MINISTÉRIO DE MINAS E ENERGIA
Secretaria de Minas e Metalurgia
Companhia de Pesquisa de Recursos Minerais

Relatório de Viagem ao Exterior
Vail - Colorado - USA
GILBERTO JOSÉ MACHADO

Outubro de 1997
SUMÁRIO

I - INTRODUÇÃO ............................................................................................................. 03

II - OBJETIVOS .................................................................................................................. 03

III - PROGRAMA DA VIAGEM ....................................................................................... 04

IV - LOCAL DO EVENTO .................................................................................................. 04

V - DESCRIÇÃO E ANÁLISE DAS ATIVIDADES DESENVOLVIDAS................................. 05

V.1 - POSTER PRESENTATION - “The Application of Geochemistry Data to Environmental Concerns in the Minas Gerais Stated, Brazil.............................................................. 05

V.2 - REUNIÃO DO IGCP 360 - GLOBAL GEOCHEMICAL BASELINES......................... 06

V.3 - WORKSHOP - COLLECTING GEOCHEMICAL DATA FOR BOTH EXPLORATION AND ENVIRONMENTAL PURPOSES..... 07

V.4 - 31st INTERNATIONAL GEOLOGICAL CONGRESS BRAZIL 2000.............................. 07

V.5 - APRESENTAÇÕES ORAIS......................................................................................... 07

VI - CONCLUSÕES E RECOMENDAÇÕES ........................................................................ 08

VII - AGRADECIMENTOS ............................................................................................... 09

RELAÇÃO DAS FIGURAS E ANEXOS
RELAÇÃO DAS FIGURAS E ANEXOS

FIGURAS
Figura 1 - Mapa de Localização de Vail - Colorado - USA
Figura 2 - Local de Realização do Simpósio - Hotel Cascade
Figura 3 - Poster Presentation - Brasil
Figura 4 - Efeito do Molibdênio no Gado - Dakota do Sul - USA
Figura 5 - Reunião do IGCP 360 - Mapeamento Geoquímico Internacional
Figura 6 - Divulgação do IGC - BRAZIL 2000 - Poster e Bottom
Figura 7 - Mina Summitville - Colorado - USA
Figura 8 - Rio Alamosa Próximo à Mina Summitville - Colorado - USA

ANEXOS
ANEXO 1 - Curriculum Vitae do Dr. John Fortescue
ANEXO 2 - Texto do Poster Presentation "The Application of Geochemistry Data To Environmental Concerns in the Minas Gerais State, Brazil"
ANEXO 3 - Agenda do IGCP 360 - IGM
ANEXO 4 - Sumário do Foregs Geochemical Mapping - Field Manual
ANEXO 5 - Proposta para Criação da Association for Global Geochemical Baseline
ANEXO 6 - Sumário do workshop - Collecting Geochemical Data for both Exploration and Environmental Purposes
ANEXO 7 - Abstract do IV ISEG
ANEXO 8 - Programação da Sessão de Encerramento do IV ISEG
ANEXO 9 - Lista dos Participantes do IV ISEG
I - INTRODUÇÃO

A atividade de geoquímica ambiental está em grande expansão no mundo atual. Isto se deve ao fato de que esta ferramenta de pesquisa dá uma resposta mais rápida para a sociedade nas questões que afetam a sua relação com o meio ambiente. As atividades de mineração, industrialização, agricultura, desflorestamento e urbanização levam a problemas de degradação da terra e contaminação de grandes áreas. A concentração natural de determinados elementos químicos podem afetar tanto o homem como os animais que se alimentam continuamente de produtos de uma mesma região.

A Companhia de Pesquisa de Recursos Minerais atenta à evolução dessa forma de conhecimento, iniciou um estudo de geoquímica ambiental através do DEGEO/DIGEOQ - Departamento de Geologia / Divisão de Geoquímica utilizando dados regionais de projetos históricos para testar a possibilidade de sua aplicação no meio ambiente.

Este estudo foi iniciado em novembro do ano passado com o Projeto Geoquímica e Meio ambiente no PLGB, com dois relatórios já publicados. O primeiro referente a Pesquisa Bibliográfica e o segundo com os resultados da primeira fase. A segunda fase terá prosseguimento com o estudo geoquímico detalhado em Pocos de Caldas, em convênio com Indústria Nucleares do Brasil - INB. Este trabalho foi submetido à Diretoria Executiva da CPRM, que aprovou a sua apresentação no IV th ISEG (International Symposium on Environmental Geochemistry). Foi enviado o trabalho “The Application of Geochemistry to Environmental Concerns in the Minas Gerais State - Brazil” para a Comissão Organizadora do IV ISEG que o aprovou para apresentação como Poster Presentation.

O presente relatório mostra os resultados obtidos durante o evento realizado entre os dias 05 de outubro a 10 de outubro de 1997 na cidade de Vail no estado do Colorado, USA, assim como as atividades desenvolvidas pelo geólogo Gilberto José Machado, chefe da Divisão de Geoquímica.

A viagem foi autorizada pelo Excelentíssimo Sr. Ministro de Minas e Energia, Dr. Raimundo Brito e publicada no Diário Oficial da União no 173, em 09 de setembro de 1997, folha no 687, seção 2.

II - OBJETIVOS

manteve contato com profissionais de diversos Serviços Geológicos sobre assunto de interesse mútuo.

III - PROGRAMA DE VIAGEM

O programa de viagem elaborado está descrito na tabela abaixo. No deslocamento foram percorridos dois trajetos, um por avião até a cidade de Denver no Colorado, e o último percurso por terra até a cidade de Vail.

O programa de viagem foi o seguinte:

Dia 05 (Domingo - 21:30 horas) - Viagem Rio/São Paulo/Atlanta
Dia 06 (Segunda-feira) - Viagem Atlanta/Denver/Vail
- Montagem do Post Presentation
Dia 07 (Terça-feira) - Atendimento ao Post Presentation
- Assistiu a apresentações orais
Dia 08 (Quarta-feira) - 2a reunião do IGCP 360 - International Geochemical Baselines
Dia 09 (Quinta-feira) - Assistiu a apresentações orais
Dia 10 (Sexta-feira) - Assistiu a apresentações orais
- Viagem retorno
- Vail/Denver/Atlanta
- Atlanta/São Paulo/Rio
Dia 11 (Sábado) - Chegada Rio de Janeiro

Foram mantidos contatos com diversos pesquisadores, como: Dr. John Fortescue (vide curriculum vitae anexo 1); Drs. Richard K. Glanzman (CH2M Hill) e L. Graham Gloss (Colorado School of Mines), coordenadores do Workshop Collecting Geochemical Data for both Exploration and Environmental Purposes - realizado no Domingo dia 05 de outubro; Dr. David Smith responsável pelas bases de dados de geoquímica do USGS e atual Project Leader do IGCP Project 360 Global Geochemical Baselines; Dra. Jane Plant - BSC UK, Dr. Arthur Darnley Project Leader, Dra. Gloria Prieto Engeominas Colômbia, Dra. Gwendy Hall GSC Canada, Dr. Pavel Koval Vinogradov Institute of Geochemistry - URSS, Dr. P. K. Govil (Índia), Dr. Timo Tarnavian GSF Finlândia, e Dr. Maurice Chafee - USGS, que participaram da reunião do IGCP 360.
IV - LOCAL DO EVENTO

O simpósio foi realizado na cidade de Vail no Estado do Colorado na região central dos Estados Unidos (figura 1). Esta cidade está localizada a cerca de 160 km a oeste da capital Denver, no aprazível cenário das Montanhas Rochosas. É facilmente acessível por serviço de transporte de van ou por carro alugado, que pode ser feito no próprio aeroporto internacional de Denver. A cidade de Vail é mundialmente conhecida por sua beleza, atividades ao ar livre e rede hoteleira.

O simpósio foi realizado no Vail Cascade Hotel que possui um número considerável de suites de luxo, confortáveis apartamentos (figura 2) e apartamentos padrões. Tendo em vista que os conferencistas ficaram hospedados neste hotel, não houve dificuldades de acesso aos locais das palestras, apesar do hotel ficar distante do comércio local e não oferecer muitas opções de locais de alimentação.

A organização do Simpósio foi perfeita, principalmente as facilidades que o hotel oferecia para realização de eventos desse porte.

V - DESCRIÇÃO E ANÁLISE DAS ATIVIDADES DESENVOLVIDAS

V.1 - POSTER PRESENTATION - ‘The Application of Geochemistry Data to Environmental Concerns in the Minas Gerais State, Brazil’


Tive a oportunidade de observar que o trabalho apresentado neste Simpósio ‘The Application of Geochemistry Data to Environmental Concerns in the Minas Gerais State, Brazil (Anexo 2)’ é apropriado para ser executado por Serviços Geológicos, onde pude observar trabalhos semelhantes. O poster estava com uma boa apresentação quando comparado aos outros painéis exibidos no local. Neste trabalho ficou evidenciado que 100 ppm de molibdênio encontrados nos sedimentos de corrente na região de Poços de Caldas (figura 3) podem ser indicativos de problemas de saúde no gado da região. Segundo a publicação ‘Understanding Our Fragile Environment - USGS Circular 1105’ foram encontrados até 40 ppm de molibdênio na grama do pasto região de Dakota do Sul, causando problema de molibdenose no gado (figura 4). O Projeto Geoquímica e Meio Ambiente terá prosseguimento na área de Poços de Caldas em parceria com a INB (Indústria Nucleares do Brasil), que possui um escritório técnico e laboratório nesta cidade, onde realiza um monitoramento ambiental na área ao redor e nas bacias de drenagens na fazendas circunvizinhas da mina de urânio, atualmente paralisada. A minha proposta é verificar se o elemento químico molibdênio presente em grande
quantidade nas rochas do Complexo Alcalino de Pocos de Caldas, uma vez sendo liberado pela ação do intemperismo para o solo e águas (superficiais e subterrânea), está causando problemas de molibdenose no gado e na população. Sabe-se que na região nascem animais com deformações nas patas dianteiras. Além do molibdênio, existe também grande concentração de manganês, presente nos gonditos que ocorrem na região, que é liberado do rejeito da mina desativada, no tratamento das drenagens ácidas, que pode estar contribuindo para causar anomalias congêntitas deformativas nas patas de animais, conforme registrado na literatura.

V.2 - REUNIÃO DO IGCP PROJECT 360 - GLOBAL GEOCHEMICAL BASELINES

Na quarta-feira, dia 08 de outubro foi realizada a segunda reunião do Grupo de trabalho do Global Geochemical Baselines (figura 5). A primeira reunião foi realizada no domingo, dia 05 de outubro, das 9 horas da manhã até as 5 horas da tarde, cuja agenda está apresentada em anexo 3. Na quarta-feira, a reunião foi reiniciada no item 4 da agenda: Review of expanded regional field manuals and additional climatic field methods, que foi apresentado pelo Dr. Timo Tarvainen do Serviço Geológico da Finlândia. O sumário do que foi tratado está apresentado no anexo 4. O Dr. Timo já enviou para o escritório do Rio de Janeiro o documento definitivo que será distribuído aos Coordenadores de Geoquímica da CPRM.


O item seguinte da agenda: Funding and PR foi conduzido pelo Project Leader, Dr. A. Darnley e Dra. Jane Plant. Foi tratado da continuação do projeto e discutida a sua Organização. O Dr. Darnley informou que o IGCP 360 terminará no final deste ano, devendo ser feito um Review em fevereiro do ano seguinte. O Projeto deverá ter continuidade com a criação de uma Associação denominada International Association for Global Geochemical Baselines que será afiliada a International Union of Geological Sciences. A proposta anexa apresenta os Objetivos, Métodos e uma condicionante: "ter uma provisão suficiente de suporte financeiro pelas organizações interessadas públicas e comerciais". O Dr. Darnley mencionou um suporte de cerca de US $ 2000,00 anuais. Com este fundo será patrocinado workshops e treinamentos em países em desenvolvimento. Essa Associação teria mais sucesso de levantar fundos do que um IUGS Working Group. (Anexo 5)

Em seguida houve a escolha do novo Coordinate leader, sendo escolhido o Dr. David Smith do USGS para substituir o Dr. Arthur Darnley. Foi escolhida a cidade
de Roma para sediar o próximo FOREGS.

V.3 - WORKSHOP - COLLECTING GEOCHEMICAL DATA FOR BOTH EXPLORATION AND ENVIRONMENTAL PURPOSES

Este Workshop foi realizado no domingo, 05 de outubro não foi possível assistir o curso. No entanto, devido ao tema ser de grande interesse para a CPRM e, tendo em vista os projetos atuais da empresa serem de cunho social, envolvendo também a área ambiental, procurei os Drs. Richard K. Glanzman e L. Graham Gloss que foram os organizadores desse workshop e solicitei que me fosse fornecido o material didático distribuído durante o curso. Ambos gentilmente me entregaram esses documentos, que são coletâneas de trabalhos técnicos versando sobre o assunto do workshop. Esses trabalhos serão posteriormente enviados aos Coordenadores de Geoquímica. No anexo 6 temos o Sumário dos assuntos tratados durante este evento.

V.4 - 31ST INTERNATIONAL GEOLOGICAL CONGRESS - BRAZIL 2000


V.5 - APRESENTAÇÕES ORAIS

No Anexo 7 temos o Abstract do IV ISEG. Dentro do possível procurou-se assistir às palestras que tratavam de estudos ambientais, que utilizavam dados regionais e estudo de tratamento de áreas degradadas por atividades de mineração. Verificou-se uma grande preocupação dos estudos de pesquisadores dos países
desenvolvidos em preservar o meio ambiente. Um exemplo bem documentado é o da Mina Summitville no estado do Colorado (Figuras 7 e 8). Esta mina funcionou entre 1985 e 1992 produzindo ouro de baixo teor utilizando a técnica moderna de lixiviação de pilha de minério por cianeto para retirar o ouro presente no rejeito da mina. O governo americano calculou que gastará entre 100 e 120 milhões de dólares para limpar a região dos efeitos da atividade de mineração. Neste Simpósio foram apresentados diversos trabalhos de pesquisa visando a remediação na região de Summitville.

Muitos dos profissionais que na década passada só desenvolviam atividades de geoquímica relacionadas com exploração mineral hoje realizam estudos que voltados para a geoquímica ambiental. O anexo 8 mostra a programação do Simpósio na sessão de encerramento.

VI - CONCLUSÕES E RECOMENDAÇÕES

1 - Creio ter sido altamente positiva a minha participação neste evento, em virtude da oportunidade de apresentar o trabalho que está sendo desenvolvido na CPRM utilizando a Geoquímica Ambiental. Somente dois trabalhos provenientes do Brasil foram apresentados neste Simpósio, sendo um da CPRM e outro da Universidade de Pernambuco;

2 - Quase 300 conferencistas de todo o mundo atenderam ao Simpósio de natureza tão específica. Foi possível estar em contato com diversos cientistas que há décadas vem realizando pesquisas na área ambiental (anexo 9).

3 - Isto evidencia que devemos dirigir nossos esforços para esta crescente atividade de Geoquímica Ambiental, sem no entanto esquecer que a geoquímica exploratória é uma atividade necessária para o crescimento do nosso país tão pouco explorado. Esta é a missão de um Serviço Geológico, fomentar a pesquisa geológica para atrair novos investimentos na área mineral e cuidar para que a terra seja preservada para que todos possam desfrutá-la da melhor maneira e deixá-la bem cuidada para nossos filhos e netos.

4 - As pesquisas que estamos iniciando na empresa na área da geoquímica ambiental mostra que estamos no caminho certo. Deveremos utilizar métodos analíticos de maior precisão e de limite de detecção bem baixos para que possamos observar as variações discretas dos elementos, mais precisamente naqueles meios de amostragem onde os elementos químicos podem estar em concentrações a nível de ppb ou mesmo ppt, como é o caso da água.

5 - A participação de profissionais da empresa em eventos internacionais serve também para treinamento, pois os coloca em contato com profissionais que realizam importantes estudos de ponta e utilizam equipamentos de última geração. Nossos geólogos podem divulgar os seus estudos e atraírem empresas interessadas em investir em nosso país.
6 - A experiência brasileira em organizar eventos internacionais de grande porte nos qualifica a pleitear em futuro próximo que seja realizado no Brasil o Simpósio Internacional de Geoquímica Ambiental, que até o presente momento não é um evento de muitos cientistas;


8 - Esses Simpósios são uma grande oportunidade de divulgar o Simpósio Internacional de Geologia - Brazil 2000 assim como o nosso país, atrair oportunidades de negócios e de turismo, melhorando a nossa balança comercial.

9 - A participação de geólogos da CPRM em eventos dessa natureza e em reuniões como as do Mapeamento Geoquímico Internacional consolida a presença do Serviço Geológico do Brasil junto à Comunidade Científica Internacional gerando oportunidades de parcerias com outros Serviços Geológicos;

VII - AGRADECIMENTOS

Agradeço ao Exmo. Ministro das Minas e Energia, Dr. Raimundo Brito, e ao Exmo. Secretário das Minas e Metalurgia, Dr. Giovanny Toniati a permissão para ausentar-me do país.

Da mesma forma agradeço ao Diretor Presidente, Dr. Carlos Oiti Berbert, ao Diretor de Geologia e Recursos Minerais, Dr. Antonio Juarez Milmann Martins, ao Diretor de Administração e Finanças, Dr. Augusto Wagner Padilha Martins, ao Diretor de Relações Institucionais Dr. Gil Pereira de Souza Azevedo, e ao Diretor de Hidrologia e Gestão Territorial, Dr. Idelmar Cunha Barbosa a oportunidade de participar do Simpósio de Geoquímica Ambiental, onde foi possível apresentar o trabalho desenvolvido na empresa, divulgar o 31st International Geological Congress - Brazil 2000, bem como participar da reunião do IGCP IGM -360 (International Geochemical Mapping), que congrega cientistas de vários partes do mundo, manter contatos com geólogos de outros serviços geológicos e assistir palestras de interesse na área ambiental.

Agradeço, também, à ASSUNI na pessoa do Dr. Samir Nahass que preparou todo o processo que permitiu a viagem.

Finalmente, agradeço aos funcionários Sylvio Sergio Ferreira e Gerson José da ASSUNI que providenciaram as passagens, diárias e o passaporte junto à Embaixada Americana.
Figura 1 - Mapa de Localização de Vail - Colorado - USA
Figura 2 - Local de realização do Simpósio - Hotel Cascade
Painel “The Application of Geochemistry Data to Environmental Concerns in the Minas Gerais State, Brazil” de Cunha, F. G., Machado, G. J. e Mello, C.S.B. – CPRM

Painel “Trace-element Contamination in the Environment of Recife Metropolitan Area, Pernambuco, Brazil - Delima, Edmilson S. et alii - UFPE

Figura 3- Poster Presentation – Brasil
Participantes da Reunião do IGM – Mapeamento Geoquímico Internacional
Primeiro plano da esquerda para direita: agachado, Gilberto J. Machado (Brasil)
Em pé: G. Ottonelo, (Ita), D. Smith (USA), Gloria Prieto (Col), T. Tarvanien (Fin),
G. Hall (Can), e J. Plant (UK). No segundo plano temos P. Kovil (India), 3º
A. Darnley (Can), J. Fortescue (antepenúltimo) e P. Koval (URSS)

Detalhe do Início da Reunião

Figura 5 – Reunião do IGCP 360 – Mapeamento Geoquímico Internacional
Figura 6 – Divulgação do IGC – BRAZIL 2000 – Poster e Bottom
Vista Aérea da Mina Summitville, 1991- Colorado
Fotografado pela Intrasearch

Poça vermelha escura rica em metais na Mina Summitville
Fotografado por Geoff Plumlee

Figura 7 - Mina Summitville - Colorado - USA
Figura 8 - Rio Alamosa Próximo à Mina Summitville
- Colorado - USA

USGS BULLETIN 2220
Anexo 1
JOHN A.C. FORTESCUE

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Resident of the U.S.A.

INTERESTS

Independent writer and teacher in environmental geoscience. Major goal: to write books on environmental geochemistry. Prepared to give introductory courses on environmental geology, environmental geochemistry and geochemical mapping. Research interests: landscape geochemistry, global geochemical mapping. Plans to offer lectures and 1, 2, or 3 day workshops in environmental geochemistry in 1998.

UNIVERSITY EDUCATION


1954 M.Sc.(Geology) University of British Columbia, Canada.

1953 B.A. (Hons. Geology) University of British Columbia, Canada.

ADDITIONAL EDUCATION


TEACHING AND ACADEMIC RESEARCH EXPERIENCE

Associate professor: (Geochemistry) Department of Geological Sciences, Brock University, St Catharines, Ontario, Canada (1970-1977)

Visiting research professor: (Environmental Geochemistry) Environmental Trace Substances Research Centre, University of Missouri, Columbia (1977-1978).

Guest lecturer: Environmental Geochemistry,(Half course) Department of Geological Sciences, Laurentian University, Sudbury, Ontario, Canada (Jan.- April, 1994)

Invited lecturer : "Landscape Geochemistry" (2-day course) - Department of Geology, Parana Federal University, Curitiba, Brazil (June, 1994).

Invited lecturer "Geochemical Mapping for Multiple Purposes"(3-day course) - V Congresso Brasileiro de Geoquimica, Fluminense Federal University Niteroi, Brazil (October, 1995).

EXPERIENCE


Anexo 2
The Application of Geochemical Data to Environmental Concerns in the Minas Gerais State, Brazil

CUNHA, F. G. MACHADO, G. J. and MELLO, C. S. B.
Geological Survey of Brazil - CPRM
Geochimica Consulting Av. Pastor 404, Praia Vermelha, Rio de Janeiro, Brazil 22290040

The Geological Survey of Brazil (CPRM) has an extensive geochemical database covering all of the Brazilian territory. The database, in conjunction with the Geochemistry and Environmental Project, assists in land-use planning such as uses of soil and agricultural productivity related to the control of endemic diseases, and environmental management. In 1977 the area for the Sapucaí Project was selected as the Poços de Caldas and Varginha cities, Minas Gerais, (MG) State. The region encompasses an area of about 44,880 km² and has geological and geochemical coverage made by CPRM. This study was based on the results from the chemical analyses of Pb, Zn, Ni, Cr, Cu, Co, and Mo based on an environmental study of 590 stream sediment samples. Using GEOSOFT software, geochemical maps for the selected elements were created. After data analysis, two areas for detailed examination were selected: Poços de Caldas showed high concentrations of Mo and low contents of Cu (possible problems for livestock and human health, such as molybdenosis and hypocuprosis); and Sao Gonçalo de Sapucaí. These areas represent old mining activities and new agricultural activity. The correlation between these geochemical data sets and those available from public health sources are being examined for the Poços de Caldas area. The study examines the utility of these data sources in assisting local governments to solve environmental geochemical problems.

Application of Mine Fire Diagnostics

DALVERNY, L. E., CHAIKEN, R. F., and KIM, A. G.
1Federal Energy Technology Center, P.O. Box 10940, Pittsburgh, PA 15236, USA
2Pittsburgh Research Center, NIOSH, P.O. Box 18070, Pittsburgh, PA 15236, USA

Mine Fire Diagnostics is based on the assumptions: (1) measurable changes in the emission of low molecular weight hydrocarbons from coal are temperature dependent, and (2) analysis of controlled underground air flow between borehole sampling points can determine the source of the hydrocarbons. Gas composition, temperature, and pressure are determined before and during operation of a suction fan attached to one of a network of cased boreholes. Fan suction influences gas movement at the base of neighboring boreholes, and differences in measured pressure indicate the degree of communication between the suction and other boreholes. A fire signature is based on a ratio of C₆-C₈ hydrocarbons to total hydrocarbons. Using a gas chromatograph, the detection level for hydrocarbons is 1 ppm; a sample can be analyzed in less than 2 minutes. Laboratory studies confirm that changes in hydrocarbon emission are detectable at temperatures below 100°C. Integrating fire signatures from multiple tests, with different underground gas flow orientations, produces a two-dimensional map of heated and cold zones.

The methodology has been used at four abandoned coal mine sites, three bituminous and one anthracite. Three non-contiguous combustion zones were delineated at the first site. At the second site, it was determined that heating extended several hundred feet into the mine and along more of the buried outcrop than indicated by surface expression. The third evaluation indicated possible heating near some houses; assessment was complicated by apparent low permeability in the mine. In the anthracite mine, changes in methane concentrations indicated the presence of seven non-contiguous heated zones.

Environmental Applications of the Regional Geochemical Mapping of Soils and Stream Sediments in South Africa

de BRUIN, D., ELSENBROEK, J. H., and LOMBARD, M.
Council for Geoscience, Private Bag X 112, Pretoria, 0001, South Africa

A regional geochemical mapping program has been conducted in South Africa since 1973 by the Council for Geoscience. A total area of 280,000 square kilometers have been covered to date at a sampling density of one sample per km². This represents coverage of 23% of the surface area of South Africa. Samples from first order streams are preferentially collected, but representative soil samples are taken if these are not present within the designated square kilometer. The <75 μm fraction of samples is collected by dry sieving and analyzed for 24 elements (TiO₂, MnO, Fe₂O₃, Si, Cr, Co, Ni, Cu, Zn, As, Rb, Sr, Y, Zr, Nb, Mo, Sn, Sb, Ba, W, Pb, Th, U) by simultaneous XRF on pressed powder pellets. Samples from selected areas have also been analyzed for additional elements (Pt, Pd, Au and major elements) using other analytical techniques. The results are processed by using a Geographical Information System (GIS). The XRF results show an excellent correlation between soil chemistry and underlying geological formations. Geological units are clearly demarcated even on 1:50,000 scale maps (700 samples), and on larger scales the chemistry clearly reflects regional geological patterns. Apart from geological correlations the data set can also be used for exploration purposes, the establishment of environmental baselines within geological units, and agricultural applications. An advantage of the methodology followed by this program is that all sample materials are stored and archived, which allows for samples to be analyzed by other and future advanced analytical techniques for additional elements as the need arises.

Prominent anthropogenic contamination can be readily detected in two separate mining areas. The area surrounding
Anexo 3
IUGS/IAGC WORKING GROUP ON GLOBAL GEOCHEMICAL BASELINES
IGCP PROJECT 360 GLOBAL GEOCHEMICAL BASELINES

Business meetings of the above project will be held in the Centennial Ballroom at the Vail Cascade Hotel and Resort from 9.00 AM to 5.00 PM on Sunday (5 October) and Wednesday (8 October) 1997.

AGENDA

1. Welcome and brief position statement
   (maximum 20 minutes)
   A Darnley/
   J A Plant

2. Present structure
   A Darnley/
   J A Plant

3. Regional progress reports:
   Europe
   FOREGS
   T Tarvainen on behalf of R Salminen; M J
   Battista; A Demetriades; M Duris; F M
   Fordyce; V Gregorauksiene; G Klaver; H Klein;
   J Locutura; K Marsina; L Martins; C Mouvet; L
   Odör, S-A Ohlsson; G Othonello; A Pasiecsna; M
   Pinto; J A Plant; C Reimann; U Sievers; J Van
   der Sluys; O Schermann; A Steenfelt.

   Russia
   P Koval

   Asia
   China
   X Xie

   India
   P K Govil

   S.E. Asia
   J A Plant on behalf of Y K Hong (Korea); C
   Johnson & M Muchsin (Indonesia)

   Australia
   J A Plant on behalf of B Minty

   South America
   G Prícto (Colombia) & A Darnley (on behalf of
   Brazil)

   North America
   R Garrett; Dr G Hall (Canada) & D Smith (USA)

   South Africa
   D De Bruin

4. Review of expanded regional field manuals
   Discussion
   and additional climatic field methods

5. Analytical strategies
   G Hall on behalf of the analytical committee

6. Data processing
   R Garrett & T Tarvainen on behalf of the data
   management committee

7. Funding and PR
   I Thornton on behalf of the PR committee

8. Future Activities
   A Darnley & J A Plant
### ATTENDANCE

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<td>Arthur Darnley</td>
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<td>John Fortescue</td>
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<td>Robert R. Craig</td>
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Dear members of the FOREGS Geochemistry Task Force and the IUGS Working Group on Global Geochemical Baselines.

As agreed in the Working Group meeting in Vail, we send the enclosed manuscript of the FOREGS field manual for your evaluation. Because this is already the 6th version of the manual and some countries have already taken part of the samples according to these instructions, only minor revision is possible. However, some parts were added to this manuscript very quickly and there are certainly some errors, both typing errors and unlogical instructions. Analytical part will not be added to this manual.

Please send your comments to me before 1 November 1997. The guide book will be printed in January 1998, and the full text with figures will be available on the web site of the Geological Survey of Finland (http://www.gsf.fi) on the same time.

Yours faithfully,

[Signature]

Timo Tarvainen
Senior Research Geologist
LIST OF CONTENTS

1. INTRODUCTION .................................................................................................................. 6
   1.1 General ......................................................................................................................... 6
   1.2 Aims ............................................................................................................................. 8
   1.3 Regional laboratories and the coordinator ................................................................. 9
   1.4 Sample media ............................................................................................................ 10

2. SELECTION OF SAMPLE SITES .................................................................................... 13
   2.1 GTN grid cells ............................................................................................................ 13
   2.2 Selecting sample sites ............................................................................................... 14
   2.3 Identifiers .................................................................................................................. 17

3. SAMPLING ...................................................................................................................... 17
   3.1 Stream water sampling .............................................................................................. 17
   3.2 Stream sediment ....................................................................................................... 22
   3.3 Humus and residual soil samples .............................................................................. 28
   3.4 Floodplain sediments .............................................................................................. 34
   3.5 Overbank sediments ............................................................................................... 37

4. FIELD OBSERVATIONS .................................................................................................. 38
   4.1 Photographs .............................................................................................................. 38
   4.2 Gamma ray spectrometry ....................................................................................... 39
   4.3 Sampling site coordinates ....................................................................................... 39

5. SENDING TO LABORATORY AND STORAGE OF SAMPLES ........................................... 39

6. DIFFERENCES BETWEEN FORERGS GEOCHEMICAL SAMPLING AND IGCP 259
   RECOMMENDATIONS ..................................................................................................... 40

7. SAMPLE PREPARATION .................................................................................................. 41

8. REFERENCES .................................................................................................................... 45
Anexo 5
A proposal for an

**International Association for Global Geochemical Baselines**

to be affiliated to the International Union of Geological Sciences

**Objectives:**

- implement the general recommendations of the UNESCO report, as identified by the UN Committee on Natural Resources;
- facilitate the assembly of a standardised global geochemical database pertaining to surface materials;
- facilitate the distribution and use of the data.

**Method:**

- provide continuity, information, training and quality assurance, by means of a small secretariat working in conjunction with regional, national or other organisations, as appropriate, under the general guidance of an international Steering Committee;

**Conditional upon:**

- the provision of sufficient financial support by interested public and commercial organisations.

**Rationale:**

The UN Committee on Natural Resources has passed a resolution stating that there is an urgent need for a global land monitoring program based on the UNESCO report. A strong case can be made for this activity. The organizations which might be expected to provide financial support for such a program are unwilling and/or unable to do so for reasons such as the following:
- no money for new projects;
- must give priority to existing activities;
- currently reducing their activities;
- are concerned with process studies rather than systematic data collection;
- consider it outside their mandate.

Global geochemical baselines cannot be established without funds earmarked for the purpose. A direct approach must be made to those with money who will benefit from the existence of baseline data. A new international association created specifically for the purpose could be more successful at fund raising than an IUGS Working Group, even if the objectives are the same.

October, 1997
Anexo 6
COLLECTION GEOCHEMICAL DATA FOR BOTH EXPLORATION AND ENVIRONMENTAL PURPOSES

1. NATURAL VARIABILITY

Outline

Introduction -
Geochemical Cycle
Basic Principles of Applied Geochemistry
Survey Components - Orientation Surveys
Sampling and Sampling Design
Summary

Introduction
The Geochemical Cycle:
Deep-seated bedrock
Surficial

Bedrock Geochemistry
Start with igneous rocks - crystal chemistry
Geochemical Variability
rock types
mineral deposits types
geochemical associations
Data Compilations
Mineral deposit models

Surficial Geochemical Environment
Sedimentary geochemical differentiation - aqueous chemistry
Range of environments - morphogenetic systems
Weathering and Soil Formation
Principle sampling media - definitions
Sources of variability
Soils - e.g., climate, catena, horizon
Drainage - e.g., Eh/pH, sorption, site setting, seasons

Conceptual/Landscape Geochemistry Models

Geoenvironmental Mineral Deposit Models

Basic Principles of Applied Geochemistry

Introduction
General - ala Goldschmidt
Landscape Geochemistry
Exploration geochemistry
Environmental geochemistry
Geoepidemiology

Key: nature of the problem!

Basic Concepts
Geochemical Cycle
Mobility(Solubility) - chemical and physical
Dispersion
Geochemical Associations
Pathfinder or Indicator Elements

Patterns of Geochemical Dispersion
Geochemical Landscape
Geochemical Relief/Contrast
Background/Baseline
Threshold/Pattern Recognition
Anomaly (Significant/Non-Significant)
Classification
Environment (Deep-seated vs surficial)
Stage (syngenetic vs epigenetic)

Survey Components
Design and Planning
Field Sampling
Sample Preparation
Chemical analysis
Data Management and Presentation
Interpretation and Recommendations

Key: Only as good as the weakest link!

Orientation Surveys
Objectives
establish geochemical dispersion operative, at appropriate scales
establish optimum geochemical techniques for detecting
dispersion, considering both technical and economic factors

Questions to be addressed
Types of Orientation Surveys
traditional, case history, consultation

Result
does geochemistry work
how, why?
routine survey specifications
technically and economically sound solution

**Sampling and Sampling Design**

**Introduction**

**Definitions**
- Populations: conceptual/target/sampled
- Sample: geological/statistical
- Geological Sample - A composite!
  - Physical isolation
  - chemical speciation
  - geochemical fingerprints (association/statistics)
- Sample representativity - of what?, for what purpose?

**Sample Design**

**Objectives of GX Program**
- Anomaly identification detection and definition

**General Statistical Model**
- Data distributions
- Independence of samples/randomizing: Miesch 1976

**Analysis of Variance (ANOVA) Evaluation**
- $V_r = V_r + V_s + V_a$
- Balanced vs Unbalanced Design
- Do we have a problem?

**Sampling: Geological & Statistical**

**Objectives**

**Types of Samples**

**Representativity**
- Homogeneous vs heterogeneous
- Nugget Effect - precision vs # of particles
- Factors - sample weight/grain size/concentration

**Trouble Shooting**

**Design/Monitoring**

**Analytical Precision**

**Geological Representativity - process appreciation**
- (natural & anropogenic)

**Statistical Representativity**
- natural heterogeneity
- (larger samples/compositing)
- sample preparation
- (procedure assessment)

**Geochemical Associations**
- an alternative approach

**Geostatistics**

**Regionalized vs Random variables**

**Area of influence, continuity, anistropy**

**Variogram - regional vs local effects model**
Kriging - weighting factors for samples via geostatistics
contouring and error estimate.

Summary
Assessment
How representative is the sample/your data
Significance to project

Summary
Geochemical Cycle: deep-seated and surficial environmental
Models - Conceptual and Geoenvironmental
Basic Principles - dispersion
Survey components - orientation surveys
Sampling: geological and statistical
Assumption: geological samples are composite

L. Graham Closs
10/2/97
Selected References


Fortescue, J.A.C., 1980, Environmental geochemistry - a holistic approach: Springer Verlag.
Anexo 7
4th International Symposium on Environmental Geochemistry

October 5-10, 1997
Vail, Colorado USA

organized by the
United States Geological Survey
Association of Exploration Geochemists
and
Society for Environmental Geochemistry and Health

in collaboration with the
International Association of Geochemistry and Cosmochemistry
UNITED STATES DEPARTMENT OF THE INTERIOR  
GEOLOGICAL SURVEY  

4th International Symposium on Environmental Geochemistry  

Program with Abstracts  

By  

Richard B. Wanty, Sherman P. Marsh, and Larry P. Gough  

Open File Report 97-496  
1997  

The use of trade names in this report is for descriptive purposes only and does not constitute endorsement by the U.S. Geological Survey.  

This report is preliminary and has not been edited or reviewed for conformity with U.S. Geological Survey standards and nomenclature.
Welcome to the
4th International Symposium on Environmental Geochemistry

Welcome to colorful Colorado. This Rocky Mountain valley is an area once used to train soldiers of the 10th Mountain Division for Alpine combat in Europe during World War II. After the war, one of those soldiers came back with the dream of starting a ski area. In 1962, Vail opened and has grown into the largest, single-mountain ski resort in North America. During your stay we hope you will be able to visit the surrounding regions and enjoy American hospitality, food, and beautiful scenery.

It is an honor to host the 4th International Symposium on Environmental Geochemistry and we are eager for you to have a successful and productive conference. You can rest assured that every member of the Organizing Committee will see to accommodating your needs. Details of the scientific program and social events are given in the following pages. If you need assistance or have any questions, please feel free to go to the Registration Desk or ask any Organizing Committee member.

The support from sponsors, exhibitors, and attendees is gratefully acknowledged. A special thank you is extended to the Association of Exploration Geochemists, the Society for Environmental Geochemistry and Health, and the International Association of Geochemistry and Cosmochemistry for their interest and financial support. The United States Geological Survey also gave significant financial support in allowing members of the Organizing Committee time to devote to the Symposium.

The Organizing Committee

This proceedings volume is published as U.S. Geological Survey Open-File Report OF97-496. Literature citations can appear as follows:

# TABLE OF CONTENTS

- HOTEL SITE MAP .............................................................................................................. iv
- GENERAL INFORMATION .................................................................................................. v
- MEETING FACILITY FLOOR PLAN .................................................................................. viii
- CALENDAR OF EVENTS .................................................................................................... ix
- WORKSHOPS ................................................................................................................... xi
- FIELD TRIPS .................................................................................................................... xii
- ACKNOWLEDGMENTS ...................................................................................................... xiii
- SESSION CHAIRPERSONS .............................................................................................. xiv
- GUEST SPEAKERS ............................................................................................................ xv
- EXHIBITORS ................................................................................................................... xvi
- TECHNICAL PROGRAM MATRIX .................................................................................... xvii
- PROGRAM ....................................................................................................................... xviii
- ABBREVIATIONS USED IN ABSTRACTS ......................................................................... xxvi
- ABSTRACT TITLE INDEX ................................................................................................ 1
- ABSTRACTS ..................................................................................................................... 6
- AUTHOR INDEX ............................................................................................................... 102

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## 4th International Symposium on Environmental Geochemistry

### ORGANIZING COMMITTEE

- Ms. Cathy Ager
- Dr. James Crock
- Mr. David Detra
- Dr. Larry Gough
- Ms. Susan Kropschot
- Ms. Pat Krupa
- Dr. Paul Lamothe
- Mr. Sherman Marsh
- Ms. Colleen Schmitt
- Mr. Richard Sanzolone
- Dr. Ronald Severson
- Dr. David Smith

### SCIENTIFIC COMMITTEE

- Dr. Willard Chappell
- Dr. Brian Davies
- Dr. Ron Fuge
- Dr. Robert Garrett
- Dr. Gwenneth Hall
- Dr. Betsy Kagey
- Dr. Donald Runnels
- Dr. Olle Slemnis
- Dr. Ian Thornton
- Dr. Richard Wanty

---

Graphical Design by
Ms. Barbara J. Ramsey
4th International Symposium on Environmental Geochemistry
Conference

October 5 - October 10, 1997

Vail Cascade Hotel & Club
Vail, Colorado

GENERAL INFORMATION

ACCOUNTS—All incidental expenses for items not covered by your registration fee are your responsibility and must be settled directly between you and the Hotel. These expenses include items such as: meals, telephone calls, room service, bar bills, additional accommodations, golf green fees, etc.

ACUTE MOUNTAIN SICKNESS—Please take the time to read the Colorado Altitude Research Institute information included in your registration bag. Vail Valley starts at 8,000-foot (2500-m) elevation, with surrounding terrain rising higher. Depending upon the altitude, 20 to 30% of all visitors from sea level have one or more symptoms of acute mountain sickness. The Organizing Committee would like your stay to be safe and enjoyable.

✓ Increase Fluid Intake
✓ Decrease Salt Intake
✓ Moderate Your Physical Activity
✓ Eat Low Fat Meals
✓ Reduce Alcohol and Caffeine Consumption
✓ Feeling Lousy? Seek Help through Hotel
✓ Have Fun!

CASCADE ATHLETIC CLUB—For a nominal daily usage fee of $12.00 ($20/4 days, $30/week), delegates have privileges to the sports, fitness, and health facility. Located adjacent to the Hotel, the Club provides a variety of spa and recreation facilities including indoor/outdoor tennis, racquetball, squash, basketball, aerobics, Nautilus equipment, steam rooms, and more. Passes can be purchased at the front desk.

HOTEL CHECK-IN AND CHECK-OUT TIME—Hotel check-in time is 4:00 p.m. on day of arrival and check-out time is 12:00 p.m. on day of departure or Friday, October 10. Luggage may be stored at the front desk. Delegates staying in their rooms beyond check-out time will be charged for an additional room night.

MESSAGE CENTER—A message center will be maintained in the Centennial Foyer for the convenience of conference attendees. Incoming messages for attendees will be posted on individual room phones or the message center board, near the Registration Desk. To call the center, dial 970-476-7111 and ask for the 4th ISEG Message Center.

NO SMOKING—For the comfort of all, please refrain from smoking in the meeting rooms, eating areas, and foyer.

BUSINESS CENTER—Fax, photocopying, or transparencies. Check at Hotel Registration Desk.

EXHIBITS—The 4th International Symposium on Environmental Geochemistry will feature an exhibition of scientific equipment, accessories, and supplies. Exhibits will be located in the Centennial Foyer. Exhibits will be open Monday, Tuesday, Thursday, and Friday during conference hours with coffee and soft drinks served each day during breaks.

EXHIBIT HOURS:  
Monday, October 5  9 a.m. to 8 p.m.
Tuesday, October 7  9 a.m. - 5 p.m.
Thursday, October 9  9 a.m. - 6:30 p.m.
Friday, October 10  9 a.m. - 12 noon

ORAL PRESENTATIONS—The Conference Center Centennial Ballroom will be the site for all lectures.

Because of the parallel sessions, Session Chairs have been asked to keep strictly to the schedule time table, which allows 20 minutes for presentations. Authors are requested to make themselves known to the Session Chairs before the session begins.

Speakers will be able to preview their slides in the Goldenrod Suite. Viewers will be available.
POSTER PRESENTATIONS—Posters will be on display in the Rocky Mountain Ballroom Sunday evenings through morning. Authors will be asked to attend their posters during the Monday mixer and Thursday social hour. Session 1, 3, and 10 authors may put up their posters between 3:00 and 5:30 p.m. on Sunday and should take them down before noon Wednesday to ensure that the boards are available. Session 2, 4, 6, and 9 authors may put up their posters Wednesday all day and should take them down by 1:00 p.m. on Friday.

REGISTRATION—Registration Badges are required for admission to all technical sessions, exhibits, and functions. Appropriate badge is required for admittance and will be checked at the entrances of all activities. Everyone attending the Conference, including speakers and exhibitors, is required to register. Advance registration pickup and on-site registration be conducted during the following hours:

- **Sunday, October 5** 1 p.m. to 6 p.m. Lobby Terrace
- **Monday, October 6** 7 a.m. to 5 p.m. Centennial Foyer
- **Tuesday, October 7** 8 a.m. to 5 p.m. Centennial Foyer

*Later registration will be available.*

REGISTRATION FEE—The registration fee is $325. This includes the published program with abstracts, refreshment breaks, opening reception on Sunday, October 5, and banquet on Thursday, October 9, and all other social functions. On passes will be available for attendance at the presentation sessions and refreshments breaks for $150 per day. Students register for $100 with a valid student card (excludes banquet); spouses for $100 (social functions including banquet).

SESSION CHAIRS—Please meet briefly with the Organizing Committee on Monday, October 6 at 12 noon in Cent A B C D.

SHUTTLE BUS—The Hotel operates a complimentary shuttle from 7 a.m. - 12 midnight to Vail Village and Lionshead general guest use. Shuttles operate on 20-minute intervals, depending on distance and weather conditions. Van transport from the Hotel to Denver International Airport is available from Colorado Mountain Express at Tel: 1-800-525-6363. When making your reservation, mention the special group code “4th ISEG” and receive a discount.

SOCIAL FUNCTIONS

**Opening Reception**—Sunday, October 6, from 6:00-8:00 p.m. in the Cascade Ballroom.

**Mixer (in conjunction with Posters)**—Monday, October 7, from 5:30-7:00 p.m. in the Centennial Foyer.

**Social Hour (in conjunction with Posters)**—Thursday, October 9, from 5:30-6:30 p.m. in the Centennial Foyer.

**Banquet**—Thursday, October 9, from 6:30-8:30 p.m. in the Cascade Ballroom.

Please notify the Organizing Committee by Monday evening if you have any special food requirements for the banquet.

A presentation for guests on Vail Valley activities will be given by the Hotel concierge in the Lobby Terrace from 9:00 a.m., Monday, October 6. Recreation information will be available at the Conference Registration Desk Monday during lunch break and during the mixer.
**FOOD SERVICE**—Breakfast will be available between 6:30 and 8:00 a.m. in the Cascade Ballroom every morning. Lunch will be served from 12:00 noon to 1:40 p.m. in the Cascade Ballroom. Refreshments will be served during the morning and afternoon breaks in the Centennial Foyer, where the exhibits will be displayed.

**MENU**—(All prices include tax and gratuity)

**Breakfast options October 6-10**

A la Carte Quick breakfast
- Coffee ................................................................. $2.00
- Juice ................................................................. $2.00
- Bagel ............................................................... $3.00
- Muffin, Danish, Doughnut ................................. $2.00

Full Continental breakfast ........................................ $11.00
Coffee, juice, fresh fruit, cold cereals, breakfast breads, Danish, muffins, toast, hard breads, and international and domestic cheeses.

Full Buffet Breakfast ............................................ $13.00
includes all of the above plus fluffy scrambled eggs, Colorado hash browns, sugar cured bacon or country sausage, and a daily griddle item.

**Lunch option Monday, October 6**

Italian Pasta Buffet ........................................... $13.00
Two pastas, tomato basil and alfredo sauce, Caesar salad, garlic bread, Chef’s choice of Italian dessert, and iced tea.

**Lunch option Tuesday, October 7**

Executive Deli Buffet ........................................... $13.00
Assorted cold cuts, soup du jour, assorted cold salads, appropriate condiments, tossed salad with two dressings, breads, brownies, and iced tea.

**Lunch option Thursday, October 9**

Mountain Grill Buffet
- Grilled hamburgers and hot dogs, corn on the cob, cowboy beans, tossed salad, fresh lettuce and tomato, appropriate condiments, fruit cobbler, and iced tea.

**Lunch option Friday, October 10**

Mexican Madness Buffet ..................................... $13.00
“Build-your-own-taco-station” with flour and corn tortillas, ground beef, shredded cheese, diced fresh tomatoes, onions, peppers, sour cream, guacamole, etc., tossed salad, sugared churros, and iced tea.
MEETING AND BANQUET FACILITIES

CONFERENCE CENTER

ROCKY MOUNTAIN BALLROOM
First Level

CENTENNIAL BALLROOM
Second Level

MAIN HOTEL

CASCADE BALLROOM
First Level

THEATERS
Second Level

MEETING SUITE

Rocky Mountain Foyer

Centennial Foyer

Access to Conference Center from Main Hotel Second Level

Cascade Foyer

Executive Screening Room

Columbine Suite

Goldenrod Suite
CALENDAR OF EVENTS

SUNDAY, OCTOBER 5, 1997

9:00 a.m. - 5:00 p.m. ............................................. Global Baselines Meeting .......................... Centennial B
9:00 a.m. - 5:00 p.m. ................................................ SEGH Meeting ................................. Centennial C
9:00 a.m. - 5:00 p.m. ................................................ Acid Forming Materials Workshop .............. Centennial E
1:00 p.m. - 6:00 p.m. ................................................ Registration ........................................... Lobby Terrace
1:00 p.m. - 5:00 p.m. ................................................ Geochemical Data Workshop ................. Centennial F
3:00 p.m. - 5:30 p.m. ................................................ Poster (Sessions 1, 3, 5, 7, 8, 10) and Exhibit Setup ... Rocky Mountain Ballroom
6:00 p.m. - 8:00 p.m. ................................................ Opening Reception .................................. Cascade Ballroom

MONDAY, OCTOBER 6, 1997

6:30 a.m. - 8:00 a.m. ............................................... Breakfast on your own .............................. Cascade Ballroom
7:00 a.m. - 5:00 p.m. ................................................ Conference Registration ......................... Centennial Foyer
7:00 a.m. - 5:00 p.m. ................................................ Speaker Ready Room .............................. Goldenrod
8:00 a.m. - 8:00 p.m. ................................................ Poster Session (1, 3, 5, 7, 8, 10) ............... Rocky Mountain Ballroom
8:20 a.m. - 10:00 a.m. ............................................. General Session .................................. Centennial ABCD
9:00 a.m. - 10:00 a.m. ............................................. Vail Valley activity presentation ............... Lobby Terrace
9:00 a.m. - 8:00 p.m. ................................................ Exhibits .............................................. Centennial Foyer
10:00 a.m. - 10:20 a.m. ............................................. Refreshment Break ............................... Centennial Foyer
10:20 a.m. - 12:00 noon ........................................... Session 1-1 to 1-4 ................................ Centennial ABCD
10:20 a.m. - 12:00 noon ........................................... Session 2-1 to 2-4 ................................ Centennial EF
12:00 noon - 1:40 p.m. ............................................. Lunch on your own ................................ Cascade Ballroom
12:00 noon - 1:40 p.m. ............................................. Tourist Information—Reg. Desk ................. Registration Desk
12:00 noon ........................................................... Chairperson meeting .......................... Centennial ABCD
1:40 p.m. - 3:20 p.m. ................................................ Session 1-5 to 1-9 ................................ Centennial ABCD
1:40 p.m. - 3:20 p.m. ................................................ Session 2-5 to 2-9 ................................ Centennial EF
3:20 p.m. - 3:40 p.m. ................................................ Refreshment Break ............................... Centennial Foyer
3:40 p.m. - 5:10 p.m. ................................................ Session 1-10 to 1-13 ........................... Centennial ABCD
3:40 p.m. - 5:10 p.m. ................................................ Session 2-10 to 2-13 ........................... Centennial EF
5:30 p.m. - 7:00 p.m. ................................................ Mixer .................................................. Centennial Foyer
5:00 p.m. - 6:30 p.m. ................................................ Tourist Information .............................. Main Centennial Foyer

TUESDAY, OCTOBER 7, 1997

6:30 a.m. - 8:00 a.m. ............................................... Breakfast on your own .............................. Cascade Ballroom
7:00 a.m. - 5:00 p.m. ................................................ Speaker Ready Room .............................. Goldenrod
8:00 a.m. - 5:00 p.m. ................................................ Registration ........................................... Centennial Foyer
8:00 a.m. - 10:00 a.m. ............................................. Session 3-1 to 3-6 ............................... Centennial ABC
8:00 a.m. - 10:00 a.m. ............................................. Session 4-1 to 4-6 ............................... Centennial D
8:00 a.m. - 5:30 p.m. ................................................ Poster Session (1, 3, 5, 7, 8, 10) ............... Rocky Mountain Ballroom
9:00 a.m. - 5:00 p.m. ................................................ Exhibits .............................................. Centennial Foyer
10:00 a.m. - 10:20 a.m. ............................................. Refreshment Break ............................... Centennial Foyer
10:20 a.m. - 12:00 noon ........................................... Session 3-7 to 3-10 ........................... Centennial ABC
10:20 a.m. - 12:00 noon ........................................... Session 4-7 to 4-10 ........................... Centennial D
12:00 noon - 1:40 p.m. ............................................. Lunch on your own ................................ Cascade Ballroom
1:40 p.m. - 3:20 p.m. ................................................ Session 3-11 to 3-15 ........................... Centennial ABC
1:40 p.m. - 3:20 p.m. ................................................ Session 4-11 to 4-15 ........................... Centennial D
3:20 p.m. - 3:40 p.m. ................................................ Refreshment Break ............................... Centennial Foyer
3:40 p.m. - 5:10 p.m. ................................................ Session 3-16 to 3-19 ........................... Centennial ABC
3:40 p.m. - 5:10 p.m. ................................................ Session 4-16 to 4-19 ........................... Centennial D
< 30 p.m. - 7:00 p.m. ................................................ SEGH Business Meeting ......................... Centennial E
WEDNESDAY, OCTOBER 8, 1997

6:30 a.m. - 8:00 a.m. ......................................................... Breakfast on your own ........................................ Cascade Ballroom

Field Trips
8:00 a.m. - 12:00 noon ............................................. Poster Take Down (Sessions 1, 3, 5, 7, 8, 10) ................... Rocky Mountain Ballroom
9:00 a.m. - 5:00 p.m. ....................................................... Global Baseline Meeting .................................. Centennial E
12:00 noon - 5:00 p.m. .................................................... Poster Setup (Sessions 2, 4, 6, 9) .......................... Rocky Mountain Ballroom
1:00 p.m. - 5:00 p.m. ....................................................... International Geoscience and Technology Symposium .......................... Centennial F

Health Working Group

THURSDAY, OCTOBER 9, 1997

6:30 a.m. - 8:00 a.m. ......................................................... Breakfast on your own ........................................ Cascade Ballroom
7:00 a.m. - 2:00 p.m. ....................................................... Speaker Ready Room ........................................ Goldenrod
8:00 a.m. - 5:30 p.m. ....................................................... Poster Session (2, 4, 6, 9) .............................. Rocky Mountain Ballroom
8:00 a.m. - 10:00 a.m. ...................................................... Session 5-1 to 5-6 ........................................... Centennial ABC
8:00 a.m. - 10:00 a.m. ...................................................... Session 4-20 to 4-25 ........................................ Centennial D
9:00 a.m. - 6:30 p.m. ....................................................... Exhibits .................................................... Centennial Foyer
10:00 a.m. - 10:20 a.m. ..................................................... Refreshment Break ........................................ Centennial Foyer
10:20 a.m. - 12:00 noon ..................................................... Session 6-1 to 6-4 ........................................ Centennial ABC
10:20 a.m. - 12:00 noon ..................................................... Session 8-1 to 8-4 ........................................ Centennial D
12:00 noon - 1:40 p.m. ...................................................... Lunch on your own ........................................ Cascade Ballroom
1:40 p.m. - 3:20 p.m. ......................................................... Session 6-5 to 6-9 ........................................ Centennial ABC
1:40 p.m. - 3:20 p.m. ......................................................... Session 8-5 to 8-9 ........................................ Centennial D
3:20 p.m. - 3:40 p.m. ......................................................... Refreshment Break ........................................ Centennial Foyer
3:40 p.m. - 5:10 p.m. ......................................................... Session 6-10 to 6-13 ....................................... Centennial ABC
3:40 p.m. - 5:10 p.m. ......................................................... Session 8-10 to 8-13 ....................................... Centennial D
5:30 p.m. - 6:30 p.m. ......................................................... AEG Business Meeting ................................... Rocky Mountain Ballroom
5:30 p.m. - 6:30 p.m. ......................................................... Social Hour .................................................. Rocky Mountain Foyer
6:30 p.m. - 8:30 p.m. ......................................................... Banquet ..................................................... Centennial Ballroom

FRIDAY, OCTOBER 10, 1997

6:30 a.m. - 8:00 a.m. ......................................................... Breakfast on your own ........................................ Cascade Ballroom
7:00 a.m. - 2:00 p.m. ....................................................... Speaker Ready Room ........................................ Goldenrod
8:00 a.m. - 10:00 a.m. ..................................................... AEG Council Meeting ...................................... Lobby Terrace
8:00 a.m. - 10:00 a.m. ..................................................... Session 5-7 to 5-12 ......................................... Centennial ABC
8:00 a.m. - 10:00 a.m. ..................................................... Session 7-1 to 7-6 ......................................... Centennial D
8:00 a.m. - 5:30 p.m. ....................................................... Poster Session & Take Down (2, 4, 6, 9) .............. Rocky Mountain Ballroom
9:00 a.m. - 12:00 noon ..................................................... Exhibits .................................................... Centennial Foyer
10:00 a.m. - 10:20 a.m. ..................................................... Refreshment Break ........................................ Main Centennial Foyer
10:20 a.m. - 12:00 noon ..................................................... Session 9-1 to 9-5 ........................................ Centennial ABC
10:20 a.m. - 12:00 noon ..................................................... Session 10-1 to 10-4 ....................................... Centennial D
12:00 noon - 12:30 p.m. ................................................... Closing General Session .................................. Centennial ABCD
12:30 p.m. ............................................................... Lunch on your own ........................................ Cascade Ballroom
WORKSHOPS—SUNDAY, OCTOBER 5

Acid-Forming Materials and Land Reclamation
9:00 a.m. - 5:00 p.m.

Centennial E
Fee: $75

Scott Fisher
River Bend Assoc.

The workshop will provide the participant with an overview of the importance and types of pre-disturbance planning procedures. It will discuss methods of mitigation of acid forming materials (AFM) resulting from mining and related forms of drastic land disturbance. Emphasis during the program will be placed on the identification of AFM and its proper handling during the mining operation. Integration of mining procedures with reclamation plans will be stressed. The limited potential for ecosystem reclamation where AFM contamination has taken place is an important thesis that will be stressed throughout the program.

Elements of the course will include a broad introduction, a discussion of pyrite and related mineral formation, processes associated with the weathering of pyrite, impact of acid plant growth media on land reclamation, and acid mine drainage. In addition, topics to be discussed include the sampling and analytical characterization of earthen materials potentially containing AFM, mitigation of terrestrial and aquatic impacts from AFM oxidation, and a review of several case studies involving AFM in the western United States.

Workshop leaders and their topical areas of expertise include: Dr. Terry Brown, Western Research Institute, Laramie, WY (analytical, mitigation, agronomy, and case studies); Margaret Condron, formerly with the Office of Surface Mining, Denver, CO (analytical, planning, agronomy); Scott Fisher, River Bend Associates and Arid Lands Reclamation Newsletter, Medicine Bow, WY (planning, analytical, mitigation).

Collecting geochemical data for both exploration and environmental purposes
1:00 p.m. - 5:00 p.m.

Richard K. Glanzman
CH2M Hill.
L. Graham Gloss.
Colorado School of Mines
and
Jeff Jaacks
BHP Minerals

Centennial E
Fee: $50

Data collected and analyzed for exploration purposes can be even more cost-effective and useful when it is used for environmental purposes. The seminar provides exploration and environmental professionals with the information to acquire more useful data for both purposes and to fulfill regulatory agency requirements. A few relatively minor changes can make exploration data not only more accurate and precise, it can also make the same data useful for environmental purposes. This approach can be used during reconnaissance but is intended for use on properties under serious exploration scrutiny.

Topics addressed in this four hour seminar include: definition of sampling objectives, orientation/background surveys, methods of efficiently collecting appropriate data of various media, sampling representativeness, background/baseline issues, analytical considerations/requirements, commercial standards versus site-specific standards (preparation/usefulness), statistical analysis, and risk/liability considerations. Exploration case histories illustrate the usefulness and advantages of this approach.

Decisions made based on the exploration data can be significantly improved. However, of considerably greater importance, the data can significantly reduce the cost and improve the effectiveness of environmental considerations. These considerations involve not only future environmental evaluation(s) but also provide data to support more effective design/evaluation of mine waste disposal to control and minimize environmental concerns.
FIELD TRIPS

David B. Smith, Coordinator

All trips start and end at the Vail Cascade Hotel & Club. Departure times will be announced and posted. If you have pre-registered for a trip, on-site registration may be possible; check at the Registration Area. Vail Cascade Hotel & Club participants will be accepted on a first-come, first-served basis.

Clear Creek Watershed—Wednesday, October 8

Clear Creek extends from the Continental Divide near the Loveland Ski Area to the confluence with the South Platte in metro Denver. Waters in Clear Creek are impacted by abandoned mines and dumps within the Colorado Mineral Belt industrial and municipal wastewater, stormwater and sewer overflows, and accidental leaks and spills of toxic substances dealing with these pollution issues. Clear Creek has a nationally recognized, award-winning watershed initiative underway; this field trip will capture both the substance of the initiative as well as the spirit of the effort. Major sources of pollution in the mine drainages and tailings piles will be visited as well as major cleanup sites using both active and passive treatments. The fee is $70, which includes a box lunch.

Leadville, Colorado—Wednesday, October 8

The historic mining town of Leadville sits near one of the world’s largest polymetallic replacement deposits. Since discovery of gold in 1858, more than $5.4 billion (1989 prices) of gold, silver, lead, and zinc have been extracted from the Leadville mining district. This large-scale mining also extracted its toll on the environment. In 1983, the town was an 18-square-mile (46.6-square-kilometer) Superfund site by the U.S. Environmental Protection Agency as a result of toxic impacts to water quality and human health due to heavy metal contamination. This field trip will explore the mining and current remedial activities in and around Leadville. The fee is $55, which includes a box lunch.

Eagle Mine—Wednesday, October 8

The Eagle Mine is an inactive mining and milling facility located on the Eagle River between the towns of Redcliff and Minturn. Silver-lead and gold-silver ore attracted miners to the area in the late 1870’s. Lead-zinc sulfide ore was mined in the 1890’s with mining of zinc ore continuing until the early 1980’s. The environmental impact of more than 100 years of mining and milling operations on the Eagle River and adjacent areas was very evident and caused the U.S. Environmental Protection Agency to place the site on its Superfund list in 1986. Since that time a remedial action plan has proceeded for the mining of mine workings, consolidation of eight tailings piles into one, placement of a multi-layer clean soil cap over the remaining consolidated piles, and construction of a water treatment plant. This field trip will provide an overview of the contaminated mine site, its environmental and public health impacts, and the ongoing remedial actions. The fee is $35. Anticlockwise duration is about 3 hours—no lunch will be provided.

Climax Molybdenum Mine—Wednesday, October 8

The Climax Mine is the world’s largest molybdenum mine and rests atop the Continental Divide at an altitude of 1 mile (3,440 m). At the headwaters of three drainages, the Eagle and Arkansas Rivers and Tenmile Creek, Climax was staked late 1800’s for gold before uses of molybdenum had been developed. Gold was never recovered at the Climax Mine, but production of molybdenum began in 1918. The mine is currently not in production, but a small staff is conducting care maintenance with reclamation and water management being major activities. Capping of tailing impoundments, water management, and revegetation activities take place in the short construction season afforded by this extreme climate. Climax has an average of 260 in. (660 cm) of snow annually and manages water discharges in excess of 200 million gallons (757,000 meters) per day. This field trip will provide the opportunity to learn about the history, geologic setting, and current environmental activities at the mine. The fee is $55, which includes a box lunch.

Upper Animas Watershed—Friday through Sunday, October 10-12

The Upper Animas Watershed, in the heart of the rugged San Juan Mountains of southwest Colorado, has been set apart from the other drainages in the Animas River Watershed. The upper basin was heavily mined for gold, silver, and base metal. Throughout the past 120 years and thousands of inactive mine sites remain. The Animas River Stakeholders Group has developed an inventory process (involving local, state, and federal agencies, mining companies, land owners, and citizens) for characterizing sources of metals-related contamination throughout the Animas River Watershed, the inactive mine sites are being characterized, evaluated, remediating potential, and prioritized for cleanup. The field trip will focus on the Animas River, the last remaining major drainage in the San Juan Mountains. It will be visited in the Animas River priority area, the last remaining major river in the San Juan Mountains. A number of sites that are undergoing remediation will be viewed, with a fee of $310, which includes 3 lunches and 2 nights lodging—double occupancy.
ACKNOWLEDGMENTS

Sponsorship

The Organizing Committee would like to express their gratitude to the following companies, organizations, and professional societies for their generous support of the 4th International Symposium on Environmental Geochemistry.

The United States Geological Survey (USGS) is the leading earth-science organization in the United States. Its mission, since its creation in 1879, has been to investigate, analyze, and disseminate earth-science information needed to solve geological and environmental problems, and to identify and assess resources. The USGS has a long tradition of providing accurate and impartial information to all customers. The USGS conducts investigations and research in geology, geophysics, hydrology, mapping, remote sensing, environmental hazards, environmental issues, and related disciplines. The USGS also conducts mineral and energy resource assessment studies.

The Association of Exploration Geochemists (AEG) was founded in 1970 to provide an international forum for persons working in the field of applied geochemistry. It is a professional, non-profit organization promoting interest in the application of geochemistry to mineral and petroleum exploration, resource evaluation, environmental issues, and related fields around the world. The AEG encourages membership and/or contributions from individuals or organizations working with or providing geochemical data for a variety of uses including mineral exploration, analytical technology, computer processing, environmental issues, agriculture, geobotany, biochemistry, and other applications. The AEG disseminates timely information on geochemistry through its journal, the Journal of Geochemical Exploration and through its quarterly newsletter, EXPLORE.

The Society for Environmental Geochemistry and Health (SEGH) was founded in 1972 to provide a forum for scientists from various disciplines (geology, biology, epidemiology, medicine, risk assessment, ecology, etc.) to study the relationship between the geochemical environment and health and disease in plants, humans and animals. SEGH recognizes the importance of this approach in opening the lines of communication between academia, industry and regulatory agencies. SEGH, through annual conferences, our journal Environmental Geochemistry and Health, and Task Forces, provides our membership the opportunity to address environmental geochemistry and health issues from their representative disciplines and, at times, conflicting points of view.

The International Association of Geochemistry and Cosmochemistry (IAGC) is affiliated with the International Union of Geological Sciences and has been one of the preeminent international geochemical and cosmochemical organizations for over twenty-five years. The principal objective is to foster cooperation in, and advancement of, geochemistry and cosmochemistry in the broadest sense. This is achieved (1) by working with any interested group in planning symposia and other types of meetings related to geochemistry and cosmochemistry; (2) by sponsoring publications in geochemistry and cosmochemistry of a type not normally covered by existing organizations; and (3) through the activities of working groups which study problems that require, or would benefit from, international cooperation.

The scientific thrust of IAGC takes place through its Working Groups (many of which organize regular symposia) and the official journal APPLIED GEOCHEMISTRY. The interests of the Working Groups cover a wide spectrum of geochemical and cosmochemical activities, including (1) geochemical prospecting; (2) water-rock interaction; (3) interaction between water and living matter; (4) extraterrestrial geochemistry; (5) geochemistry of the earth surface; (6) geochemistry of isotopes; (7) thermodynamics of natural processes; (8) cooperation in applied geochemistry; special training for the developing countries; (9) geochemistry of health and disease. Although partial financial support for the Working Groups comes from IAGC, most are self-sustaining. Participants in the Working Groups may include geochemists who are not Individual Members of IAGC.
Session Chairpersons

The 4th ISEG Organizing Committee thanks the session chairs named below for their contribution:

Session 1: Mine Drainage Formation and Geochemistry —
Kathleen Smith, Jenny Webster, Donald Runnells, and Willard Chappell

Session 2: Geochemistry of Fresh Water & Marine Environments —
Frank Manheim, Edeltraud Helios-Rybicka, Joy Rae, and Martin Fey

Session 3: SEGH-Sponsored Session—Environmental Geochemistry and Health
Betsy Kagey, Iain Thornton, Brian Davies, and Ron Fuge

Session 4: Methods of Environmental Geochemical Monitoring, Modeling, and Mapping and
Use and Determination of Geochemical Baselines
Olle Selinus, Alina Kabata-Pendias, Jürg Matschullat, and Dave Smith

Session 5: Trace Substances, Ecosystems, and Bioavailability—Aquatic/Atmosphere
Laurie Balistrieri, David Levy, John Gray, and Gianni Cortecchi

Session 6: AGE-Sponsored Session—Environmental Geochemistry of Ore Deposits
Sherman Marsh, Eion Cameron, Robert Garrett, and Maurice Chaflee

Session 7: Environmental Analytical Techniques & Applications
Gwenyth Hall and James Crock

Session 8: Trace Substances, Ecosystems, and Bioavailability—Terrestrial
William Orem, Irina Stangeeva, Harald Püchelt, and Rama Kotra

Session 9: Remediation of Mining-Related Disturbances
Harry Posey and Suresh Kumar

Session 10: Natural and Man-Made Radiogenic Hazards
Rich Wanty and John Glendinning
GUEST SPEAKERS

P. Patrick Leahy, Chief Geologist
U.S. Geological Survey
Reston, Virginia

Dr. P. Patrick Leahy was named Chief Geologist of the Geologic Division of the U.S. Geological Survey in 1995. He has been with the U.S. Geological Survey since 1974, having served in various technical and managerial positions, including Chief of the National Water-Quality Assessment Program.

Dr. Leahy was born in Troy, New York, in 1947. He holds undergraduate and graduate degrees in geology (1968) and geophysics (1970) from Boston College. He received his doctorate in geology (1979) from Rensselaer Polytechnic Institute where he specialized in regional ground water studies and hydraulics.

Dr. Leahy is a Fellow in the Geological Society of America and is a member of the American Geophysical Union and the American Institute of Hydrology. He has received many awards and is active in numerous professional organizations. Currently he is President of the International Association of Hydrogeologists.

Linda C. Gunderson
U.S. Geological Survey
Mineral Resources Program
Reston, Virginia

For the last 18 years, Linda Gunderson has worked as a geologist with the US Geological Survey. She is Coordinator of the Mineral Resources Program which is a $58 million domestic program with a staff of 440 people and a $12 million international mission in Saudi Arabia. She started with the USGS as a field assistant working on diverse projects in sedimentology, stratigraphy, and economic geology. She spent 12 years conducting research and heading projects in the field of radionuclides—from determining the origin of hard rock uranium deposits to studying radon, uranium, and radium in soil, rocks, and water, and eventually assessing the geologic radon potential of the United States. In 1995, she took a temporary assignment as Coordinator of the Energy Program and in 1996 became the Coordinator of the Minerals Program—overseeing a major reorganization. Currently she also serves on a National Academy of Sciences Committee on Risk Assessment of Exposure to Radon in Drinking Water and on the Steering Committee of the IUGS-UNESCO Deposit Modeling Program. Her academic background includes undergraduate and graduate work in structural geology and geochemistry at the State University of New York at Stony Brook and at the University of Colorado in Boulder.

Alina Kabata-Pendias
Trace Element Laboratory
Pulawy, Poland

Professor Kabata-Pendias is Professor of Soil Chemistry and head of the Trace Element Laboratory of the Institute of Soil Science and Plant Cultivation in Pulawy, Poland, where she has worked for over 30 years. She is an author of more than a hundred publications on the occurrence of trace elements in natural and contaminated environments including the much-acclaimed book "Trace Elements in Soils and Plants" (CRC Press). Professor Kabata-Pendias also works in the Geological Institute in Warsaw on the mobility of trace elements and on the alteration of minerals in weathered zones of various geological formations. She has been involved in analytical and methodological studies on trace elements and clay minerals. Dr. Kabata-Pendias continues to be very active in numerous scientific societies as both councilor and committee member.

Thomas J. Noel
Banquet Speaker
University of Colorado at Denver
Denver, CO

Dr. Noel is a professor of history at the University of Colorado, Denver who specializes in Colorado history. He has authored over 50 publications including articles, books, reviews, and television scripts. He has won numerous awards for both his writing and his teaching. He is a recognized expert on the mining camps and "Old West" flavor of Colorado. He is active in many professional associations many of which are dedicated to the preservation of the architecture and culture of historical Colorado.
EXHIBITORS

Paul Lamothe, Coordinator

The 4th International Symposium on Environmental Geochemistry thanks vendors for providing an opportunity to discuss their products and services. The following exhibitors will be in attendance:

5th ISEG
University of Cape Town
Department of Geological Sciences
Rondebosch, South Africa 7700

ACZ Laboratories, Inc.
30400 Downhill Drive
Steamboat Springs, CO 80487
(800) 334-5493

Canadian Certified Reference Materials Project
555 Booth Street
Ottawa, Ontario, Canada
K1A 0G1
(613) 992-1055

Crystals Unlimited
P.O. Box 5054
Golden, CO 80401
(303) 278-1218

Quanterra Environmental Services, Inc.
4955 Yarrow Street
Arvada, CO 80002
(303) 421-6611

Shepherd Miller, Inc.
3801 Automation Way
Fort Collins, CO 80525
(970) 223-9600

U.S. Geological Survey
Mineral Resources Program
12201 Sunrise Valley Dr., MS-913
Reston, VA 20192
(703) 648-6620

AEG
P.O. Box 26099
72 Robertson Road
Nepean, ON K2H 9R0
Canada
4th International Symposium on Environmental Geochemistry

Program Matrix

Senior authors consult table of titles for presentation time

(please note that some changes have been made since the publication of the preliminary program matrix)

<table>
<thead>
<tr>
<th>Time:</th>
<th>Sun. Mon. 10/6</th>
<th>Tues. 10/7</th>
<th>Wed. Thurs. 10/9</th>
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Poster sessions: 1, 3, 5, 7, 8, 10, 2, 4, 6, 9
# 4th International Symposium On Environmental Geochemistry — PROGRAM

| SENIOR AUTHOR | TITLE | COUNTRY | P/O | Oral: Session-Date Sequence* | P/S
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<td><strong>SPECIAL SESSION—Guest Speakers</strong></td>
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<tr>
<td>Leahy P.</td>
<td>Patrick (USGS Chief Geologist, Reston, VA—INVITED) The role of environmental geochemistry in the U.S. Geological Survey</td>
<td>USA</td>
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<tr>
<td>Kabata-Pendias Alina</td>
<td>(Trace Element Laboratory, Pulawy, Poland—INVITED) Soil parameters as a basis for the assessment of trace metal pollution</td>
<td>POLAND</td>
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<td><strong>Session 1. Mine Drainage Formation and Geochemistry</strong></td>
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<tr>
<td>Smith Kathleen</td>
<td>S.</td>
<td>Geochemical characterization of a fluvial tailings deposit along the Arkansas River, Colorado, USA</td>
<td>USA</td>
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<td>Balistenn Laureen</td>
<td>S.</td>
<td>A comparison of the geochemistry of water draining from adits and tailings ples in the Coeur d'Alene mining district—information for the geoenvironmental component of mineral deposit models</td>
<td>USA</td>
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<tr>
<td>Kelley Karen</td>
<td>D.</td>
<td>Natural acid drainage associated with shale-hosted Ag-Pb-Zn massive sulfide deposits in the Brooks Range, northern Alaska, USA USA USA</td>
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<td>Overly Bryan</td>
<td>M.</td>
<td>Variations in chemical and bacterial species of acid mine drainage affecting the Snow Fork drainage basin, Ohio—the Esco #40 underground mine</td>
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<td><strong>Session 2. Source Rock Characteristics and Geochemical Controls on Radionuclide Mobility</strong></td>
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<td>Pearce Nicholas J.G.</td>
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<td>Behavior of heavy metals and REE in acid mine drainage—implications for the behavior of transuranic metals</td>
<td>WALES UK</td>
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<td>Evangelou V.</td>
<td>P.</td>
<td>Influence of bicarbonate on pyrite oxidation</td>
<td>USA</td>
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<td>Webster Jenny G.</td>
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<td>Trace metal adsorption onto schwertmannite (iron oxyhydroxysulfate) in acid mine drainage systems</td>
<td>USA</td>
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<td>Stanton Mark R.</td>
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<td>Mineral crusts or microbial mats? Alteration of surficial mine tailings in the Leadville District, Colorado</td>
<td>USA</td>
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<td>Hammarstrom Jane M.</td>
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<td>Formation of goethite and oxidation of sulde ores as analogs of oxidation of tailings ples</td>
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<td><strong>Session 3. Geochemistry and Environmental Impacts of Acid Drainage</strong></td>
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<td>Odor L.</td>
<td></td>
<td>Mobilization and attenuation of metals downstream of a base-metal mining site in the Maitra Mountains, northeastern Hungary</td>
<td>USA</td>
<td>O</td>
<td>1-10</td>
</tr>
<tr>
<td>Lind C.</td>
<td></td>
<td>In-situ alteration of minerals by acidic ground water resulting from mining activities</td>
<td>USA</td>
<td>O</td>
<td>1-11</td>
</tr>
<tr>
<td>Church Stanley</td>
<td></td>
<td>Geochemical and lead-isotopic studies of the environmental effect of mining at Summitville, Colorado</td>
<td>USA</td>
<td>O</td>
<td>1-12</td>
</tr>
<tr>
<td>Fricker James</td>
<td></td>
<td>Biotreatment of metal mine waste waters—case histories</td>
<td>USA</td>
<td>O</td>
<td>1-13</td>
</tr>
<tr>
<td>Amacher M. C.</td>
<td></td>
<td>Reactions and transport of copper in headwater streams receiving acid rock drainage</td>
<td>USA</td>
<td>P</td>
<td>S-V</td>
</tr>
<tr>
<td>Bliss Linda</td>
<td></td>
<td>Buffering of acid rock drainage by silicate minerals</td>
<td>USA</td>
<td>P</td>
<td>S-V</td>
</tr>
<tr>
<td>Gray Floyd</td>
<td></td>
<td>Source chemistry and characteristics of intermittent stream waters having low pH and elevated metal concentrations.</td>
<td>USA</td>
<td>P</td>
<td>S-V</td>
</tr>
<tr>
<td>Halicz Torsten</td>
<td></td>
<td>Biogeochemistry of acid drainage from coal mining operations in the Witbank area</td>
<td>S. AFRICA</td>
<td>P</td>
<td>S-V</td>
</tr>
<tr>
<td>Lanyon Ruth</td>
<td></td>
<td>Dispersal of arsenic by gold mining near Barberton, South Africa</td>
<td>S. AFRICA</td>
<td>P</td>
<td>S-V</td>
</tr>
<tr>
<td>Kempton J. H.</td>
<td></td>
<td>Moisture and salinity limits on pyrite oxidation in semi-arid climates</td>
<td>USA</td>
<td>P</td>
<td>S-V</td>
</tr>
<tr>
<td>Lee Gregory</td>
<td></td>
<td>Geoenvironmental assessment of Montana—potential for acidic metal-rich drainage</td>
<td>USA</td>
<td>P</td>
<td>S-V</td>
</tr>
<tr>
<td>Miller Rebecca A.</td>
<td></td>
<td>Geochemistry and water quality prediction for sediment deposits in the New World Mining District</td>
<td>USA</td>
<td>P</td>
<td>S-V</td>
</tr>
<tr>
<td>Pride Douglas</td>
<td>E.</td>
<td>Identification and characterization of mine effluent in streams of the Colorado mineral belt—the Snake River Montana mining district</td>
<td>USA</td>
<td>P</td>
<td>S-V</td>
</tr>
<tr>
<td>Rysk Eri</td>
<td></td>
<td>The influence of mine-drainage formation on the geochemical and hydrogeological state of the environment in Estonia</td>
<td>ESTONIA</td>
<td>P</td>
<td>S-V</td>
</tr>
<tr>
<td>Rjhev William</td>
<td></td>
<td>An integrated environmental geosciences project in the Santa Cruz River drainage basin, southern Arizona</td>
<td>USA</td>
<td>P</td>
<td>S-V</td>
</tr>
</tbody>
</table>

*Presentation type (Ooral, PPoster, S-Socket program number for session number, date, and time: P-Poster, s-socket program number for session dates)
**Poster presentation times (S-W-Sunday, W-Wednesday, W=Wednesday, F=Friday)
Session 2. Geochemistry of Fresh Water & Marine Environments

Session Chairs: Frank Manheim and Edeltrauda Helios Rybicka (a.m.); Joy Rae and Martin Fey (p.m.)

<table>
<thead>
<tr>
<th>Author</th>
<th>Title</th>
<th>Country</th>
<th>Oral/P</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>McLemore V. T.</td>
<td>Geology and geochemistry of water and stream-sediment samples of the upper Pecos River Wilderness area, eastern New Mexico</td>
<td>USA</td>
<td>O</td>
<td>2-1</td>
</tr>
<tr>
<td>Reid Caroline</td>
<td>Lead and zinc contamination of sediments in Zoar Vlei, Cape Peninsula, South Africa</td>
<td>S. AFRICA</td>
<td>O</td>
<td>2-2</td>
</tr>
<tr>
<td>Birch F.</td>
<td>Towards a contaminant model for Port Jackson—Sydney’s main estuary</td>
<td>AUSTRALIA</td>
<td>O</td>
<td>2-3</td>
</tr>
<tr>
<td>Klavins Mans Zober</td>
<td>Metal fluxes and accumulation in lakes of Latvia Hydrological explanation of the heavy metals concentration in the Wyszogrod Island, Vistula River, Plock, Poland</td>
<td>LATVIA</td>
<td>O</td>
<td>2-4</td>
</tr>
<tr>
<td>Parsons B. Michael</td>
<td>Hydrogeochemical controls on trace element release from the Penn Mine base metal slag dump, Calaveras County, California—linking field, laboratory, and geochemical modeling studies</td>
<td>GERMANY</td>
<td>O</td>
<td>2-5</td>
</tr>
<tr>
<td>Manheim Frank</td>
<td>Mapping chemical contaminants in estuarine and coastal marine sediments—new approaches to validating and using historical data</td>
<td>USA</td>
<td>O</td>
<td>2-6</td>
</tr>
<tr>
<td>Lambeth H. Robert</td>
<td>Metal release and reocclusion characteristics of tailings in a marine environment—a laboratory study and site demonstration</td>
<td>USA</td>
<td>O</td>
<td>2-7</td>
</tr>
<tr>
<td>Knesi Oliver</td>
<td>A geochemical investigation of the water and sediments of Babber’s Pan, North West Province</td>
<td>S. AFRICA</td>
<td>O</td>
<td>2-8</td>
</tr>
<tr>
<td>Matthai C.</td>
<td>The application of the equilibrium partitioning method in surficial sediments near a deepwater ocean outfall off Malabar, Sydney, Australia</td>
<td>AUSTRALIA</td>
<td>O</td>
<td>2-9</td>
</tr>
<tr>
<td>Sullivan B. Annett</td>
<td>Temporal variation in the concentrations and speciation of metals in Peru Creek, Summit County, Colorado</td>
<td>USA</td>
<td>O</td>
<td>2-10</td>
</tr>
<tr>
<td>Schettler Georg</td>
<td>Lacustrine records of heavy metal pollution—problems of dating</td>
<td>GERMANY</td>
<td>O</td>
<td>2-11</td>
</tr>
<tr>
<td>Taylor S. E.</td>
<td>Contaminant dynamics in Port Jackson Estuary, Sydney, Australia</td>
<td>AUSTRALIA</td>
<td>O</td>
<td>2-12</td>
</tr>
<tr>
<td>Brown Kevin L.</td>
<td>Metals in an estuarine system—sources and sinks</td>
<td>N. ZEALAND</td>
<td>P</td>
<td>W-F-1</td>
</tr>
<tr>
<td>Margolina Sofia E.</td>
<td>The determination of heavy metal fractions in estuarine sediments</td>
<td>RUSSIA</td>
<td>P</td>
<td>W-F-2</td>
</tr>
<tr>
<td>Majer Vladimir</td>
<td>Pollution of Czech freshwaters by trace elements</td>
<td>CZECH REP.</td>
<td>P</td>
<td>W-F-3</td>
</tr>
<tr>
<td>Helios Rybicka E.</td>
<td>Impact of the Pb-Zn industry on the contamination of the Przemysza River, Upper Silesia, Poland</td>
<td>POLAND</td>
<td>P</td>
<td>W-F-4</td>
</tr>
<tr>
<td>Kim Kyoung-Woong</td>
<td>Heavy metal contamination in dusts and stream sediments, Taepo area, Korea</td>
<td>KOREA</td>
<td>P</td>
<td>W-F-5</td>
</tr>
<tr>
<td>Kraik Martin</td>
<td>Unique ground water (karst) monitoring system as an important tool of drinking water protection in Austria</td>
<td>AUSTRIA</td>
<td>P</td>
<td>W-F-6</td>
</tr>
<tr>
<td>Rosales-Hoz L.</td>
<td>Distribution of trace and major elements in surface sediments from Coatzaocoacoc, River, Mexico</td>
<td>MEXICO</td>
<td>P</td>
<td>W-F-7</td>
</tr>
<tr>
<td>Savchenko Vladimir</td>
<td>Low-water sediment in rivers of Belarus—origin, mineralogical and geochemical composition, potential for use in environmental assessments</td>
<td>BELARUS</td>
<td>P</td>
<td>W-F-8</td>
</tr>
<tr>
<td>Savchenko Vladimir</td>
<td>Some approaches to the biogeochemical study of contaminated river ecosystems</td>
<td>BELARUS</td>
<td>P</td>
<td>W-F-9</td>
</tr>
<tr>
<td>Schettler Georg</td>
<td>Lead isotope anomalies in Maar Lake sediments—indications of extensive lead mining in the Northwestern Eifel (Germany) during the time of the Roman Empire</td>
<td>GERMANY</td>
<td>P</td>
<td>W-F-10</td>
</tr>
<tr>
<td>Perkins W. T.</td>
<td>Monitoring marine pollution and determining paleoclimate: the application of laser ablation ICP-MS studies to marine bivalve molluscs</td>
<td>WALES UK</td>
<td>P</td>
<td>W-F-11</td>
</tr>
<tr>
<td>Shakherdov V.</td>
<td>Heavy metals as indicators of anthropogenic pollution of bottom sediments in Neva Bay</td>
<td>RUSSIA</td>
<td>P</td>
<td>W-F-12</td>
</tr>
<tr>
<td>Zhamoda Vladimir A.</td>
<td>Modern shallow-water Fe-Mn concretions as an indicator of the contamination of marine environments—a new type of environmental geochemical monitoring</td>
<td>RUSSIA</td>
<td>P</td>
<td>W-F-13</td>
</tr>
</tbody>
</table>

*Presentation type (O=oral, see program matrix for session number, date, and time. P=poster, see program matrix for session dates)
**Poster presentation times (S=Sunday, W=Wednesday, W-F=Wednesday-Friday)
<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Country</th>
<th>Code</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woodling</td>
<td>Recovery of brown trout (Salmo trutta) and brook trout (Salvelinus fontinalis) populations in the Eagle River, Colorado. USA during and following CERCLA recovery actions</td>
<td>USA</td>
<td>O</td>
<td>3-1</td>
</tr>
<tr>
<td>Farago</td>
<td>Exposure to platinum from vehicle catalytic converters and possible health implications</td>
<td>ENGLAND</td>
<td>O</td>
<td>3-2</td>
</tr>
<tr>
<td>Gauthier</td>
<td>Relationship between Alzheimer's disease and aluminium speciation in drinking water—a case-control study in Saguenay-Laurentides, Quebec (IMAGE Project)</td>
<td>CANADA</td>
<td>O</td>
<td>3-3</td>
</tr>
<tr>
<td>Schaefer</td>
<td>Emissions of platinum-group elements (PGE) from automobile catalytic converters in soils along highways</td>
<td>GERMANY</td>
<td>O</td>
<td>3-4</td>
</tr>
<tr>
<td>Thornton</td>
<td>Risk assessment related to metals—the role of the geochemist</td>
<td>ENGLAND, UK</td>
<td>O</td>
<td>3-5</td>
</tr>
<tr>
<td>Kolker</td>
<td>Geochemistry of coals causing arsenicism in Southwest China</td>
<td>USA</td>
<td>O</td>
<td>3-6</td>
</tr>
<tr>
<td>McCaffrey</td>
<td>Distribution and origin of fluoride in drinking water supplies in the western Bushveld area of South Africa</td>
<td>S. AFRICA</td>
<td>O</td>
<td>3-7</td>
</tr>
<tr>
<td>Rae</td>
<td>Pesticide adsorption onto aquifer sediments</td>
<td>ENGLAND UK</td>
<td>O</td>
<td>3-8</td>
</tr>
<tr>
<td>Gulson</td>
<td>Mobilization of lead from maternal skeleton during pregnancy</td>
<td>AUSTRALIA</td>
<td>O</td>
<td>3-9</td>
</tr>
<tr>
<td>Hunt</td>
<td>Source attribution of lead particles in pre- and post-lead paint abatement interior dusts</td>
<td>USA</td>
<td>O</td>
<td>3-10</td>
</tr>
<tr>
<td>Smith</td>
<td>Geochemical factors controlling infantile exposure to cerium and its implications to the aetiology of endemic myeloneural fibrosis in Uganda</td>
<td>ENGLAND UK</td>
<td>O</td>
<td>3-11</td>
</tr>
<tr>
<td>Kavanagh</td>
<td>Arsenic exposure in southwest England. UK— significance for human health</td>
<td>ENGLAND UK</td>
<td>O</td>
<td>3-12</td>
</tr>
<tr>
<td>Hoogewerf</td>
<td>Use of archaeological bone in present-day baseline human exposure studies</td>
<td>NETHERLANDS</td>
<td>O</td>
<td>3-13</td>
</tr>
<tr>
<td>Li</td>
<td>Concentration and chemical partitioning of heavy metals in road dusts and urban soils in Hong Kong</td>
<td>HONG KONG</td>
<td>O</td>
<td>3-14</td>
</tr>
<tr>
<td>Wang</td>
<td>Exposure of children to lead in the home environment—a comparative study in Shanghai and Birmingham</td>
<td>ENGLAND UK</td>
<td>O</td>
<td>3-15</td>
</tr>
<tr>
<td>Zhang</td>
<td>Lead in the environment, China</td>
<td>PR CHINA</td>
<td>O</td>
<td>3-16</td>
</tr>
<tr>
<td>Pooley</td>
<td>Soil chemical patterns possibly linked to Mesolithic Joint Disease among rural inhabitants in northern KwaZulu-Natal, South Africa</td>
<td>S. AFRICA</td>
<td>O</td>
<td>3-17</td>
</tr>
<tr>
<td>Heinrichs</td>
<td>Natural arsenic in Triassic sediments as source of drinking water contamination in Bavaria, Germany</td>
<td>GERMANY</td>
<td>O</td>
<td>3-18</td>
</tr>
<tr>
<td>Li</td>
<td>The application of regional geochemical data in environmental studies</td>
<td>PR CHINA</td>
<td>O</td>
<td>3-19</td>
</tr>
<tr>
<td>Malikzadeh</td>
<td>Methods of monitoring environmental health</td>
<td>RUSSIA</td>
<td>P</td>
<td></td>
</tr>
<tr>
<td>Pearce</td>
<td>Vehicle related emissions of heavy metals and platinum group elements in the urban environment—examples</td>
<td>WALES UK</td>
<td>P</td>
<td></td>
</tr>
<tr>
<td>Hutchinson</td>
<td>Changes in urban geochemistry in Nottingham and Birmingham between 1982 and 1997</td>
<td>ENGLAND UK</td>
<td>P</td>
<td></td>
</tr>
<tr>
<td>Bieniulis</td>
<td>Evaluation of baseline soils geochemistry in support of environmental health studies in the Rocky Mountain Region</td>
<td>USA</td>
<td>P</td>
<td></td>
</tr>
<tr>
<td>Cameron</td>
<td>Recent (1930's) natural acidiﬁcation and ﬁsh kill in a lake that was an important food source to the population of Akulivik, northern Quebec</td>
<td>CANADA</td>
<td>P</td>
<td></td>
</tr>
<tr>
<td>Cunha</td>
<td>The application of geochemical data to environmental concerns in the Minas Gerais State, Brazil</td>
<td>BRAZIL</td>
<td>P</td>
<td></td>
</tr>
<tr>
<td>Martin</td>
<td>Allozyme variation upstream and downstream of metal contaminant sources in the brown trout (Salmo trutta) and caddis fly (Trichoptera) in Clear Creek, Colorado, USA</td>
<td>USA</td>
<td>P</td>
<td></td>
</tr>
<tr>
<td>Zhang</td>
<td>Environmental geochemical features in the coal mine areas in China</td>
<td>PR CHINA</td>
<td>P</td>
<td></td>
</tr>
<tr>
<td>Fordyce</td>
<td>Geochemistry and human selenium imbalances in China</td>
<td>ENGLAND, UK</td>
<td>P</td>
<td></td>
</tr>
<tr>
<td>De Lima</td>
<td>Trace-element contamination in the environment of Recife metropolitan area, Pernambuco, Brazil</td>
<td>BRAZIL</td>
<td>P</td>
<td></td>
</tr>
<tr>
<td>Kralik</td>
<td>Fine dust (PM10) composition in a major city—mineralogy, lead-isotope and PAH-composition in Vienna</td>
<td>AUSTRIA</td>
<td>P</td>
<td></td>
</tr>
<tr>
<td>Basinski</td>
<td>Biogeochemical heavy metal regionalization and human health assessment</td>
<td>RUSSIA</td>
<td>P</td>
<td></td>
</tr>
</tbody>
</table>

*Presentation type (Oral, see program matrix for session number; date; time; Poster, see program matrix for session date; time)
Wang Yanxin
Remediation of high fluoride groundwaters from and regions using heat-treated soils: a column experiment study in Xinzhou, China
PR CHINA P S-W-24

Hoogewerff Janus
Quantification of environmental exposure vectors by geochemical methods
NETHERLANDS P S-W-25

Tristan E.
Application of exposure assessment models to Shipham, Somerset, UK—an area with soil contaminated by lead and cadmium
ENGLAND. UK P S-W-26

Session 4: Methods of Environmental Geochemical Monitoring, Modeling, and Mapping and Use and Determination of Geochemical Baselines

Session Chairs: Olle Selinus and Alina Kabata-Pendias (a.m.j: fӧrg Matschullat and Dave Smith (p.m.j)

Talbot D. K.
A comparison of field and laboratory analytical methods of radon-potential mapping in areas with and without global drift coverage
ENGLAND UK O 4-1

Chaffee Maunce A.
Discriminating between natural and anthropogenic anomalies in the surficial environment in Yellowstone National Park, Idaho, Montana, and Wyoming
USA O 4-2

Ander E. L.
Temporal variability in the geochemistry of waters from abandoned coal mines. County Durham, United Kingdom
ENGLAND UK O 4-3

Swennen Rudy
Unravelling the degree and the history of environmental pollution based on the evaluation of vertical geochemical profiles in overburden sediments
BELGIUM O 4-4

Selinus Olle
Integrating GIS and multivariate statistics in environmental geochemistry
SWEDEN O 4-5

Wang Bronwen
Trace Elements in the Kuskokwim River, Alaska
USA O 4-6

Van Tienhoven Mieke
Baseline survey of air pollution impacts on soil and water quality in Mpumalanga Province, South Africa
S. AFRICA O 4-7

Hudson Edwards Karen A.
The use of Holocene fluvialplain sedimentary sequences for geochemical mapping
ENGLAND UK O 4-8

Russ Jon
A new palaeoclimate indicator based on AMS 14C dates of biogenic whelwellite
USA O 4-9

Posey Harry
Establishing pre-disturbance water quality standards in areas of natural acid-metal contamination, upper Alamosa River, southern Colorado
USA O 4-10

Caron Francois
A large-scale laboratory experiment to determine the mass transfer of CO2 from a sandy soil to moving ground water
CANADA O 4-11

Dodds Heather A.
Classifying and mapping the sensitivity of South African highveld soils to acidification
S. AFRICA O 4-12

Matschullat Jörg
Custos lichenaceum—capable of monitoring the atmospheric deposition of trace elements and organochlorines?
GERMANY O 4-13

Zielinski Robert A.
Uranium and uranium isotopes as tracers of nutrient addition—a case study in South Florida
USA O 4-14

Reimann C.
The ‘Kola Ecogeochemy’ Project
NORWAY O 4-15

Runnells D. D.
Determination of natural background concentrations of dissolved components in water at mining, milling, and smelting sites
USA O 4-16

McMartin I.
Distribution of trace metals in soils near the base metal smelter at Flin Flon, Manitoba—natural and anthropogenic enrichments from a remote single point source area
CANADA O 4-17

de Bruin D.
Environmental applications of the regional geochemical mapping of soils and stream sediments in South Africa
S. AFRICA O 4-18

Seal. II Robert R.
Stable isotope characteristics of waters draining massive sulphide deposits in the eastern United States
USA O 4-19

Smith Barry
High resolution baseline mapping of hydrochemical processes and their correlation with geochemical anomalies and anthropogenic activities—Wales and Welsh borders
ENGLAND UK O 4-20

Wawrzynski Alecia L.
The utilization of high spectral resolution imagery and field spectra for the detection and monitoring of mining sites
USA O 4-21

Magnuszewski Artur
Ground truth versus a GIS model—the ground water quality of the Vistula River floodplain near the city of Plock, Poland
POLAND O 4-22

Himer A. V.
Testing contaminant mobility in soils and waste materials
GERMANY O 4-23

Tumbielen Tom
Delineating risk areas of contaminated ground water using geochemical databases
FINLAND O 4-24

Holmes Charles
Ecological changes in Florida Bay—can we tell when it happened?
USA O 4-25

*Presentation type (O=oral), see program matrix for session number, date, and time. **Poster presentation times (S=Saturday - Wednesday, W=Wednesday - Friday)
<table>
<thead>
<tr>
<th>Author</th>
<th>Title</th>
<th>Location</th>
<th>Page</th>
<th>Week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birke Manfred</td>
<td>Environmental geochemistry in the surroundings of the central waste deposit of Berlin</td>
<td>GERMANY</td>
<td>P</td>
<td>W</td>
</tr>
<tr>
<td>Matschullat Jorg</td>
<td>What is background? A statistical approach, introduced with data for the Baltic Sea</td>
<td>GERMANY</td>
<td>P</td>
<td>W</td>
</tr>
<tr>
<td>Lin Zhixun</td>
<td>Investigation of the environmental impact from industry wastes deposited in an urban area of Falun, Sweden</td>
<td>SWEDEN</td>
<td>P</td>
<td>W</td>
</tr>
<tr>
<td>McNeal James M.</td>
<td>The spatial reliability of geochemical maps</td>
<td>USA</td>
<td>P</td>
<td>W</td>
</tr>
<tr>
<td>De Vivo Benedetto</td>
<td>Environmental geochemical mapping in Sardinia, Italy</td>
<td>ITALY</td>
<td>P</td>
<td>W</td>
</tr>
<tr>
<td>Fuge Ron</td>
<td>Temporal and spatial variations in the chemistry of oches derived from an abandoned metalliferous mine</td>
<td>WALES UK</td>
<td>P</td>
<td>W</td>
</tr>
<tr>
<td>Havis Robert N.</td>
<td>Leaching of contaminants from an aggregate</td>
<td>USA</td>
<td>P</td>
<td>W</td>
</tr>
<tr>
<td>Jerz Jeanette A.K.</td>
<td>Laboratory leaching behavior of an Arkansas River fluvial tailings deposit, Leaville, Colorado</td>
<td>USA</td>
<td>P</td>
<td>W</td>
</tr>
<tr>
<td>Jordan David L.</td>
<td>Geochemical transport modeling of mine tailings pore water</td>
<td>USA</td>
<td>P</td>
<td>W</td>
</tr>
<tr>
<td>Kapinus Evgeny I.</td>
<td>Environmental monitoring of geochemical changes in ash-dumps and silage-heaps</td>
<td>USA</td>
<td>P</td>
<td>W</td>
</tr>
<tr>
<td>Komov Igor L.</td>
<td>Environmental geochemical mapping in the Ukraine</td>
<td>UKRAINE</td>
<td>P</td>
<td>W</td>
</tr>
<tr>
<td>Locke W. W.</td>
<td>Comparison of the measured and modeled geochemical composition of a Nevada pit lake</td>
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<td>Mukhejee P.K.</td>
<td>Heavy metal distribution and environmental status of Doon Valley soils. Uttar Pradesh, India</td>
<td>INDIA</td>
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</tr>
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<td>Niskavaara Heikki</td>
<td>The use of two leaches in environmental geochemical mapping to assess the concentration and mobilities of elements in soils</td>
<td>FINLAND</td>
<td>P</td>
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<td>Reimann C. C.</td>
<td>A geochemical atlas of the central parts of the Barents region</td>
<td>NORWAY</td>
<td>P</td>
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<tr>
<td>Roulier Leanne M.</td>
<td>A survey and analyses of the oxygen and carbon isotope composition of selected shells from core tops at five locations in Florida Bay</td>
<td>USA</td>
<td>P</td>
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<td>Shakverdov V.</td>
<td>Principles of landscape geochemical map composition and landscape geochemical zonality of the Aral Sea rim</td>
<td>USA</td>
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<td>Staines Russell</td>
<td>Small scale spatial relationships between geology, stream water chemistry and stream sediment chemistry in small upland catchments</td>
<td>RUSSIA</td>
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<td>Talbot D.K.</td>
<td>Radiometric risk mapping using existing geoscience datasets</td>
<td>ENGLAND UK</td>
<td>P</td>
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<td>Turner David R.</td>
<td>Perched water zones in environments—geochemical constraints on hydrological modeling for high-level radioactive waste disposal</td>
<td>USA</td>
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<td>Birke Manfred</td>
<td>Geochemical mapping in the new Federal States of Germany</td>
<td>GERMANY</td>
<td>P</td>
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<td>Wen Dongguang</td>
<td>Possibility of geological disposal of CO2—results from geochemical modeling</td>
<td>PR CHINA</td>
<td>P</td>
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</tr>
</tbody>
</table>

Session 5. Trace Substances, Ecosystems, and Bioavailability — aquatic/atmosphere

Session Chairs: Laurie Balistreri and David Levy (Thursday a.m.): John Gray and Gianni Cortecci (Fri.)
<table>
<thead>
<tr>
<th>Author</th>
<th>Presentation Title</th>
<th>Country</th>
<th>Code</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fannin</td>
<td>A study of the rare earth elements in aqueous carbonate and chloride systems</td>
<td>ENGLAND</td>
<td>O</td>
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<tr>
<td>Montoro</td>
<td>Aluminum and iron mobility in an acid sulfate environment and consequences for the local population—the case of the Lower Casamance (Senegal)</td>
<td>FRANCE</td>
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<td>Gurren</td>
<td>Distribution of metals and effects on aquatic biota in the upper Stillwater River Basin, Montana</td>
<td>USA</td>
<td>O</td>
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<tr>
<td>Bourg</td>
<td>Migration of heavy metals away from landfills in leachate—observations at the near- and far-field scale</td>
<td>FRANCE</td>
<td>P</td>
<td>S-W-27</td>
</tr>
<tr>
<td>Bezuidenhout</td>
<td>Chemical and mineralogical changes associated with leachate production at Kriel power station ash dam, Mpumalanga, South Africa</td>
<td>S. AFRICA</td>
<td>P</td>
<td>S-W-28</td>
</tr>
<tr>
<td>Harck</td>
<td>Denitrification of nitrate-rich ground water entering Verlorenvlei Lake on the west coast of South Africa</td>
<td>S. AFRICA</td>
<td>P</td>
<td>S-W-29</td>
</tr>
<tr>
<td>Gray</td>
<td>Environmental geochemistry and mercury speciation of abandoned mercury mines in southwestern Alaska</td>
<td>USA</td>
<td>P</td>
<td>S-W-30</td>
</tr>
<tr>
<td>Hall</td>
<td>Preservation of arsenic species in natural waters</td>
<td>CANADA</td>
<td>P</td>
<td>S-W-31</td>
</tr>
<tr>
<td>Sedzorek</td>
<td>Solubilization of heavy metals (Cd, Ni, Pb) during the percolation of the chelating agent EDTA through polluted soils and sediments</td>
<td>FRANCE</td>
<td>P</td>
<td>S-W-32</td>
</tr>
<tr>
<td>Mageera</td>
<td>The connection of some heavy metals with the magnetic phase of fly ash from two Polish thermal power plants</td>
<td>POLAND</td>
<td>P</td>
<td>S-W-33</td>
</tr>
<tr>
<td>Tagusche</td>
<td>Ground water flow system estimated by water quality</td>
<td>JAPAN</td>
<td>P</td>
<td>S-W-34</td>
</tr>
<tr>
<td>Finch</td>
<td>Identification of arsenic-rich ground water using geochemical signatures and geophysical log analysis, Albuquerque, New Mexico</td>
<td>USA</td>
<td>P</td>
<td>S-W-35</td>
</tr>
<tr>
<td>Yao</td>
<td>Environmental and hydrogeological problems caused by overexploitation of geothermal ground water in coastal cities of south-eastern China—a case study in Fuzhou Basin</td>
<td>PR CHINA</td>
<td>P</td>
<td>S-W-36</td>
</tr>
<tr>
<td>Guerin</td>
<td>Application of a three dimensional coupled transport and equilibrium chemistry model to the fate and transport of contaminants in the Königstein Uranium Mine</td>
<td>AUSTRALIA</td>
<td>P</td>
<td>S-W-37</td>
</tr>
<tr>
<td>Guerin</td>
<td>Coupling three dimensional transport with geochemistry—MT3D and PHREEQ3E</td>
<td>AUSTRALIA</td>
<td>P</td>
<td>S-W-38</td>
</tr>
</tbody>
</table>

**Session 6. **AGE-Sponsored Session — Environmental Geochemistry of Ore Deposits

**Session Chair:** Sherman Marsh and Eion Cameron (a.m.: Robert Garrett and Maurice Chaffee (p.m.)

*Presentation type (O) oral, (P) poster. See program matrix for session number, date, and time. Poster session: see program matrix for session dates.

**Poster presentation times (S=W-Sunday, W=Wednesday, W-F=Wednesday, Friday)**
### Session 7. Environmental Analytical Techniques & Applications  
(Session Chairs: Gwenyth Hall and James Crock)

<table>
<thead>
<tr>
<th>Name</th>
<th>Institution</th>
<th>Country</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ingram Jani C</td>
<td>USA</td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>Taylor Howard E</td>
<td>USA</td>
<td></td>
<td>7-1</td>
</tr>
<tr>
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<td>USA</td>
<td></td>
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<td>USA</td>
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<td>7-3</td>
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<tr>
<td>Leinz Reinhard W</td>
<td>USA</td>
<td></td>
<td>7-4</td>
</tr>
<tr>
<td>Matschullat Jörg</td>
<td>Germany</td>
<td></td>
<td>7-5</td>
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<td>Krüger Gero</td>
<td>Germany</td>
<td></td>
<td>7-6</td>
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<tr>
<td>Ping Ren</td>
<td>China</td>
<td></td>
<td>P</td>
</tr>
<tr>
<td>Viman Vasile</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

### Session 8. Trace Substances, Ecosystems, and Bioavailability — terrestrial  
(Session Chairs: William Orem and Irina Stangeevo (a.m.); Harald Puchelt and Rama K)

<table>
<thead>
<tr>
<th>Name</th>
<th>Institution</th>
<th>Country</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuge Ron</td>
<td>Wales</td>
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<td>8-1</td>
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<tr>
<td>Van der Sluis Jan</td>
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</tr>
<tr>
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<td>Asami Teruo</td>
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</tr>
<tr>
<td>Harrison Wendy J</td>
<td>USA</td>
<td></td>
<td>8-9</td>
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</tbody>
</table>

*Presentation type (Oral): see program matrix for session number, date, and time. Poster: see program matrix for session date.*

*Poster presentation times (S=Sunday - Wednesday, W=Wednesday - Friday)*
Gowil P. K. Effect of industrial effluents on trace element mobility in soil
Ayräs Matti Distribution of sulphur and heavy metals in podzolized tills
in northern Finland
Bailey E. A. Mercury speciation in soils and vegetation, southwest Alaska
Bondar Galina S. Assessment of suitability of some disturbed land for herb cultivation
Carranza-Edwards Arturo Textural analysis and its importance as an indicator of energy levels
in environmental geochemistry
Evans, Jr. Andrew Biodegradation of C-labeled organic acids and organo-metal complexes in soil
Nicholson Keith Environmental geochemistry of boron
Nowicki Tom Afforestation-induced enhancement of soil-solution aluminum and manganese concentrations in South African highland catchments
Gao Xiaojian Environmental geochemistry of rare earth elements in a typical landscape, Jiangxi, southern China
Gennadiyev A. Behavior of polycyclic aromatic hydrocarbons in soil ecosystems
Gonzalez Luz Myrian Heavy metals in soils of the Sabana de Bogota, Colombia
Kadosky Valery B. Heavy metals in humus and soil organic layers with different human activities
Kasimov N. S. The behavior of rocket-fuel components in soil and plants in the Kazakhstan and Altay region of Russia
Kotra Rama K. Geochemistry of mercury and trace elements in organic-rich sediments and vegetation from the everglades, south Florida
Fumoto T. Sulfate adsorption model for predicting soil acidification
Rashed M. N. Biogeochemistry of trace elements in plants and interactions with soil around Nassar Lake, Egypt
Renchiri Jack E. Environmental impact of phosphogypsum use in agriculture
Somov Yury M. Differentiation of heavy metals as a reflection of landscape-use levels
Sakurai Yasuhiro Laboratory measurements of the absorption and oxidation of sulfur dioxide by the soil surface
Sarvcheiko Vladimir Trace element distribution in soils and factors affecting metal uptake by plants in the contaminated flood plain of the Svislach River, Belarus
Sonke Jeroen A chemical and mineralogical reconstruction of emissions from Zn-smelters in the Kempen region (Belgium), based on peat cores
Shtanggeva Irina Some peculiarities of chemical element bioaccumulation in different environmental samples
Strzyzcz Zygmunt Iron deposition and magnetic susceptibility of forest soils, Katowice Province, Poland
Wang Lijun Environmental geochemistry of rare earth elements in common soils of China

Session 9. Remediation of Mining-Related Disturbances
(Session Chairs: Harry Posey and Suresh Kumar)

Rebedea Irina An investigation into the mechanism by which synthetic zeolite amendments reduce soil phytotoxicity
Deissmann Guido Geochemical assessment of passive treatment methods for acid mine waters from a flooded uranium mine
Vandiereme M. M. Comparative testing between conventional and microencapsulation approaches in controlling pyrite oxidation
Cheong Young-Work Metal removal efficiencies of substrates for treating acid mine drainage of the Dalsung Mine, Korea
Bowen R. J. A review of sulfate removal options from mine waters
Joshi D. C. Characterization of gypsum mine wastelands and their rehabilitation
Kumar Suresh Rehabilitation induced vegetation progression at gypsum mined land in western Rajasthan—analytical approaches and empirical evidence
Lund D. Uses of chemical speciation for impact evaluation and remediation of mining waste
Mite Ongari P. Dairy types and milk production in the Eastern Province, Kenya
Edwards Robert J. Biogeochemical mechanisms influencing metal mobility in natural and constructed wetlands

*Presentation time (O opens; see program matrix for session number, date, and time. Posters; see program matrix for session dates)
**Poster presentation times (S=Sunday, W=Wednesday, F=Friday)
<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliation</th>
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<tr>
<td>Thompson</td>
<td>Bruce</td>
<td>Adsorption of metal cations on manganese oxide-coated filter sand: a novel method for water treatment</td>
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<tr>
<td>Kagan</td>
<td>Leonid M.</td>
<td>Chernobyl nuclides in soils and gamma-dose rate in the air of Belarus</td>
</tr>
<tr>
<td>Giendinning</td>
<td>John</td>
<td>Weathering and colloid mobility as factors influencing the migration of radioactive elements at Steenkampskaal Mine in the Northern Cape Province, South Africa</td>
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<td>Smith</td>
<td>Barry</td>
<td>The distribution of natural radionuclides in ground waters and post Cretaceous sediments from the southern Mediterranean margin</td>
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<td>Shvarcsev</td>
<td>Stepan L.</td>
<td>The experience and the results for the disposal of liquid radioactive waste (LRW) on the Siberian Chemical Industrial Plant</td>
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<td>Mazeika</td>
<td>Jonas</td>
<td>Radiogeochemical mapping in the Ignalina Nuclear Power Plant region—bottom sediments and soils</td>
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<tr>
<td>Shumyanskiy</td>
<td>Vladislav O.</td>
<td>The radioactive mineral encrustation on the casings in the oil producing wells in the Dnieper-Donets depression, Ukraine</td>
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<tr>
<td>Golovko</td>
<td>Natalia V.</td>
<td>Organic substances and the migratory processes of radionuclides</td>
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<td>Katspav</td>
<td>Olga V.</td>
<td>Chernobyl contamination as a new geographical factor in Belarus</td>
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<tr>
<td>Kadatsky</td>
<td>Valery B.</td>
<td>Re-suspension of the radionuclides in the Belarus soils distant from the Chernobyl Nuclear Power Plant</td>
</tr>
</tbody>
</table>

*Presentation type (O=oral; see program matrix for session number, date, and time. P=poster; see program matrix for session dates)

**Poster presentation times (S=Sunday - Wednesday; W=Wednesday - Friday)

**ABBREVIATIONS USED IN THE ABSTRACTS:

<table>
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<th>Description</th>
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<tbody>
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<td>dL</td>
<td>deciliter</td>
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<tr>
<td>dpm</td>
<td>disintegrations per minute</td>
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<tr>
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<td>ha</td>
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<td>μg</td>
<td>microgram (10⁻⁶ gram)</td>
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<td>μm</td>
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</tr>
<tr>
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<td>week</td>
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</tbody>
</table>
Abstract Title Index

A Chemical and Mineralogical Reconstruction of Emissions from Zn Smelters in the Kempen Region (Belgium), Based on Peat Cores ........................................ 86
A Comparison Of Field And Laboratory Analytical Methods Of Radon-Potential Mapping In Areas With And Without Glacial Drift Coverage ............................................. 89
A Comparison of Regional Geochemical Surveys of Till and Lake Sediment, Labrador, Canada ...................................................... 45
A Comparison of the Geochemistry of Water Draining from Adits and Tailings Piles in the Coeur d’Alene Mining District: Information for the Geoenvironmental Component of Mineral Deposit Models ........................................... 8
A Geochemical Atlas of the Central Parts of the Barents Region ................................................................. 76
A Geochemical Investigation of the Water and Sediments of Barber’s Pan, North West Province .................................................. 46
A Large-Scale Laboratory Experiment to Determine the Mass Transfer of CO2 From a Sandy Soil to Moving Ground Water ................................................................. 16
A New Paleoclimatic Indicator Based on AMS 14C Dates of Biogenic Wheepleite ................................................................. 78
A Review of Sulfate Removal Options from Mine Waters ................................................................. 14
A Study of the Analytical Variation of Sampling and Analysis of Stream Sediments from Mining and Milling Contaminated Areas ................................................................. 14
A Study of the Rare Earth Elements in Aqueous Carbonate and Chloride Systems ................................................................. 23
A Survey and Analyses of the d18O and d13C Composition of Selected Shells from Core Tops at Five Locations in Florida Bay ................................................................. 77
Acid Buffering Capacity and Metals Mobility in Acid-Impacted Agricultural Soils, San Luis Valley, Colorado ................................................................. 34
Acid/saline Ground Waters in the Southern Yilgarn Craton, Western Australia ................................................................. 30
Adsorption of Metal Cations on Manganese Oxide-Coated Filter Sand—A Novel Method for Water Treatment ......................... 91
Afforestation-Induced Enhancement of Soil-Solution Aluminum and Manganese Concentrations in South African Highland Catches ................................................................. 68
Allozyme Variation Upstream and Downstream of Metal Contaminants in the Brown Trout (Salmo trutta) and Caddis Fly (Arctopsyche grandis) in Clear Creek, Colorado, USA ................................................................. 10
Aluminium and Iron Mobility in an Acid Sulfate Environment and Consequences for Local Population—The Case of the Lower Casamance (Senegal) ................................................................. 65
An Integrated Environmental Geosciences Project in the Santa Cruz River Drainage Basin, Southern Arizona ................................................................. 77
An Investigation into the Mechanism by Which Synthetic Zeolite Amendments Reduce Soil Phytoxicity ................................................................. 75
Anthropogenic and Geogenic Sources of Trace Metals in the Environment—A Case Study of Contaminated Soils in the Pzsiom-Pernek Region of Malé Karpaty Mountains, Slovakia ................................................................. 84
Application of a Three Dimensional Coupled Transport and Equilibrium Chemistry Model to the Fate and Transport of Contaminants in the Komstein Uranium Mine ................................................................. 101
Application of Exposure Assessment Models to Shilpin, Somerset, UK. An Area with Soil Contaminated by Pb and Cd ................................................................. 92
Application of Mine Fire Diagnostics ................................................................. 12
Application of the Equilibrium Partitioning Method in Surficial Sediments near a Deepwater Ocean Outfall Of Malabar, Sydney, Australia ................................................................. 61
Archaeological Bone as Baseline for Present Day Human Exposure ................................................................. 38
Arsenic Exposure in SW England, U.K. Significance for Human Health ................................................................. 43
Assessment of Suitability of Some Disturbed Land for Herb Cultivation ................................................................. 12
Baseline Survey of Air Pollution Impacts on Soil and Water Quality in Mupamalanga Province, South Africa ................................................................. 93
Behavior of Heavy Metals and REE in Acid Mine Drainage—Implications for the Behavior of Transuranic Metals ................................................................. 70
Behavior of Polycyclic Aromatic Hydrocarbons in Soil Ecosystems ................................................................. 27
Biodegradation of 14C Labeled Organic Acids and Organic-Metal Complexes in Soil ................................................................. 23
Biogeochemical Heavy Metal Regionalization and Human Risk Assessment ................................................................. 9
Biogeochemical Mechanisms Influencing Metal Mobility in Natural and Constructed Wetlands ................................................................. 22
Biogeochemistry of Acid Drainage from Coal Mining Operations in the Witbank Area ................................................................. 33
Biogeochemistry of Trace Elements in Plants and Soils Around Nasser Lake (Egypt) ................................................................. 74
Biotreatment of Metal Mine Waste Waters—Case Histories ................................................................. 25
Buffering of Acid Rock Drainage by Silicate Minerals ................................................................. 12
Changes in Urban Geochemistry in Nottingham and Birmingham between 1982 and 1997 ................................................................. 39
Charactarization of Gypsum Mine Wasteילs and Their Rehabilitation ................................................................. 40
Chemical and Mineralogical Changes Associated With Leachate Production at Kriel Power Station Ash Dam, Mupamalanga, South Africa ................................................................. 10
Chernobyl Contamination As A New Geographical Factor In Belarus ................................................................. 41
Chernobyl Nuclides in Soils and Gamma-Dose Rate in Air Of Belarus ................................................................. 42
Classifying and Mapping the Sensitivity of South African Highveld Soils to Acidification ................................................................. 20
Comparative Testing Between Conventional and Micro-encapsulation Approaches in Controlling Pyrite Oxidation ................................................................. 93
Comparison of Ground-Water Chemistry from the Carbonate Platform Region of the Ozark Mountains, USA ................................................................. 87
Comparison of the Measured and Modeled Geochemical Composition of a Nevada Pit Lake ................................................................. 55
Compatibility of Data Derived from Different Selective Extraction Schemes ................................................................. 33
Concentration and Chemical Partitioning of Heavy Metals in Road Dusts and Urban Soils in Hong Kong ................................................................. 54
Contaminant Detection On Soils Using Static SIMS ................................................................. 39
Contaminant Dynamics in Port Jackson Estuary, Sydney, Australia ................................................................. 90
Contamination of Ground Water in Diverse Hydrogeochemical Environments, SE Hungary ................................................................. 94
Coupling Three Dimensional Transport with Geochemistry—MT3D and PBE/EOF ................................................................. 101
Cyanide Emissions—The Atmospheric Deposition of Trace Elements and Organophosphates ................................................................. 66
Delineating Risk Areas of Contaminated Ground Water Using Geochemical Databases ................................................................. 90
<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denitrification of Nitrate-Rich Ground Water Entering Verlorenvlei Lake on the West Coast of South Africa</td>
<td>34</td>
</tr>
<tr>
<td>Determination Of Lead In Environmental Matrices By Hydride Generation Atomic Fluorescence Spectrometry ( HGAFS )</td>
<td>71</td>
</tr>
<tr>
<td>Determination of Natural Background Concentrations of Dissolved Components in Water at Mining, Milling, and Smelting Sites</td>
<td>78</td>
</tr>
<tr>
<td>Differentiation of Heavy Metals as a Reflection of Landscape-Use Levels</td>
<td>82</td>
</tr>
<tr>
<td>Direct Methods Used for Identification of Heavy Metal Forms</td>
<td>36</td>
</tr>
<tr>
<td>Discriminating Between Natural and Anthropogenic Anomalies in the Surficial Environment in Yellowstone National Park, Idaho, Montana, and Wyoming</td>
<td>16</td>
</tr>
<tr>
<td>Dispersal of Arsenic by Gold Mining Near 2river, South Africa</td>
<td>51</td>
</tr>
<tr>
<td>Dispersion and Enrichment of Potentially Toxic Elements in Areas Underlain by Black Shales and Slates in Korea</td>
<td>52</td>
</tr>
<tr>
<td>Distribution and Origin of Fluoride in Rural Drinking Water Supplies in the Western Bushveld Areas of South Africa</td>
<td>62</td>
</tr>
<tr>
<td>Distribution of Metals and Effects on Aquatic Biota in the Upper Stillwater River Basin, Montana</td>
<td>32</td>
</tr>
<tr>
<td>Distribution of Sulfur and Heavy Metals in Podzolized Tills in Northern Finland</td>
<td>7</td>
</tr>
<tr>
<td>Distribution of Trace and Major Elements in Surface Sediments from Coatzaacoalcos River, Mexico</td>
<td>77</td>
</tr>
<tr>
<td>Distribution of Trace Metals in Soils near the Base Metal Smelter at Flin Flon, Manitoba: Natural and Anthropogenic Enrichments from A Remote Single Point Source Area</td>
<td>63</td>
</tr>
<tr>
<td>Ecological Changes in Florida Bay - Can We Tell When It Happened?</td>
<td>37</td>
</tr>
<tr>
<td>Ecological-Biogeochemical Status of the Baikal Region, Russia</td>
<td>48</td>
</tr>
<tr>
<td>Effect of Industrial Effluents on Trace Element Mobility in Soil</td>
<td>29</td>
</tr>
<tr>
<td>Effects of Evapoconcentration on Water Quality in Mine Pit Lakes</td>
<td>21</td>
</tr>
<tr>
<td>Emissions of Mercury to the Atmosphere: Natural Sources and Pathways</td>
<td>74</td>
</tr>
<tr>
<td>Emissions of Platinum-Group-Elements (PGE) from Automobile Catalytic Converters in Soils Along Highways</td>
<td>81</td>
</tr>
<tr>
<td>Environmental and Hydrogeological Problems Caused by Overexploitation of Geothermal Ground Water in Coastal Cities of South-Eastern China: A Case Study in Fuzhou Basin</td>
<td>97</td>
</tr>
<tr>
<td>Environmental Applications of the Regional Geochronometric Mapping of Soils and Stream Sediments in South Africa</td>
<td>18</td>
</tr>
<tr>
<td>Environmental Geochemical Features in the Coal Mine Areas in China</td>
<td>99</td>
</tr>
<tr>
<td>Environmental Geochemical Mapping in Sardinia (Italy)</td>
<td>19</td>
</tr>
<tr>
<td>Environmental Geochemical Mapping in the Ukraine</td>
<td>46</td>
</tr>
<tr>
<td>Environmental Geochemistry and Mercury Speciation of Abandoned Mercury Mines in Southwestern Alaska</td>
<td>31</td>
</tr>
<tr>
<td>Environmental Geochemistry in the Surroundings of the Central Waste Deposit of Berlin</td>
<td>12</td>
</tr>
<tr>
<td>Environmental Geochemistry of Boron</td>
<td>19</td>
</tr>
<tr>
<td>Environmental Geochemistry of Gold Deposits in the Mother Lode Belt, California</td>
<td>82</td>
</tr>
</tbody>
</table>

Environmental Geochemistry of Mercury Deposits in the Coast Range Mercury Belt, California
Environmental Geochemistry of Rare Earth Element: Typical Landscape in Jiangxi, Southern China
Environmental Geochemistry of Rare Earth Element: Type Soils in China
Environmental Impact of Phosphagypsum Use in Agriculture

Environmental Impacts of Lignite Open-cast Mining in Eastern Germany
Environmental Monitoring of Geochemical Changes in Dumps and Silage-Heaps
Environmental Studies of Mineral Deposits in Alaska
Establishing Pre-Disturbance Water Quality Standards in Areas of Natural Acid-Metal Contamination in the Alamosa River, Southern Colorado
Evaluation of Baseline Soil Geochemistry in Support of Environmental Health Studies in the Rocky Mountain Region

Exposure of Children to Lead in the Home Environment: Comparative Study in Shanghai and Birmingham
Exposure to Platinum from Vehicle Catalytic Conves: Possible Health Implications
Fine Dust (PM10) Composition in a Major City: M-lead-Isootope and PAH-Composition in Vienna
Formation of Gossan and Oxidation of Sulfide Ores: Analogs of Oxidation of Tailings Piles
Geochemical and Lead-Isootope Studies of the Enviro-effects of Mining in Summitville, Colorado
Geochemical Assessment of Passive Treatment of Acid Mine Waters from a Flooded Uranium Mine
Geochemical Characterization of a Fluvial Tailings Along the Arkansas River, Colorado, USA
Geochemical Factors Controlling Infantile Exposure to Mercury and Its Implications to the Aetiology of Endemic Fibrosis in Uganda

Geochemical Mapping in the New Federal States of Germany
Geochemical Transport of Mining in South Africa
Geochemistry and Human Selenium Imbalances in the Water System
Geochemistry and Water Quality Prediction for Ska Church Deposits in the New World Mining District
Geochemistry of Arsenic and Fluorine in Shallow Ground Water: Eastern Owens Lake, California
Geochemistry of Coals Causing Arsenism in South America

Geochemistry of Heavy Metals Derived from Sulfide Mineral Deposits in the Marimbas, Colombia
Geochemistry of Mercury and Trace Elements in Ochre Deposits and Vegetation from the Everglades, Florida
Geochemistry of Overbank Sediments in Belgium: A Way to Assess Environmental Pollution
Geochemical Assessment of Montana: Potentially Polluted Metal Rich Drainage
Geochemistry and Geochemistry of Water and Stream-Sediment Samples of the Upper Pecos River, from the San Antonio Wilderness to Brantley Dam, North of Eastern New Mexico
Ground Truth Versus GIS Model—The Ground-Water Quality of the Vistula River Floodplain near the City Of Plock (Poland) .................................................. 57
Ground-Water Flow System Estimated by Water Quality .......... 89
Heavy Metal Contamination in Dusts and Stream Sediments in the Taegon Area, Korea ...................................... 44
Heavy Metal Distribution and Environmental Status of Doon Valley Soils, U. P. India .................................................. 65
Heavy Metals as Indicators of Anthropogenic Pollution of Bottom Sediments in Neva Bay ........................................... 83
Heavy Metals in Humus and Organogenous Layers with Different Human Activities .................................................. 42
Heavy Metals in Soils of the Sabana de Bogotá, Colombia ....... 29
High Resolution Baseline Mapping of Hydrochemical Processes and Their Correlation with Geochemical Anomalies and Anthropogenic Activities: Wales and the Welsh Borders .............................................. 85
Hydrogeochemical Controls on Trace Element Release from the Penn Mine Base Metal Sediment, Calaveras County, California—Linking Field, Laboratory, and Geochemical Modeling Studies .................................................. 69
Hydrological Explanation of the Heavy Metals Concentration in the Wyszogrod Island (Vistula River near Plock, Poland) .................................................. 100
Identification and Characterization of Mine Effluent in Streams of the Colorado Mineral Belt—The Snake River, Montezuma Mining District ........................................... 72
Identification of Arsenic-Rich Ground Water Using Geochemical Signatures and Geophysical Log Analysis, Albuquerque, New Mexico ........................................... 24
Impact of the Pb-Zn Industry on the Contamination of the Przemsza River, Upper Silesia, Poland ........................................... 36
Incidental Amendment of Mercury to Agricultural Fields by Turbid Irrigation Waters and Natural Floods in Nebraska and Oregon .................................................. 51
Inductively Coupled Plasma — Atomic Emission Spectrometry Used in Analysis of Pollutants from an Area With Non-Ferrous Extraction and Ore-Processing ........................................... 94
Influence of Bicarbonate on Pyrite Oxidation ................................ 22
In-Situ Alteration of Minerals by Acidic Ground Water Resulting from Mining Activities ........................................... 55
Integrating GIS and Multivariate Statistics in Environmental Geochemistry .................................................. 82
Interdisciplinary Training Modules in Mining and the Environment—Case Study On The .................................................. 100
Investigation of the Environmental Impact from Industry Wastes Deposited in an Urban Area of Falun, Sweden .................................................. 55
Iron Deposition and Magnetic Susceptibility of Forest Soils in Katowice Province .................................................. 88
Isotopic and Chemical Compositions of Rain and Snow Precipitation at Bologna, Italy .................................................. 17
Laboratory Leaching Behavior of an Arkansas River Fluvial Tailings Deposit, Leadville, Colorado .................................................. 40
Laboratory Measurements of the Absorption and Oxidation of Sulfur Dioxide by Soil Surfaces .................................................. 79
Lacustrine Records of Heavy Metal Pollution—Problems of Dating .................................................. 81
Leach of Contaminants from an Aggregate ................................ 35
Lead and Zinc Contamination of Sediments in Zoor Vlei, Cape Peninsula, South Africa .................................................. 75
Lead in the Environment, China .................................................. 98
Lead Isotope Anomalies in Maar Lake Sediments - Indications for Extensive Lead Mining in the Northwestern Eifel (Germany) During the Time of the Roman Empire ......................... 81
Lithochemical Map of the Chesapeake Bay Watershed—An Example of Usable Repackaging of Traditional Geologic Information .................................................. 63
Low-Water Sediment in Rivers of Belarus—Origin, Mineralogical and Geochemical Composition, Potential Use For Environmental Assessment .................................................. 79
Management System (SEMS)—Carletonville Gold Mining Area as a Pilot Study .................................................. 100
Manifold Heavy Metal and As Contamination by a German Zn-Pb Deposit With a Two-Thousand Year Mining History .................................................. 10
Mapping Chemical Contaminants in Estuarine and Coastal Marine Sediments: New Approaches to Validating and Using Historical Data .................................................. 59
Measurement and Simulation of Pyrite Oxidation in the Blasted Rock of an Open-Pit Mine .................................................. 7
Measurement of Gas Exchange Processes Between Soils and the Atmosphere and Applications in Environmental and Exploration Geochemistry .................................................. 46
Mercury Occurrence, Transport, and Speciation in the Sacramento River Basin, California .................................................. 21
Mercury Speciation In Soils And Vegetation, Southwest Alaska .................................................. 8
Metal Fluxes and Accumulation in Lakes of Latvia ................................ 45
Metal Release and Reclonization Characteristics of Tailings in a Marine Environment — A Laboratory Study and Site Demonstration .................................................. 50
Metal Removal Efficiencies of Substrates for Treating Acid Mine Drainage of the Dalsung Mine, Korea .................................................. 17
Metals in an Estuarine System: Sources and Sinks ................................ 15
Methods and Evaluation Models for Standardized Risk Assessment of Gold Mining Waste Sites in South Africa .................................................. 99
Methods of Monitoring of Environmental Health—With Special Reference to Regions in Ecological Crisis .................................................. 58
Migration of Heavy Metals Away from Landfills in Leachate: Observations at the Near- and Far-Field Scale .................................................. 13
Mineral Crusts or Microbial Mats? Alteration of Surficial Mine Tailings in the Leadville District, Colorado .................................................. 87
Mobilization and Attenuation of Metals Downstream of a Base-Metal Mining Site in the Matra Mountains, Northeastern Hungary .................................................. 68
Mobilization of Lead from Maternal Skeleton during Pregnancy .................................................. 31
Modern Shallow-Water Fe-Mn Concretions as an Indicator of the Contamination of Marine Environments: A New Type of Marine Environmental Geochemical Monitoring .................................................. 98
Moisture and Salinity Limits on Pyrite Oxidation in Semi-And Climates .................................................. 44
Monitoring Marine Pollution and Determine Palaeoclimates: The Application of Laser Ablation ICP-MS Studies to Marine Bivalve Mollusks .................................................. 71
Multimedia Environmental Geochemical Mapping Using Field Portable X-Ray Fluorescence .................................................. 28
Multistage Reflectance Spectroscopic Analyses of Central German Lignite Overburden Dumps (First Results) ................................................. 49
Natural Acid Drainage Associated with Shale-Hosted Ag-Pb-Zn Massive Sulfide Deposits in the Brooks Range, Northern Alaska, USA .......................................................... 44
Natural Analogue for Bedrock Pollution: Environmental Impact of Ni-Cu-Zn-Rich Black Shales at Talvivaara in Finland .................................................. 56
Natural Arsenic In Triassic Sediments As Source Of Drinking Water Contamination In Bavaria, Germany ......................................................... 35
NEOCHEM - An Electrogrochemical Method for Environmental Applications .......................................................... 53
On Determination of Heavy Metal Fractions in Estuarine Sediments ..................................................................................... 59
Ore Fields, Deposits, and Zones of Deep Faults As Probable Geo-Pathogenic Biogeochemical Provinces and Belts .... 47
Organic Substances in Migratory Processes of Radionuclides ..................................................................................... 28
Organometal(loid) Species In Geochemical Exploration: Preliminary Qualitative Results .................................................. 36
Perched Water Zones in Arid Environments: Geochemical Constraints on Hydrological Modeling for High-Level Radioactive Waste Disposal ........................................................................ 91
Pesticide Adsorption onto Aquifer Sediments ..................................................................................... 73
Plant-Soil Relationships in the Serpentinite Screes of Mt. Prinzer, Northern Apennines, Italy ................................................................. 20
Pollution of Czech Freshwaters by Trace Elements ..................................................................................... 58
Pollution of Sediments, Soils, and Plants by Thallium ..................................................................................... 6
Possibility of Geological Disposal of CO₂: Results from Geochemical Modeling .......................................................... 97
Preservation of Arsenic Species in Natural Waters ..................................................................................... 33
Principles of Landscape Geochemical Map Composition and Landscape Geochemical Zonality of Aral Sea Rim ............................................................................. 83
Purifying Toxic Metal Contaminated Ground Water by Chitosan in Partially Converted Crab Shell ..................................................................................... 66
Quantification of Environmental Exposure Vectors by Geochemical Methods ..................................................................................... 37
Radiochemical Mapping in the Ignalina Nuclear Power Plant Region (Bottom Sediments and Soils) .................. 62
Radiometric Risk Mapping Using Existing Geoscience Data Sets ..................................................................................... 89
Reactions and Transport of Copper in Headwater Streams Receiving Acid Rock Drainage ................................................................. 6
Recent (1930's) Natural Acidification and Fish Kill in a Lake That Was an Important Food Source to the Population of Akulivik, Northern Quebec .................................................. 15
Recovery of Brown Trout (Salmo Trutta) and Brook Trout (Salvelinus Fontinalis) Populations in the Eagle River, Colorado, U.S.A., During and Following CERCLA Recovery Actions ..................................................................................... 97
Regression Methods in Bedrock Ground-Water Composition Estimation from Hydrogeological Parameters ..................................................................................... 56
Rehabilitation-Induced Vegetation Progression at a Gypsum Mine in Western Rajasthan—Analytical Approaches and Empirical Evidence ..................................................................................... 50
Relationship Between Alzheimer's Disease and Aluminum Speciation in Drinking Water: A Case-Control Study in Santiago, Chile St. Jean, Quebec, Canada .... 27
Remediation of High Fluoride Ground Waters from Arid Regions Using Heat-Treated Wastewater Column Experiment Study in Xinjiang, China ..................................................................................... 58
Resuspension Of Radionuclides In Belarus Soils Di From The Chernobyl Nuclear Power Plant .......... 3
Risk Assessment of Ecosystem Buffering to Acid In Russia ..................................................................................... 3
Risk Assessment Related to Metals: The Role of the Geochemist ..................................................................................... 3
Small Scale Spatial Relationships Between Geological Water Chemistry and Stream Sediment Chemistry Smallest Upland Catchments ........................................................................ 23
Soil Chemical Patterns Possibly Linked to Malaria Disease Among Rural Inhabitants in Northern Natal, South Africa ..................................................................................... 4
Soil Parameters as a Basis for the Assessment of Toxic Pollution ..................................................................................... 5
Soil Pb, Zn, and Cd in Metropolitan New Orleans—Geological Characterization and Association Solid Phase AAS - A New Old Technique: First Run with Environmental Material ..................................................................................... 4
Solubility of Heavy Metals in Relation to Geologic Context: A Theoretical Approach ..................................................................................... 4
Solubilization Of Heavy Metals (Cd, Ni, Pb) During Percolation Of The Chelating Agent EDTA Through Polluted Soils And Sediments ..................................................................................... 4
Some Approaches to the Biogeochemical Study of Nitrified River Ecosystems ..................................................................................... 4
Some Methods for Estimating Phytoavailable Cadmium In Prairie Soils ..................................................................................... 4
Some Peculiarities of Chemical Element Bioaccumulation in Different Environmental Samples ..................................................................................... 4
Source Attribution Of Lead Particles In Pre- And Post-Flooded Post-Lead Paint Abatement Interior Dust ..................................................................................... 4
Source Chemistry and Characteristics of Intermediate Waters Having Low pH and Elevated Metal Concentrations, Patagonia Mountains, Santa Cruz County, Arizona ..................................................................................... 4
Stable Isotope Characteristics of Waters Draining Sulfide Deposits in the Eastern United States Sulfate Adsorption Model for Predicting Soil Acidification Temporal and Spatial Variations in the Chemistry Derived from an Abandoned Metalliferous Mine Temporal Variability in the Geochemistry of Water Abandoned Coal Mines, County Durham, UK Temporal Variation in the Concentrations and Spectra of Metals in Peru Creek, Summit County, Colorado Temp OR Testifying Contaminant Mobility in Soils and Waste Textural Analyses and its Importance as Indicator Levels in Environmental Geochemistry ..................................................................................... 4
The "Kola Ecotoxichemistry" Project ..................................................................................... 4
The Application of Geochemical Data to Environmental Concerns in the Minas Gerais State, Brazil ..................................................................................... 4
The Application of Regional Geochemical Data in Environmental Study ..................................................................................... 4
The Behavior of Cd and Hg During Weathering of Environmental Implications ..................................................................................... 4
The Behavior of Rocket-Fuel Components in Soil in Kazakhstan and Alta Region in Russia ..................................................................................... 4
The Biogeochemistry of Sulfur in the Freshwater Ecosystems—Sources, Cycling, and Relation Mmechanism ..................................................................................... 4
The Combination of Some Heavy Metals With A Mixture of Fly Ashes from Two Polish Thermal Plants ..................................................................................... 4
The Development of a Biological Toxicity Based Test for Water Quality ................................................................. 21
The Distribution of Natural Radioelements in Ground Waters and Post-Cretaceous Sediments from the Southern Mediterranean Margin ................................................................. 84
The Effects of Glacial Dispersal and Glacial Process on Till Geochemistry, Labrador, Canada ........................................... 45
The Experience and Results of the Disposal of Liquid Radioactive Waste (LRW) on a Siberian Chemical Industrial Plant .................................................................................................. 84
The Influence of Mine-Drainage Formation on the Geochemical and Hydrogeological State of Environment in Estonia ........................................................................................................ 74
The Investigation of Redox Reactions and Adsorption of Chromium in Soils ........................................................................ 58
The Radioactive Mineral Encrustation on the Casings in the Oil-Producing Wells in the Dnieper-Donets Depression, Ukraine .................................................................................................... 83
The Response of the Interlayering of Clay Minerals to the Mobility of Aluminum in Acidified Podzols ........................................ 73
The Role of Environmental Geochemistry in the U.S. Geological Survey .................................................................................. 51
The South African Environmental Geochemistry ....................................................................................................................... 100
The Spatial Reliability of Geochemical Maps ............................................................................................................................ 64
The Use of Holocene Floodplain Sedimentary Sequences for Geochemical Mapping in the Yorkshire Ouse River Basin, UK .......................................................................................... 38
The Use of Sedimentation Field Flow Fractionation - Inductively Coupled Plasma Mass Spectrometry for the Chemical Characterization of Suspended Particulate Matter in Environmental Hydrologic Systems ................................................................. 90
The Use of Two Leaches in Environmental Geochemical Mapping to Assess Concentration Levels and Mobilities of Elements in Soils .............................................................................. 67
The Utilization of High Spectral Resolution Imagery and Field Spectra for the Detection and Monitoring of Mining Sites ........................................................................................................... 96
Three-Dimensional Nanocrystalline Networks Limit Limestone Drain Remediation: A Role for Environmental Mineralogy .................................................................................................................. 67
Towards a Contaminant Model for Port Jackson, Sydney's Main Estuary ......................................................................................... 11
Trace Element Distribution in Soils and Factors Affecting Metal Uptake By Plants in the Contaminated Floodplain of the Svisloch River, Belarus ......................................................................... 80
Trace Elements in the Kuskokwim River, Alaska ................................................................................................................................. 95
Trace Metal Adsorption onto Schwertmannite (Iron Oxyhydroxysulfate) in Acid Mine Drainage Systems ........................................... 96
Trace-Element Contamination in the Environment of Recife Metropolitan Area, Pernambuco, Brazil .............................................. 19
Unique Ground Water (Karst) Monitoring System as an Important Tool of Drinking Water Protection in Austria ............................................ 49
Unraveling the Degree and the History of Environmental Pollution Based on the Evaluation of Vertical Geochemical Profiles in Overbank Sediments ........................................................................... 88
Uptake of Trace Elements by Nutrient Plants from Soils Contaminated by Mining Activities in SW-Germany and North-Central Mexico ......................................................................................... 73
Uranium and Uranium Isotopes as Tracers of Nutrient Addition: A Case Study in South Florida .......................................................... 99
Uses of Chemical Speciation for Impact Evaluation and Remediation of Mining Waste ............................................................................. 56

Variable Geochemical Responses to Water-Rock Interactions at Two Undisturbed Zn-Pb Massive Sulfide Deposits, Bathurst Mining Camp, N.B., Canada ............................................................................ 53
Variations in Chemical and Bacterial Species of Acid Mine Drainage Affecting the Snow Fork Drainage Basin, Ohio—The Esco #40 Underground Mine ...................................................................... 69
Vehicle Related Emissions of Heavy Metals and Platinum Group Elements in the Urban Environment—Examples from Birmingham, UK .................................................................................................. 70
Weathering and Colloid Mobility as Factors Influencing the Migration of Radioactive Elements at Steenkampsraal Mine in the Northern Cape Province, South Africa ........................................................................... 28
What Is Background? A Statistical Approach, Introduced with Data for the Baltic Sea .......................................................................... 60
Zambian Copperbelt, Central Africa ......................................................................................................................................................... 100
Reactions and Transport of Copper in Headwater Streams Receiving Acid Rock Drainage

AMACHER, M.C., KOTUBY-AMACHER, J., and BROWN, R.W.
USDA, Forest Service, 860 North 1200 East, Logan, UT 84321, USA
Utah State University, Logan, UT, USA

Acid rock drainage (ARD) from Fisher Mountain near Cooke City, Montana has severely contaminated Fisher Creek, a headwater stream of the Clark's Fork of the Yellowstone River. The pH of Fisher Creek increases from 3.0 at the Glengarry Mine adit to near neutral about 4500 m downstream. Tributaries in the upper part of the watershed dilute ARD from the Glengarry Mine, but because they flow through acidic igneous rock, they have low alkalinity levels and do not increase stream pH. Tributaries in the lower part of the watershed flow through more calcareous rock and add sufficient alkalinity to increase the pH of Fisher Creek to near neutral levels. Ferrihydrite precipitates in the upper part of the stream but particulate ferrihydrite and ferrihydrite-coated sediment fines are transported downstream during periods of high flow resulting in a high iron oxide content of sediments along a 4500 m length of stream. Hydrologic mass balance calculations indicate that downstream decreases in Cu concentrations in the upper part of Fisher Creek result from dilution by tributaries. Further downstream as tributaries add some alkalinities and the pH increases to near neutral levels, decreases in Cu concentrations in Fisher Creek are the result of adsorption by ferrihydrite in streambed sediments. These decreases were predicted using the diffuse-layer adsorption model, a surface-complexation model included in the equilibrium chemical speciation computer program MINTEQA2. The Cu content of the ferrihydrite fraction of Fisher Creek sediment increased as pH increased over the stream reach where Cu adsorption was predicted to occur.

Temporal Variability in the Geochemistry of Waters from Abandoned Coal Mines. County Durham, UK

ANDER, E.L., THORNTON, E, FARAGO, M.E., and RICHARDS, D.G.

Environmental Geochemistry Research Group, Centre for Environmental Technology, Imperial College of Science, Technology & Medicine, Prince Consort Road, London, SW7 2BP, UK
RTZ Technical Services Ltd., PO Box 50, Castlemead, Lower Castle Street, Bristol, BS99 7RY, UK

The County Durham coalfield, NE England, has a long history of subsurface mining of Carboniferous coal. The recent closure of all remaining deep mines in this coalfield has raised the possibility that ground water withdrawal from mine water may be discontinued. Research into the hydrogeology of the coal measures by other workers has established that much of the rebounded ground water drains into the river Wear, a regionally important watercourse. Tributaries indirectly, via tributaries. The occurrence of pyrite oxidation products in flooded workings has been widely studied by many other researchers. Such ground water enters surface water via the precipitation of ochres and some reduction in the waters in the river Wear catchment may be expected. This study aims to assess the potential occurrence of dispersed forms, of which may be toxic to the tributary waters of the river Wear. Uncontrolled spoil heap drainages from previously abandoned the west of County Durham have provided eight example discharge and three downstream traverses. Samples undertaken at these sites on several occasions, in hydrological conditions, and was followed by multi analyses of water, suspended sediment and stream. The results have shown that there is much chemically clean deep mine and spoil heap issues. Terrestrial chemical variations of up to several orders of magnitude were observed at some sites a few of emergence and marked changes were also observed downstream hydrogeochemistry seasonally. There are such that they strongly alter the potential toxic waters and the nature of the minerals precipitating them. These differences have been attributed to hydrological behavior of the mine spoil heaps an mines and to seasonal effects.

Pollution of Sediments, Soils, and Plants by Thallium

ASAMI, Tetsuo, MIZUI, Chizuru, NOGAMI, Naoko, M, Masatsugu
School of Agriculture, Ibaraki Univ., Ami, Ibaraki 300

Thallium (Tl) is a highly toxic element. Pollution thought to be restricted to places such as non-ferrous mines, smelters, and factories using Tl. However, discovery of high-temperature superconductivity in the system Ti-Ca-Ba-Cu-O, has attracted great attention as a potential pollutant on a large scale in the future. Therefore, we established a method for Tl content in sediments, soil, and plants, and determined concentrations of Tl and other harmful metals in and soils of Japan. Effects of Tl on some crops studied.

Method of Tl determination: The determination of Tl in sediment and soil by FAAS, involving extraction of at least 1 g of sediment or soil by digestion with HClO4 followed by separation of extracted Tl into 5 ml isopropanol from HClO3 solution including 10 ml. The organic phase is determined by direct aspiration FAAS. The geometric mean range of 18 Japanese loam surface soils was 0.31 ± 0.10-0.56 mg kg⁻¹. MATSUKI, y., et al. Water Resour. Res. 42, 1503-1509 (2006).
Anexo 8
4th ISEG

FRIDAY OCTOBER 10, 1997

CLOSING GENERAL SESSION
“Conference Summary and a Look to the Future”

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<td>Geoffrey Plumlee</td>
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