Pb, Rb, S, Sb, Sc, Se, Si, Sm, Sn, Sr, Ta, Tb, Th, Tl, U, V, W, Y, Yb and Zn), pH and LoI. All the samples were always analysed for a defined set of elements/parameters in only one laboratory.

sample media, analysed for very many elements using state of the art analytical techniques to obtain the lowest possible detection limits. Regional geochemical maps have been drawn for more than 50 elements to show their distribution in four main media, moss, uppermost humus (0-3 cm beneath the surface), and the B- and C-horizons in podzol profiles. Whereas the moss maps largely reflect atmospheric input of elements (emissions from industry, sea spray and dust from local geogenic sources), the chemical elements in the upper humus layer reflect a more complex interplay between atmospheric input, sea spray, local geogenic background fluctuations and the biological cycle. The samples from the B- and C-horizons tend to reflect regional geology, thus revealing variations in the natural background levels of the elements. Only where the organic layer of the soil is destroyed, close to the most polluted industrial sites in Russia, is the chemistry of the deeper soil horizons affected by anthropogenic contamination. During the course of the project more than 30 elements were identified as part of the emissions from the Russian nickel industry.

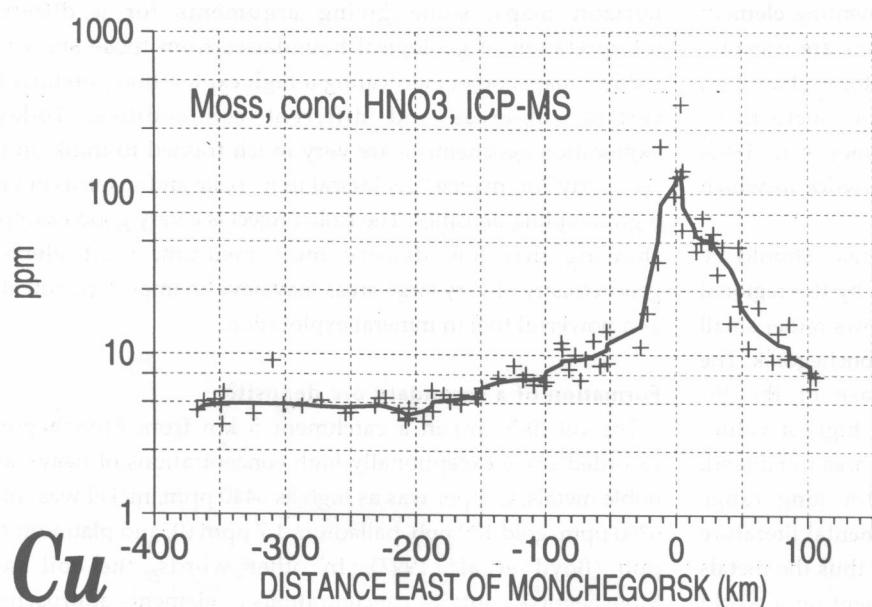


Figure 3: Copper concentration profile from the western border of the survey area eastwards through Monchegorsk.

All three project phases were funded by the Royal Norwegian Ministry of the Environment and the three participating organisations.

In a first follow-up project led by Prof. E.F. Stumpfl, Mining University Leoben and funded by the Austrian Research Council, the mineralogy of snow and humus samples from the immediate vicinity of Nikel, Zapoljarnij and Monchegorsk is presently being investigated using the classical methods of economic geologists (ore microscopy, electron microprobe analysis, geochemistry) (Gregurek et al., 1997).

Regional distribution of elements in different sample media

In terms of exploration geochemistry the Kola ecogeochemistry project is rather unusual: a very low sample density (on average 1 site per 300 km²) is combined with a multitude of different

The copper map (Fig. 2) reflects the degree to which contamination from the nickel-copper industry has a regional impact on the chemical composition of the moss. Elevated concentrations can be observed over more than half of the survey area. When studying such a map it is, however, important to look not only at the pattern displayed, but also at the contrast. When looking at an east west profile from the western border of the survey area eastwards through Monchegorsk (Fig. 3) it becomes obvious that element concentrations decrease exponentially from the source towards the background areas. With regard to the ongoing debate concerning long range atmospheric transport of pollutants across national boundaries for hundreds or thousands of km, one of the major surprises of this study is that most elements do not seem to travel very far.

At 100 to at most 200 km (depending on the main wind directions) from the source, it becomes very difficult, if not impossible to separate "pollution" from the natural background fluctuations. Each element shows its own characteristic dispersal function. Simple mass balance calculations for Monchegorsk, based on these results and the official emission figures show that practically the complete mass of heavy metals emitted is needed to create the observed patterns (Caritat et al., 1997b). These observations are backed by recent investigations near Flin Flon in Canada, where a similar regional investigation has shown that a very high percentage of the total metals emitted since start up of the operation in 1930 is still bound in the humus layer in the near surroundings (<100 km) of the smelter (Bonham-Carter and McMartin, 1997).

It is important that geochemists get involved in these very practical research topics. Today much of this research is left to

biologists, chemists and meteorologists, who have limited experience about to geoscience and the natural levels and fluctuations of element concentrations with changing bedrock (and local dust...) composition. For many of these authors any measured heavy metal concentration in nature is "man-made pollution". Inventories are published (e.g., Pacyna, 1995) in which the amount of certain metals stated as emitted by the smelting industry on Kola is larger than the actual content of this element in the ore entering the process. Enormous differences in opinion about fluxes of elements and their respective sources are documented in current literature (see Rasmussen, 1996). In the long run, the metals industry will be damaged severely by misconceptions and wrong budgets of biogeochemical cycles if not corrected. There is no doubt that metal mining and smelting has a negative impact on the environment which should be kept at a minimum. At the same time, industry should not be asked that clean up after closure results in lower metal concentrations in the environment than those that are natural for the area, and should not be blamed for any observed environmental degradation just because there is no better explanation at hand. Large scale, regional geochemical maps, documenting element levels and their variation in space at a given time are urgently needed for this purpose. Thus, unbiased inventories, based on sound knowledge of natural element levels and fluctuations, should be produced on a world wide scale (Darnley et al., 1995) to promote the generation of a fair legal framework in which industry can continue to operate.

Another interesting example why geochemists should be involved in environmental work is exemplified by the regional distribution of Bi in humus. The map (Fig. 2) shows rather small anomalies surrounding industry at Nikel and Monchegorsk. The most prominent feature is a steady increase of the Bi-concentrations from north to south, with the highest values reached at the southern boundary of the project area in Finland. Such patterns are interpreted as "typical for long range transported air pollutants" in today's environmental literature (e.g., Steinnes et al., 1992, Berg et al., 1995) and thus the metals industry is blamed for polluting the environment on a world wide scale. Sources would have to be located somewhere in central Europe. Are there, however, other possible explanations for the pattern observed? A first question to the critical reader is, of course, why the anomalies surrounding Nikel and Monchegorsk, which are both rather prominent Bi-emitters on a European scale, are so limited in size, while rather undefined "central European sources" should be able to cause such a major feature as the south - north gradient in the map. The next question could be why all the long travelled Bi (most possible sources are more than 2000 km away) precipitates on the last 250 km before it reaches the coast of the Barents Sea, where such a pattern would be no longer detectable? There are actually several possible alternative explanations that have nothing to do with industry: from north to south, three important vegetation zones are crossed in the survey area (sub-arctic tundra, sub-arctic birch forest, boreal forest). Already in 1937 Goldschmidt described the influence of vegetation on high levels observed for a multitude of elements in humus without any apparent explanation. Plant species and biomass production can have a major influence on element concentrations observed in humus.

Other possible explanations include the ever increasing population and traffic density from north to south. Interestingly, some other elements, for example Rb, for which nobody would assume an anthropogenic origin, show a similar north - south concentration gradient as Bi (and Tl), highlighting the importance of truly multi-element geochemical studies to guide the understanding of the obtained patterns.

More interesting to the explorationist is the very large regional scale of geochemical signatures related to mineralising events visible in many maps. The maps for As and Na (Fig. 2) in the C-horizon show just two examples. The highest As concentrations (note that these are concentrations in the < 2mm fraction) occur over parts of a greenstone belt in the Finnish part of the project area, which is a "hot spot" for gold exploration in Finland. The same area is clearly marked as an anomaly for a multitude of elements even at this low sampling density. The Na map can be taken as an indication that the emplacement of the alkaline intrusions of Khibiny and Lovozero had a major influence on the regional distribution of Na in the C-horizon soils. Many other interesting patterns are visible in the B- and C-horizon maps, some giving arguments for a different interpretation of geological boundaries from those shown in today's maps, others indicating a high exploration potential for certain sub-areas and different commodities. Today's exploration geochemists are very much trained to think on the "property" or, maybe "geological unit" scale and in terms of very high sampling densities. The Kola Project is a very good example, showing that low density multi-medium, multi-element geochemistry of very large areas may have an important potential as a powerful tool in mineral exploration.

Formation of a secondary ore deposit?

Topsoil (0-5 cm) in a catchment 5 km from Monchegorsk recorded some exceptionally high concentrations of heavy and noble metals. Copper was as high as 6440 ppm, nickel was up to 6360 ppm, gold 100 ppb, palladium 1.7 ppm (!), and platinum 466 ppb (Boyd et al., 1997). In other words, the soil near Monchegorsk contains concentrations of elements approaching ore grade and may be an interesting resource rather than a pollution problem in the future. Ore geologists could thus study the formation of a secondary ore deposit on land here, almost certainly detect interesting, new mineral phases in soils and might even learn something about the low temperature geochemistry of the noble metals. In terms of value of the yearly emissions from the smelters, the observation of high concentrations of noble metals indicates that above-mentioned US\$ 20 million are probably a very conservative estimate.

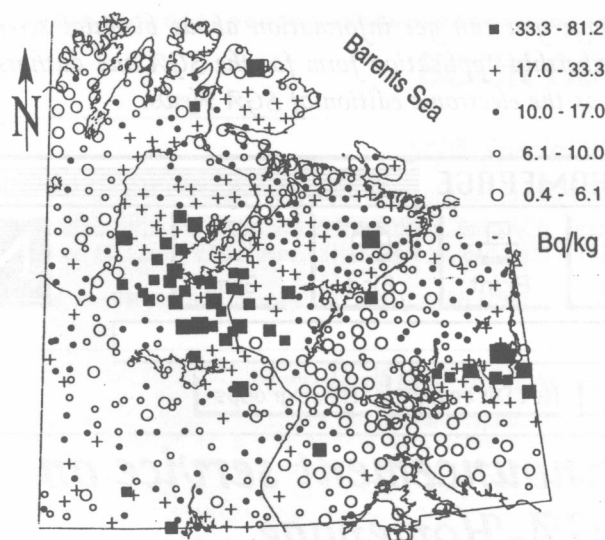
Radioisotopes

An important aspect of the project was to identify the level of radionuclides in the soils throughout the area studied. For this purpose, large composite samples of the uppermost 5 cm of the soil were collected at each site. The samples were analysed at the Norwegian Radiation Protection Authority for artificial and naturally occurring radionuclides, using gamma spectrometry. The values proved to be very low and can be ascribed to precipitation from atmospheric testing of nuclear bombs in the 1950's and 1960's. An interesting pattern was observed for the

naturally occurring radioisotope ^{228}Ac , which has a half life of only 6.1 hours, but is in equilibrium with ^{232}Th . A large, regional scale anomaly of ^{228}Ac occurs on top of the granulite belt running from Norway through Finland into Russia (Fig. 4).

Ecosystem damage

The vegetation is completely destroyed over several hundred square kilometres in the surroundings of the smelters, creating "moonscapes" or, in the terminology of our Russian colleagues, "technogenic deserts". They can be easily detected in satellite images and satellite imagery was used to reveal the development of vegetation damage over time (e.g., Tømmervik et al., 1995). A very surprising result of the project was that beginning soil erosion was a more widespread problem in the Finnish and especially Norwegian project areas, far from industry, than in Russia. In these areas, it was not heavy metal contamination or SO_2 that was causing the damage, but overgrazing by reindeer. The damage is most widespread on the Norwegian side of the border where 71% of all sites visited showed serious ecosystem damage compared with only 7% in Russia (Kashulina et al., 1997). Thus, an ecosystem whose lichen and mosses contain rather high heavy metal contents, but where no reindeer grazing takes place, can appear substantially healthier than similar grazed areas in Norway with 10 times less metal in lichens, mosses and soil. Reindeer herding, which has been a "natural" part of the way of living of the native population for centuries, has been turned into an industry with much larger herds in the last 30 years.



^{228}Ac Topsoil (0-5 cm), <2 mm, gamma spectrometry

Figure 4: Radioactivity values induced by ^{228}Ac in the Kola peninsula.

Recent investigations into the health situation of the local population failed to show an impact of the metal smelters on levels of nickel in blood and urine, car traffic being an apparently more important source (Smith-Sivertsen, 1997a, b).

Conclusions

The data presented in the environmental geochemical atlas of the central Barents Region can be used to identify and document human impact in the area, as well as the natural levels of the elements. The results show that parts of the area are extremely polluted with a large number of different elements. The data could give a good basis for selecting monitoring sites and will be important for planning investigations of the biological impact of severe heavy metal contamination on the environment. They provide fundamental information on element levels and variations in several media, in both a severely polluted environment and in one of the most pristine areas that can be found in Europe. They show that metal concentrations in all media decrease very abruptly (exponentially) with distance from industry. The amount of metals available for long range atmospheric transport is thus quite limited. They show that more factors than just industry (e.g., vegetation) can have an important influence on metal values observed in other sample media. The environmental impact of the smelters is rather limited in area when compared to other "mobile" human activities using much larger areas. The difference is, that these activities, e.g., reindeer herding (or cars) look rather nice when compared to a metal smelter and the environmental impact is not as obvious to the untrained eye. Public awareness is focused on industry due to the very apparent damage in the immediate surrounding of the smelters or the appearance of many industrial sites in general. Industry might be well advised to put some money into "appearances" - or, as an old German saying goes: "Kleider machen Leute".

For more information see "The Kola Ecogeochemistry Project" on internet: <http://www.ngu.no/Kola>

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BOOK REVIEW

Atlas de asociaciones minerales en lámina delgada

J.C. Melgarejo (Ed.), ISBN 84-89829-24-1. Servei de Publicacions, Universitat de Barcelona, Gran Via de les Corts Catalanes 585, E 08007 Barcelona, Spain. Fax +34 93 4035446. E-mail: sipu-sec@org.ub.es. 1074 pages. 1997. Price 14800 pts (about 98 USD).

Atlas de asociaciones minerales en lámina delgada is a most unusual book edited by Prof. Joan Carles Melgarejo at the University of Barcelona. The main interest of the book, what makes it unique, is its second part consisting of an atlas of thin section photographs of about 625 (!) mineral species occurring as gangue minerals in ore deposits or of general petrogenetic interest. Each species is presented in a full page containing the essential crystallographic, optic, and mineralogic properties, and at least two photographs of excellent quality (generally plane polarized light and crossed nicols, pictures taken with different elongation angles are included for some minerals). A selection of well chosen typical occurrence environments and of bibliographic references complete the documentation of each mineral species.

The first part of the book contains syntheses of the present knowledge of mineral associations. The coverage is extremely broad, and includes 28 chapters totalling over 400 pages on the main rock and ore deposits types but also on mineral associations in other environments as for instance concrete, ceramic materials, degradation of building stones, or also on non-opaque minerals in meteorites. Most chapters are excellent summaries but the encyclopedic character makes this first part somewhat inhomogeneous in scope and quality. From the economic

geology viewpoint the main interest of this part is that the book offers updated summaries in Spanish on the main ore deposit types. The chapters on pegmatites (P. Cerny, P. Alfonso, and J.C. Melgarejo), borates (R. Alonso and V. Ruiz), sulfates (F. Ortí and L. Rosell), hydrothermal alteration (F. Tornos), Mississippi Valley-type (J. Tritlla and A. Canals), and supergenic alteration (J. C. Melgarejo) are probably the more useful.

The large number of minerals considered in the atlas, the excellent quality of the photographs, and the care in the presentation of the data will make this book an obliged reference for every advanced user of a petrographic microscope. An English version is being prepared in cooperation with the Mineralogical Association of Canada. Those not scared of reading "grunerita" instead of grunerite or "autunita" instead of autunite should consider buying already the Spanish version (a Catalan version exists too, *Atles d'associacions minerals en lámina prima*, ISBN 84-89829-23-3), especially taking into account that the price (14.800 pts, about 98 USD) is a real bargain for this excellently printed hardbound book with 1076 pages and about 2000 color photographs. The extremely low price for a book of these characteristics has been possible thanks the support of the "Fundació Folch" honoring Dr. Joaquim Folch-Girona (1891-1984), creator of one of the best European private mineral collections.

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Papunen, H. (1997) **Research and Exploration: where do they meet?** Proceedings of the fourth Biennial SGA Meeting, Turku, Finland, 11-13 August 1997, Balkema, Rotterdam, 980 p. (ISBN 90 5410 889 4). Orders to: Balkema, P.O. Box 1675, NL 3000 BR Rotterdam, The Netherlands; Fax +31 10 4135947, (US\$ 115)

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Metallogenetic investigations in the Punta del Cobre belt, northern Chile by R. Marschik (1996) *Terre & Environnement*, Geneva, v. 5, 200 p. ISBN 2-940153-04-3. Orders to: Département de Minéralogie, Rue des Maraichers 13, CH-1211 Genève 4, Switzerland: 30 Swiss Francs (ca. 25 US\$).

Geochemical (elemental and isotopic) constraints on the genesis of the Mississippi Valley-type zinc-lead deposit of San Vicente, central Peru, by J. Spangenberg (1995). *Terre & Environnement*, Geneva, v. 1, 123 p. ISBN 2-940153-00-0, Orders to: Département de Minéralogie, Rue des Maraichers 13, CH-1211 Genève 4, Switzerland: 30 Swiss Francs (ca. 25 US\$).

Lithogeochemistry of Lower Cretaceous sediments from the Bilbao Anticline, Basque-Cantabrian basin by I. Yusta. (1994, in Spanish) Orders to: Dpto. Mineralogía y Petrología, Universidad del País Vasco, Apdo. 644, E-48080 Bilbao, Spain: 2500 pesetas (about 25 US\$).

The Pb-Zn-As-Tl-Ba-deposit at Lengenbach, Binn Valley, Switzerland - Petrogenesis based on combined geochemical and isotopic (U,Pb,Rb,Sr,S,O,C) investigations by M.D. Knill. *Beiträge zur Geologie der Schweiz, geotechnische Serie*, Lief. 90, 1996. 87 p. (includes numerous color figures). Orders: Schweizerische Geotechnische Kommission, ETH-Zentrum, 8092-Zürich, Switzerland: 35 SFR, (about 28 US\$).

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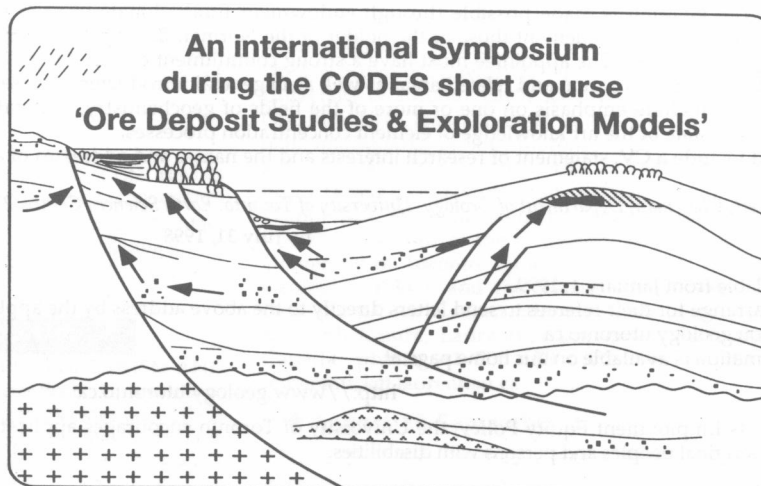
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Day 2, Tuesday 16

North American sediment-hosted Zn-Pb Deposits
Wayne Goodfellow (Geological Survey of Canada) and Peter McGoldrick (CODES)

Day 3, Wednesday 17

Mississippi Valley and Irish Style Zn-Pb deposits
Murray Hitzman (Colorado School of Mines) and Peter Muhling (BHP)

Day 4, Thursday 18

Hydrology and geochemistry of fluids in basins
Grant Garven (Johns Hopkins University) and Jeff Hanor (Louisiana State University)

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ANNOUNCEMENTS

TENURE STREAM POSITION IN ORE GENESIS

The Department of Geology invites applications for a tenure stream position at the ASSISTANT PROFESSOR level in the field of ORE GENESIS (St. George Campus). The position is made possible through endowment funds donated to the Department by the Canadians Resident Abroad Foundation and the duties will complement those of the holder of the Norman B. Keevil Chair in Ore Genesis and of related faculty in the broad field of mineral deposits geology. The appointee must have a strong commitment to both teaching and research. He/she will be expected to teach courses within the field of specialization and related areas as well as in general introductory courses. Research interests should focus on processes of ore formation and may include emphasis on one or more of the fields of geochemistry, mineralogy, petrology, structural geology or computer simulation as applied to state of the art knowledge of element concentration processes.

Applications should include a CV, statement of research interests and the names and addresses of at least three referees and be sent to:

Professor J. J. Fawcett, Chairman, Department of Geology, University of Toronto, Earth Sciences Centre, 22 Russell Street, Toronto, Ontario, Canada M5S 3B
by July 31, 1998

The position is available from January 1, 1999.

Applicants should arrange for their referees to send letters directly to the above address by the application deadline.

email to: chair@zircon.geology.utoronto.ca

Departmental information is available on our home page at

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In accordance with its Employment Equity Policy, the University of Toronto encourages applications from qualified women or men, members of visible minorities, aboriginal peoples and persons with disabilities.

MEETINGS, CONFERENCES AND SHORT COURSES

5TH ANNUAL SHORT COURSE ON "MAGMATISM, VOLCANISM AND METALLOGENY"

Brest, France

SGA-SPONSORED

June 3-5, 1998 (CHANGED DATES!!!)

An in-depth examination with lectures and hands-on practical sessions of magmatic and volcanic processes and their ores in continents, ocean basins and island arcs from a geological, petrological and geochemical point of view. Organized by Steve Scott (University of Toronto), Thierry Juteau (l'Université de Bretagne Occidentale: UBO) and Yves Fouquet (IFREMER). Other instructors include Nick Arndt (Rennes University), Harold Gibson (Laurentian University), Roger Hekinian (IFREMER) and Rene Maury (UBO). Sponsored by the SGA, IFREMER, Conseil General du Finistere and UBO. CONTACT: Professor Thierry Juteau, Dépt. des Sciences de la Terre, Université de Bretagne Occidentale, 6 avenue Le Gorgeu, B.P. 809, 29285 Brest Cedex, France Tel (33) (0)298 01 61 75, Fax (33) (0)298 01 66 20, Internet: juteau@univ-brest.fr

INTERNATIONAL MEETING OF GOLD EXPLORATION AND MINING IN NW SPAIN

Oviedo, Spain

September 22-23 1998

Sponsored by the Facultad de Geología de Oviedo, Rio Narcea Gold Mines, Ltd., San Diego Gold Minery Ltd., Siemcalsa and Universidad de Oviedo. Field trips (24 and 25 September) to the mines of Valle-Boinas, Carlés, Salave and the gold prospect at the Navia river.

Contact address:

Dr. Daniel Arias Prieto, Facultad de Geología, C/ Arias de Velasco s/n, 33005 Oviedo (Spain); phone: +34 8 5103109; fax: +34 8 5103085; e-mail: darias@asturias.geol.uniovi.es; web site: <http://www4.uniovi.es/es/D-Facultad>

INVITATION TO A NEW IGCP 429

"Roles of organic matter in the environmental sector" is the recently announced IGCP Project 429. The objectives of the Project are to correlate the different roles of organic matter in the environment, generated from interdisciplinary studies covering interactions between the biosphere, geosphere, and atmosphere. Direct and indirect microbiological and biogenic leaching studies, the weathering of fossil organic matter and associated

sulfides in waste heaps and environmental geochemical models of black shale hosted mineral deposits will be used to provide guidance on minimizing negative environmental impacts of mining activities, and promoting remediation processes. Studies of the immobilization of fission products by organic matter in ore deposits will be applied to man-made radioactive waste repository sites. Atmospheric processes to be examined include organic roles in the formation of potentially carcinogenic atmospheric particulates. The nature and fate of organic pollutants in surface and groundwaters will be a significant aspect of the Project activities. The IGCP Project 429 will run from 1998-2002. The inaugural meeting will be held in Prague (Czech Republic), September 12-14, 1998. Further information can be obtained from the Project Leader, Dr. Jan Pasava, Czech Geological Survey, Geologická 5, 152 00 Praha 5, Barrandov, Czech Republic (Fax: +420-2-5818748, Phone: +420-2-5817390, E-mail: pasava@cgu.cz).

CONGRESO DE MINERALOGIA Y PETROLOGIA SEM98, XVIII REUNION DE LA SOCIEDAD ESPAÑOLA DE MINERALOGIA

Bilbao, Spain

October 3-6, 1998

Contributions from all fields of Crystallography, Mineralogy, Petrology and Geochemistry are welcome. Manuscripts will be written preferentially in Spanish or in English. They will be grouped into appropriate oral and poster sessions. Deadline for Abstracts: 30 April 1998.

Principal themes of the conference:

- Mineralogy
- Ore deposits
- Igneous and metamorphic petrology
- Sedimentary petrology
- Geochemistry and isotope geology
- Clay mineralogy
- Applied mineralogy
- Crystallography and crystal growth
- Archeometry and conservation
- Teaching of crystallography, mineralogy and petrology

There will be three pre-congress excursions on 3 and 4 October 1998 in the Basque-Cantabrian Basin and Spanish Pyrenees devoted to: 1) Upper Cretaceous volcanic rocks, 2) Magnesite deposits in Paleozoic sediments, and 3) The Peñas de Haya pluton and country rocks and shale-hosted Zn-Pb-F ore deposits.

Contact address:

Dr. José-Miguel Herrero Rubio, Dpto. Mineralogía y Petrología, Universidad del País Vasco (Euskal Herriko Unibertsitatea), Apdo. 644, E-48080 Bilbao (Spain); phone: +34 4 464 7700 (ext. 2473); fax: +34 4 464 8500; e-mail: sem98@lg.ehu.es; Conference web site: <http://www.ehu.es/sem98>

⇒⇒⇒FORTHCOMING EVENTS⇒⇒⇒

★ marks a new entry

1998

June 1-4

PACROFI VII, PAN AMERICAN CURRENT RESEARCH ON FLUID INCLUSIONS, Las Vegas, Nevada, USA - Contact address: UNLV Continuing Education / PACROFI VII, 4505 Maryland Parkway, Box 451019, Las Vegas, NV 89154-1019, USA; phone: +1 702 895 3394; fax: +1 702 895 4195; e-mail: baker@ccmail.nevada.edu

★**June 2-6**

CARBONACEOUS FORMATIONS IN GEOLOGICAL HISTORY: CONDITIONS OF FORMATION, ORE POTENTIAL, PHYSIOCHEMICAL CHARACTERISTICS OF CARBON AND TECHNOLOGY, Petrozavodsk, Karelia, Russia - Contact address: Natalia N. Rozhkova, Institute of Geology, Pushkinskaya St. 11, Petrozavodsk, Russia; phone: +814 2 770 189; e-mail: rozhkova@shungit.karelia.su

June 3-5 (Changed dates)

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5TH ANNUAL SHORT COURSE ON "MAGMATISM, VOLCANISM AND METALLOGENY", Brest, France - Organized by Steve Scott (University of Toronto), Thierry Juteau (l'Université de Bretagne Occidentale: UBO) and Yves Fouquet (IFREMER). Contact address: Professor Thierry Juteau, Dépt. des Sciences de la Terre, Université de Bretagne Occidentale, 6 avenue Le Gorgeu, B.P. 809, 29285 Brest Cedex, France; phone: +33 298 01 61 75; fax: +33 298 01 66 20; e-mail: juteau@univ-brest.fr (see page 14)

June 3-5

INTERNATIONAL SYMPOSIUM CORDILLERA DE LOS ANDES. GEOLOGICAL AND MINING POTENTIAL. THE NEW TECTONIC AND METALLOGENIC APPROACH, Mendoza, Argentina - Contact address: GRK Catamarca 31, Piso 12, Depto. D, 5500-Mendoza-Argentina; phone: +54 61 200673; fax: +54 61 202330; e-mail: grkpcpsarg.com

★**June 15-18**

JOINT CONVENTION OF THE CANADIAN SOCIETY OF PETROLEUM GEOLOGISTS, CANADIAN SOCIETY OF EXPLORATION GEOPHYSICISTS, AND CANADIAN WELL LOGGING SOCIETY, University of Calgary, Canada - Contact address: Geo-Triad '98, 905, 510-5th Street SW, Calgary, Alberta, Canada T2P 3S2; e-mail: info@geotriad98.ab.ca, world wide web site: <http://www.geotriad98.ab.ca>, or participating societies: CSPG, phone: +1 403 264 5610; fax: +1 403 264 5898; CSEG, phone: +1 403 262 0015; fax: +1 403 262 7383; CWLS, phone: +1 403 269 9366; fax: +1 403 269 2787

June 29-July 2

SGA-COSPONSORED

8TH IAGOD/CODMUR INTERNATIONAL PLATINUM SYMPOSIUM WITH THE THEME "PLATINUM - GENESIS TO BENEFICIATION", Rustenburg, South Africa - Excursions to the Great Dyke, Zimbabwe, Bushveld Complex, South Africa. Contact address: Mrs. Elmarie Walker, Conference Co-ordinator, South African Institute of Mining and Metallurgy, PO Box 61127, Marshalltown 2107, South Africa; phone: +27 11 834 1273/7; fax: +27 11 838 5923; e-mail: saimm@iafrica.com

★**July 6-10**

15TH AUSTRALIAN GEOLOGICAL CONVENTION, Townsville, Queensland - Contact address: The Secretariat, 14th AGC, School of Earth Sciences, James Cook University, Townsville, Queensland 4811, Australia; phone: + 61 77 81 5047; fax: +61 77 25 1501; e-mail: jcu.agc@jcu.edu.au

July 7-10

GEOCONGRESS 98, Pretoria, South Africa - Contact address: Secretary of Geocongress '98, P.O.Box 798, Pretoria, 0001 Pretoria, South Africa; fax: +27 12 841 1221; e-mail: eaucampgeoscience.org.za or organizer of the Economic Geology Session: Dr. M. du Toit, Council for Geoscience, P.B. X112, 0001 Pretoria, South Africa; phone: +27 12 841 1124; fax: +27 12 841 1221; e-mail: eaucamp@geoscience.org.za

★**July 11-17**

IACVEI INTERNATIONAL VOLCANOLOGICAL CONGRESS, Cape Town, South Africa - Contact address: Secretariat, IVC'98, Department of Geological Sciences, University of Cape Town, Private Bag, Rondebosch 7701, Republic of South Africa; fax: +27 21 650 3783; e-mail: ivc98@geology.uct.ac.za

August 5-8

COM/IMA/MAC SHORT COURSE, MODERN APPROACHES TO ORE AND ENVIRONMENTAL MINERALOGY, Ottawa and Guelph, Canada - Contact address: Louis J. Cabri; phone: 1-613-995-4073 CANMET; fax: 1-613-996-9673 555 Booth Street; e-mail: lcabri@nrcan.gc.ca Ottawa, CANADA K1A 0G1

August 9-14

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IMA '98 (17TH GENERAL MEETING OF THE INTERNATIONAL MINERALOGICAL ASSOCIATION), Toronto, Canada - Contact address: Dr. Eva Schandl, Secretary to Organising Committee, Dept. of Geology, University of Toronto, Earth Sciences Centre, 22 Russell Street, Toronto ON, M5S 3B1 Canada; phone: +1 416 978 7084; fax: +1 416 978 3938; e-mail: ima@quartz.geology.utoronto.ca. First circular with response form are available on the IMA98 web site at: <http://www.geology.utoronto.ca/IMA98>

Within IMA '98 a symposium on "Ore Deposits in Mafic and Ultramafic Rocks", in honour of the retirement of Professor A.J. Naldrett of the University of Toronto. Sponsored by IMA, the Society of Economic Geologists (SEG), and the Society for Geology Applied to Mineral Deposits (SGA). Contact address: C.M. Leshner, Mineral Exploration Research Centre, Laurentian University, Sudbury, Ontario P3E 2C6 Canada; phone: +1 705 673 6572; fax: +1 705 673 6508; e-mail: leshner@nickel.laurentian.ca

★**August 30-September 2**

17TH CONGRESS OF THE CARPATHIAN-BALKAN GEOLOGICAL ASSOCIATION, Vienna, Austria - Contact address: Dr. Werner Janoscheck, Geological Survey of Austria, Rasumofskygasse 23, A-1031 Vienna, Austria; phone: +43 1 712 567 443; fax: +43 1 712 567 456; e-mail: wjanoscheck@cc.geolba.ac.at

★**August 30-September 3**

THE 8TH ANNUAL V.M. GOLDSCHMIDT CONFERENCE, Toulouse, France - Contact address: Conference Organization, 8th Annual V.M. Goldschmidt Conference, Laboratoire de Géochimie, 38, rue des 36 Ponts, 31400 Toulouse, France; phone: +33 561 55 65 18 (J. Schott) or +33 561 55 87 85 (E. Oelkers); fax: +33 561 52 05 44; e-mail: goldconf@lucid.ups-tlse.fr; world wide web site: <http://www.obs-mip.fr/omp/umr5563/goldconf98.html>

September 1-12

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INTERNATIONAL IGCP-373 FIELD CONFERENCE, ANATOMY AND TEXTURES OF ORE-BEARING GRANITOIDES OF SIKHOTE-LIN (PRIMORYE REGION, RUSSIA) AND RELATED MINERALIZATION, Vladivostok, Russia - Contact address: Dr. Galina Gonevchuk, Far East Geological Institute of FEB of Russian Academy of Sciences, 159, Prospect 100-letiya, Vladivostok, 690022, Russia; phone: +7 4232 318 750; fax: +7 4232 31 78 47; e-mail: fegi@online.marine.su or Dr. Reimar Selmann, GeoForschungsZentrum Potsdam (GFZ) Telegrafenberg A50, D-14473 Potsdam, Germany; phone: +49 331 288 1433; fax: +49 331 288 1436; e-mail: setm@gfz-potsdam.de

September 21-24

IGCP 373 INTERNATIONAL CONFERENCE, GENETIC SIGNIFICANCE OF PHOSPHORUS IN FRACTIONATED GRANITES, Perslák, Czech Republic - Contact address: Karel Breiter, Czech Geological Survey, Geologická 6, 152 00 Praha 5, Czech Republic; phone/fax: 420 2 581 73 90; e-mail: breiter@cgu.cz; world wide web site: <http://www.cgu.cz/p/p.htm>

★**September**

4TH ARGENTINIAN MEETING OF MINERALOGY AND METALLOGENY, Bahia Blanca, Argentina - Contact address: e-mail: edomin@criba.edu.ar

September 22-23

INTERNATIONAL MEETING OF GOLD EXPLORATION AND MINING IN NW SPAIN, Oviedo, Spain - Post-Congress excursions. Contact address: Dr. Daniel Arias Prieto, Facultad de Geología, C/ Arias de Velasco s/n, 33005 Oviedo (Spain); phone: +34 8 510 3109; fax: +34 8 5103085; e-mail: darias@asturias.geol.uniovi.es; world wide web site: <http://www4.uniovi.es/es/D-Facultad> (see page 14)

★**October 1-3**

II SYMPOSIUM APIFIS (ASIAN AND PACIFIC INTERNATIONAL FLUID INCLUSION SOCIETY), Tashkent, Republic of Uzbekistan - Contact address: II APIFIS, 70 Gogol Street, Tashkent 700047, Republic of Uzbekistan; phone: +7 3712 337 069; fax: +7 3712 334 901; e-mail: root@seismo.tashkent.su

★October 1-4

INTERNATIONAL SYMPOSIUM "THERMOBAROGEOCHEMISTRY OF ENDOGENIC SYSTEMS", Dushanbe, Republic of Tajikistan - Contact address: F. G. Gafurov, Geological and Mining Faculty, Tajik. State University, Rudaki str. 17, 734025 Dushanbe, Tajikistan

★October 3-6

CONGRESO DE MINERALOGIA Y PETROLOGIA SEM98, XVIII REUNION DE LA SOCIEDAD ESPAÑOLA DE MINERALOGIA, Bilbao, Spain - Pre-Congress excursions. Contact address: Dr. José-Miguel Herrero Rubio, Dpto. Mineralogía y Petrología, Universidad del País Vasco (Euskal Herriko Unibertsitatea), Apdo. 644, E-48080 Bilbao, Spain; phone: +34 4 464 7700 (ext. 2473); fax: +34 4 464 8500; e-mail: sem98@lg.ehu.es; world wide web site: <http://www.ehu.es/sem98> (see page 14)

★October 19-21

8TH INTERNATIONAL WILLISTON BASIN SYMPOSIUM, Regina, Saskatchewan, Canada - Contact address: Dr. Doug Paterson, Saskatchewan Geological Society, P.O. Box 234, Regina, Saskatchewan, Canada S4P 2Z6; phone: +1 306 787 2625; fax: +1 306 787 4608; e-mail: dpaterson@gov.sk.ca; world wide web site: <http://www.gov.sk.ca/enermine/about/semnew.htm>

October 21-23

"MARINE RESEARCH MEETS LAND EXPLORATION", Day's Inn, Toronto, Canada - The contribution of ocean drilling and seafloor research to the exploration for base and precious metals on land. Additional sessions on marine diamonds and a variety of topics on marine mining. Sponsored by the International Marine Minerals Society for the 29th annual Underwater Mining Institute organized by S. Scott (University of Toronto), R. Moore (Falconbridge) and R. Garnett (Valrik). Contact address: Mrs. Karynne Chong Morgan, UMI Conference Coordinator, 811 Olomehani Street, Honolulu, Hawaii 96813-5513, USA; phone: +1 808 587-5320; fax: +1 808 587-5325; e-mail: klei@compuserve.com

October 26 - 29

SOCIETY OF ECONOMIC GEOLOGISTS (SEG) AND GEOLOGICAL SOCIETY OF AMERICA (GSA) ANNUAL JOINT MEETING, Toronto, Canada - Contact address: GSA Meetings Dept., P.O. Box 9140, Boulder, CO 80301-9140 USA; phone: +1 303 447 2020; fax: +1 303 447 1133; e-mail: meetings@geosociety.org; world wide web site: <http://www.geosociety.org/meetings/index.htm>

★November 8-13

X CONGRESO LATINOAMERICANO DE GEOLOGIA, VI CONGRESO DE GEOLOGIA ECONOMICA, Buenos Aires, Argentina - Contact address: Secretaria; fax: +54 1 349 31 55; e-mail: conglat@secind.mecon.ar

★November 9-12

5TH ANNUAL AFRICAN MINING INVESTMENT SYMPOSIUM, and ARAB MINING INVESTMENT SYMPOSIUM, Marrakech, Morocco - Field excursions before and after. Sponsored by MIGA (World Bank). Contact address: Ms. L. Gorman at MIGA, Washington D.C.; fax: 1-202-522-2650; e-mail: lgorman@worldbank.org

★November

6TH NATIONAL CONFERENCE OF MINERAL DEPOSITS OF CHINA, Beijing, China - Contact address: Dr. Mao Jingwen and Ms. Sun Wenhong, Institute of Mineral Deposits, Chinese Academy of Geological Sciences, 26 Baiwanzhuang Road, Beijing 100037, China; fax: +86 10 638 32 336 or +86 10 683 10 894; e-mail: hyli@public3.bta.net.cn

1999

★February 15-18

SYMPOSIUM GEOLOGY ALPTRANSIT, Zürich, Switzerland - Contact address: Secretariat, Ingenieurgeologie ETH, GEAT99, ETH

Hönggerberg, 8093 Zürich; phone: +41 1 633 31 90; fax: +41 1 633 11 08; e-mail: geat99@erdw.ethz.ch

★May 26-28

GEOLOGICAL ASSOCIATION OF CANADA - MINERALOGICAL ASSOCIATION OF CANADA, JOINT ANNUAL MEETING, Sudbury, Ontario, Canada - Contact address: Dr. P. Copper, Department of Earth Sciences, Laurentian University, Sudbury, Ontario, Canada P3E 2C6; phone: +1 705 675.1151 (ext 2267); fax: +1 705 675 4898; e-mail: gacmac99@nickel.laurentian.ca

August 22-25

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5TH, BIENNIAL SGA MEETING AND 10TH IAGOD QUADRIENNIAL SYMPOSIUM, London, U.K. - Contact address: Dr. C. J. Stanley, Dept. of Mineralogy, The Natural History Museum, Cromwell Rd., London, SW7 5BD, U.K.; fax: +44 171 938 9268; e-mail: cjs@nhm.ac.uk (see page 20 for details)

★August 26-September 5

IGCP-373 FIELD CONFERENCE ON GEODYNAMICS AND MINERAL DEPOSITS IN UZBEKISTAN MURUNTAU, Kochbulak, Almalyk - Contact address: A. Kremenetsky, krem@sovam.com and R. Seltmann, seltm@gfz-potsdam.de

September 12-16

SUDBURY '99, MINING AND THE ENVIRONMENT II. First announcement and call for papers - Contact address: Sudbury 99, Centre in Mining and Mineral Exploration Research (CIMMER), Laurentian University, Sudbury, Ontario P3E 2C6 Canada; phone: +1 705 673 6572; fax: +1 705 673 6508; e-mail: cmosher@nickel.laurentian.ca or bevans@nickel.laurentian.ca

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(See page 2 for details concerning the format of the documents to be sent)

2000

★August

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@cristal.cprm.gov.br; world wide web site: <http://www.cprm.gov.br/31igc.htm>

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

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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.

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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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First Circular

Joint SGA - IAGOD Meeting



SGA

SOCIETY FOR GEOLOGY APPLIED TO
MINERAL DEPOSITS
5th Biennial Meeting

IAGOD

INTERNATIONAL ASSOCIATION ON THE
GENESIS OF ORE DEPOSITS
10th Quadriennial Symposium

London 1999

August 22 to 25, 1999

Imperial College / The Natural History Museum

"Mineral Deposits: Processes to Processing"

Science and technology applied to mineral formation and breakdown, mineral processing and environmental problems

The organizing committee invite offers to lead pre- and post- meeting field excursions, put on workshops or short courses, and organize scientific sessions. We also invite offers of sponsorship from industry for a range of activities, Icebreaker Party, Conference Dinner, Workshops etc. or to enable students and scientists from poorer countries to attend.

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To express an interest and to receive the second circular (July 1998) and final circular (February 1999) please fill in the linked form and send it by post, fax, or e-mail to the address given:

Dr C J Stanley (SGA), Department of Mineralogy, The Natural History Museum, Cromwell Road, LONDON, SW7 5BD, United Kingdom. Fax: +44 (0)171 938 9268. E-mail: cjs@nhm.ac.uk

Details will also be posted on the SGA home page at: <http://www.immr.tu-clausthal.de/sga.html>

5th SGA-10th IAGOD JOINT MEETING: PRE-REGISTRATION FORM (Please type or use BLOCK letters)

Title..... First Name

Last Name

Institution

Address

E-mail

Fax..... Telephone

I am very likely to attend ☐

I am likely to attend ☐

It is possible I will attend ☐ the 5th Biennial SGA meeting

☐ I will require hotel accommodation (more than 40 GBP per night)

☐ I will stay in student halls of residence (25 to 35 GBP per night)

I offer to organize:

☐ pre/post meeting field excursion to

☐ workshop on

☐ short course on

☐ scientific session on

My company is interested in sponsoring:

☐ Icebreakers Party

☐ Conference Dinner

☐ Workshops

☐ Scientific Session on

☐ Short Course

☐ Student attendance

☐ Scientists from NIS etc.

I am a *student/scientist from a World Bank designated poorer country and it is likely that I will require *full costs/ accommodation and/or registration fee/subsidy to enable me to attend the meeting.

* delete as appropriate