May 2001

MEDICAL GEOLOGY NEWSLETTER

MEDICAL GEOLOGY - AN EMERGING DISCIPLINE Continued

Newsletter No. 3

- Report on Seminar in Uppsala, September, 2000
- The legacy of Mining in Jordan
- Medical Geology at the USGS
- Calcium Oxalate in Street Sediments

Participants at the Seminar on Health and the Geochemical Environment, Uppsala, Sweden, September 4 - 6, 2000

Inside this issue:

Special points of interest:

- *New book on Medical Geology (back cover).*
- *Second East and Southern Africa Regional Workshop in Geomedicine, Zambia, June 2001*

MESSAGE FROM THE CHAIRMAN

Many things have happened. since the last newsletter.

MEETINGS

IGCP meeting at the 31st International Geological Congress in August 2000 (Rio de Janeiro, Brazil) The scope of this meeting was to inform participants about Medical Geology, present the background, and to stimulate the involvement of participants from additional developing countries. This was achieved with the involvement of several new participants from Slovakia, Yugoslavia, India, Ethiopia, Russia, Ukraine, Mexico and Saudi Arabia.

Workshop and seminar in September 2000 (Uppsala, Sweden). The seminar was organised in cooperation with Catherine Skinner, Yale, USA and Tony Berger, Canada. The aim was to present the state of the art and recent scientific advances in medical geology, and to plan future activities. The meeting gathered some 50 people. Decisions were reached on publications including a book, flyers, webpage, and other informative material. Further information is given in the next article in this Newsletter and on the webpage.

WEBPAGE

The webpage has been progressively improved (http://home.swipnet.se/medicalgeology). The number of visitors is increasing steadily, to usually more than 400 visitors every month (about 20 visitors each working day). I have added a guest book and a discussion group to the site. I encourage everyone to enter the discussion group, although, so far it has not had many visitors. I am also constantly adding new conferences, new information etc. If you wish to publish anything on the webpage please let me know. I have had many contacts from members who want to share some information on the site, which I normally update weekly.

NEWSLETTER

We will try to publish the newsletter twice a year, but that will only be possible with your help in contributing short papers, general information etc. Please mail the editor of the newsletter (delliott@cadvision.com) with contributions

FLYER

An information flyer can be found and downloaded frim the webpage. Please feel free to give it to people interested. If you have any difficulties downloading it please mail me and I can send you copies of it.

MEMBERSHIP

The number of members is increasing steadily. At present we have about 120 active members and each month several new persons ask to become members.

BOOK

The book on medical geology is advancing and we are now identifying all authors. Not all members of the group can be authors, but if you wish to include references or particular information, just mail me. The book is planned to be published by Academic Press in 2003. For more information please see page 10 in this newsletter.

UPCOMING EVENTS

The next international activity will be in Zambia in June this year. In conjunction with the Second East and Southern Africa Regional Workshop in Geomedicine we will have a short course on Metal Ions and Health led by Jose Centeno, US Armed Forces of Pathology and Bob Finkelman, US Geological Survey. See information on the web page.

I wish you all the best and do not hesitate to contact me if you want more information.

Olle Selinus, Chairman

MEDICAL GEOLOGY - AN EMERGING DISCIPLINE

By A.R. Berger, O. Selinus and H.C.W. Skinner

A Report on a Seminar on Health and the Geochemical Environment, Uppsala, Sweden, September 4-6, 2000

If there was any doubt in the minds of the 40 or so earth and medical scientists who gathered in Uppsala last month that medical geology was emerging as a distinct discipline, it was soon dispelled. In a final declaration they agreed to join a medical geology network to share expertise and research in biology, biochemistry, geology and geochemistry related to health issues, with the overall aim of helping to create a better quality of life for people all around the world.

The seminar explored the continuum between the biogeochemical sciences by bringing together hydrologists, soil scientists, mineralogists, geochemists, geologists, geographers, physicians, dentists, pathologists, epidemiologists, veterinarians, plant physiologists and others. The discussions covered many aspects of the environment and climate that affect plant, animal and human populations locally, regionally and globally. Though study of the relationships between soil, water and rock chemistry and animal and human health goes back many years, and even to the very early days when the connection between salt and diet was first realized, current concerns and research progress are helping to re-establish the linkages between the earth and medical sciences. These build on an extensive knowledge base especially in geochemistry, including, for example, the work of the late Norwegian geologist J. Låg, who did much in his many books and papers to promote what he termed "geomedicine".

Ravi Naidu (CSIRO, Adelaide) began the first-day session on **"External pathways - geochemistry and geology"** with a broad overview of natural ("geogenic") contaminants and toxicity problems associated with the groundwater-soil-plant-animal-human continuum. He concentrated on the source, release and transfer of As and Se from native minerals to plants and humans via water and soil in South Asia. Colin Neal (Centre for Ecology and Hydrology, Wallingford, UK) gave a broad overview of large-scale patterns of air, water, and soil chemistry resulting from land use changes in Britain. He showed how industrial contaminants released over a century ago are still being dispersed by rivers today, and decried the general lack of monitoring of organic contaminants in surface and groundwater. A fascinating story of how Cu has been recycled between rocks, water and plants since the Precambrian was presented by Norrie Robbins (USGS, Reston) as "life in a copper province."

Pointing out that wildlife all over Africa have to survive on ancient (naturally degraded) soils commonly poor in nutrition, particularly where animals enclosed in parks and reserves cannot browse more widely, John Maskall (University of Plymouth, UK) described on-going studies to investigate this situation in Kenya. Levels of essential and toxic elements in animals living in rivers draining the Zambian copper belt were reported by Maxwell Mwase (University of Zambia), and Paula Cerruti (University of Capetown) described her initial studies on the effects of deficiencies in soil nutrients on joint disease and dwarfism in Maputoland.

In reviewing geophagy, the practice of eating clay or soil, Peter Abrahams (University of Wales), pointed out that in addition to obvious benefits (e.g., reduction of stomach acidity) there were also harmful effects including mineral deficiency, toxicity, and excessive tooth wear. Archaeological work on an ancient mining and smelting site in Jordan (John Grattan, University of Wales, see page 7) provides evidence of the absorption of copper in the skeletons of Byzantine metal workers, and the effect is felt even today as bioaccumulation of metals in local plants, people and animals. Other topics included were the effect on pneumoconiosis in Asia of the common and widespread dust storms (Edward Derbyshire, Royal Holloway University of London), and the mobilization of As and its tragic effect on health in the Bengal Delta (Prosun Bhattacharya, Royal Institute of Tech-

nology, Stockholm).

Extensive studies on the geochemistry of urban environments in the USA were reviewed by Howard Mielke (Xavier University of New Orleans), and in particular the effect on the health of children of Pb from paints, gasoline and, more recently, from tire wear. Eiliv Steinnes (Norwegian University of Science and Technology, Trondheim) discussed the biogeochemical cycling from sea to land of I and Se in southern Norway and showed how human influences might be distinguished from natural inputs such as those from atmospheric transport from coastal to inland areas. Gunnar Hillerdal (Uppsala University) discussed the effects of asbestos and other fibrous minerals on human health. Local problems in Greece were caused by the application of crushed tremolite used in household whitewash, and in Turkey inhabitants of cave dwellings dug in tuffs rich in fibrous and porous zeolites had high incidences of lung cancer.

Antony Berger (Victoria, BC) argued the importance of separating human from natural contributions to reduced health: the former can often be eased through effective policies and regulations, the latter not necessarily so. He suggested that medical geology may have an important role to play in re-conceptualizing the beneficial and harmful sides to the natural world.

The second day of the seminar, on **"Internal pathways - biochemistry and biology"** began with an overview of the biogeochemistry of bones and teeth by Catherine Skinner (Yale University). She reviewed the way in which specialized cells, enzymes and hormones record living conditions in the bones and teeth - rather like coral and tree growth rings. Considerable progress can be made using the kind of mineralogical approaches unfamiliar to medical doctors in investigating dentine and enamel, and minerals in bones such as apatite, hydroxyapatite and whitlockite. Likewise, Matt Pawlikowski (Academy of Mining, Cracow, Poland) summarized his extensive studies on mineralization of human blood vessels. He held out hope that a means could be found to dissolve these minerals, thereby clearing the circulatory system of some obstructions.

In his review of the connection between metals in the environment and the etiology of human diseases Jose Centeno (US Armed Forces Institute of Pathology, Washington DC) described the various internal pathways - absorption, ingestion, inhalation. Though most of the seminar focused on the harmful health effects of metals and ions, he reminded participants that some metals are essential, for example as catalysts in cellular functions or forming integral part of important enzymes.

Jane Plant (British Geological Survey, Nottingham) described her own fight with breast cancer and the startling conclusions from careful study of the relationship between cancer and environmental conditions especially in China and Japan. She presented much evidence for links between risk of breast and prostate cancer and the presence of long-lived endocrine-disrupting chemicals (EDCs) such as pesticides and dioxins. Her major published conclusion is that there is an especially strong link between EDCs and dairy and other products from animals fed with growth hormones.

Ulf Lindh (Centre for Metal Biology) reviewed the principles of metal biology, stressing the importance of organic chemistry. The pathways from the environment through food into the body are well illustrated by direct links between coal use and human health in China (Robert Finkelman, USGS, Reston). Here, some 3000 people have been severely poisoned through the consumption of chili peppers dried over fires burning high-As coal. More than 10 million people suffer dental and skeletal fluorosis due to eating corn dried over burning briquettes made from high F coals and high F clay binders.

GIS techniques applied to the study of ground radon shows that the risk of leukaemia in children is higher where radon exposure is higher (Owe Löfman,

Linköping University Hospital, Sweden)
Anders Lindvall (Centre for Metal Biology, Uppsala) related that the relatively high number of Swedes complaining about metal dental fillings seemed to reflect metal intolerance in those people. However, removal of dental amalgam did correlate in reduced Hg content of plasma and red blood cells. Calin Tatu (Country Hospital, Timisoara, Romania) described the search for causes of a kidney disease apparently restricted to Croatia, Serbia and Romania. Despite the spatial association with Pliocene lignite deposits being mined, there was still doubt as to the source of the toxins involved.

At the end of the seminar there was discussion about the name of this interdisciplinary field of research. Much work has already been done under the rubric of environmental geochemistry and environmental medicine, and the consensus was that the term "geomedicine" would not be accepted by the medical profession and that "medical geology" was a better term. The time was ripe now to push forward, with environmental concerns much in the public eye and in view of concern over large-scale issues such as the As poisoning in Bangladesh. It was pointed out that there was already some cooperation between geochemists, biologists and veterinary scientists, but that it was difficult to get the doctors to join. Clearly, it would be important to show medical practitioners how information from medical geology would benefit patients. Medical schools in Sweden are beginning to include environmental medicine as a standard component of the syllabus. An important tool in the search for connections between disease and rock/water/soil chemistry was regional geochemical mapping, and contributions to the IUGS Global Geochemical Mapping project were invited by its co-Chair, Jane Plant.

The seminar was co-sponsored and co-organized by Olle Selinus, Catherine Skinner and Antony Berger representing three overlapping activities. These are the IUGS Working Group on Medical Geology, directed by Olle Selinus of the Geological Survey of Sweden, IGCP Project 454 "Medical Geology" co-directed by Selinus and Peter Bobrowsky (Geological Survey of British Columbia), and the Unesco-ICSU-IUGS funded project "Paracelsus Revisited" lead by Catherine Skinner from Yale University and Antony Berger, Co-Director of the IUGS Geoindicator Initiative.

A series of short papers from the seminar are to be published in 2001 in the Special Paper series of the Geological Society of America. Researchers in the earth and other natural sciences, and in the health and social sciences, who are interested in contributing to the growing medical geology network are invited to contact Olle Selinus (olle.selinus@sgu.se) or Cathy Skinner (catherine.skinner@yale.edu).

REQUEST FOR NEWSLETTER CONTRIBUTIONS

Please send me material for publication in the Newsletter. Short articles, brief notes, accounts of conferences, announcements of upcoming conferences, or anything else of interest, would be welcome.

E-mail to: delliott@cadvision.com or by snail mail to Geosgil Consulting Ltd., 3507 Boulton Rd. NW, Calgary, AB T2L 1M5, CANADA

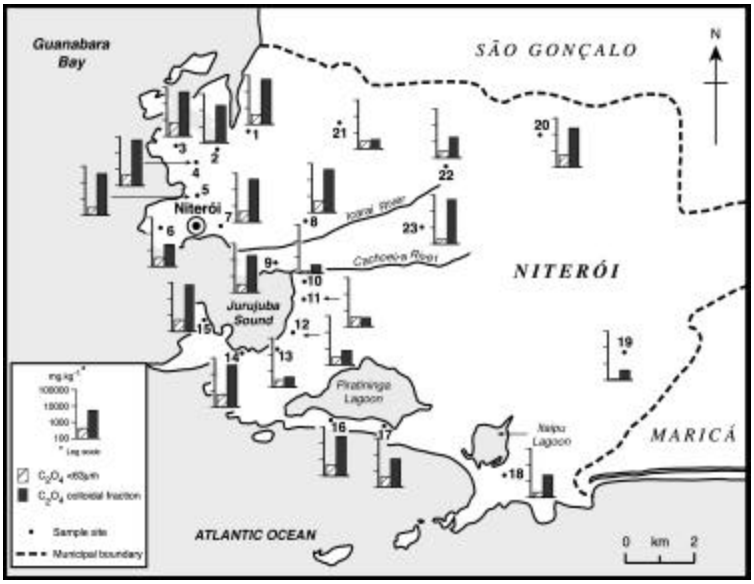
Dave Elliott, Newsletter Editor

THE PRESENCE OF CALCIUM OXALATE DIHYDRATE (WEDDELLITE) IN STREET SEDIMENTS FROM NITERÓI, BRAZIL AND ITS HEALTH IMPLICATIONS.

*John J. McAlister[*1] Bernard J. Smith[2] and Jose A. Baptista Neto[3]*

1,2 School of Geography, Queens University Belfast, Belfast, BT7 1NN, U.K.
3Departamento de Geologia/Lagemar, Universidade Federal Fluminense,Av. Litorânea s/n, 24210-310, Gragoatá, Niterói, R.J., Brazil. (e-mail: j.mcalister@qub.ac.uk)

Established research in First World urban environments has shown street sediments to be effective sinks for heavy metals and emphasises the health risks to children by its inhalation or ingestion. In Third World countries with fewer pollution controls, contamination may be augmented by additional pollutants such as sewage discharge into urban streets and/or periodic inundation with sewage-laden runoff. This pollutant not only contains heavy metals and organic matter, but calcium oxalates that may derive directly from the sewage its self. To study this premise, street sediments were collected from sites of varying industrialisation and sewage contamination within the city of Niteroi. Calcium oxalate dihydrate (weddellite) was identified by X-ray diffraction, Fourier transform infra red and scanning electron microscopy techniques and oxalate concentrations in <63µm and colloidal (clay and organic matter) fractions, were determined by ion chromatography. Oxalate in colloidal fractions averaged 43601mg kg^{-1} in sewage contaminated industrialised urban zones, 4519 mg kg^{-1} in suburban areas and 17477 mgkg^{-1} in suburbs with favelas (shanty towns). Oxalate concentrations coincide with high levels of metal ions (Fe, Mn, Zn, Pb, Ni, Cr) that stabilise calcium oxalate dihydrate and prevent its dehydration to the monohydrate (whewellite). Lower levels of oxalate were found in lichen-covered roof sediment, plaster and mortar samples. Oxalate concentration coincides with sewage contamination and street sediments appear to act as a sink for calcium oxalate dihydrate derived from sewage. Previous studies have shown that low levels of exposure can damage kidneys and the nervous system, while prolonged exposure can cause severe corneal, retinal and skin damage, cyanosis and possibly gangrene. Contact with blood serum may result in hypocalcemia, muscular stimulation, convulsions and finally collapse. The conditions described are common throughout urban areas of the developing world and may suggest a particular environmental hazard in these regions



AN IMPERIAL LEGACY? AN EXPLORATION OF THE ENVIRONMENTAL IMPACT OF ANCIENT METAL MINING AND SMELTING IN SOUTHERN JORDAN.

John Grattan[1], Brian Pyatt[2], Ziad al Saad[3], Lotus Adwany[3]

1. Institute of Geography and Earth Sciences, The University of Wales, Aberystwyth, SY23 3DB U.K. jpg@aber.ac.uk

2. Department of Life Sciences, Nottingham Trent University, Clifton Lane, Nottingham NG11 8NS, U.K.

3. The Institute of Archaeology and Anthropology, Yarmouk University, Irbid, Jordan

This project investigates the character and significance of the pollution legacy of ancient metallurgical activity in the desert landscapes of Wadi Faynan in southern Jordan and suggests that profound metaliferrous pollution has persisted and continued to influence the desert environment in southern Jordan for at least two millennia. Comparatively little geoarchaeological research has focused on the ancient and continuing environmental impacts of the ancient industrial activities in areas where these activities took place. This project addresses that imbalance through a study of the metal content of human skeletal material, plants, animals and sediments in the vicinity of one of the major mining and smelting centres of the ancient world, known today as Khirbet Faynan.

Studies of areas polluted during and after the Industrial Revolution worldwide show that metal pollution may affect all areas of agriculture and productivity. Inevitably metals absorbed by vegetation may pass up the trophic levels into livestock and ultimately into people with potentially serious consequences for health. The aim of this study was therefore to explore the extent to which ancient metal working activity continues to exert an influence upon the modern environment.

The Study Area

Khirbet Faynan, probably the ruins of the Roman city of Phaino, was a major centre of metal working activity in the ancient world. The sedimentary ore deposits at Faynan have been exploited since the seventh millennium BC with peaks of copper production in the Early Bronze Age, the Iron Age and the Roman period. From the Bronze Age and thence through the Iron Age, Nabatean, Roman and Byzantine periods, extensive mining and smelting

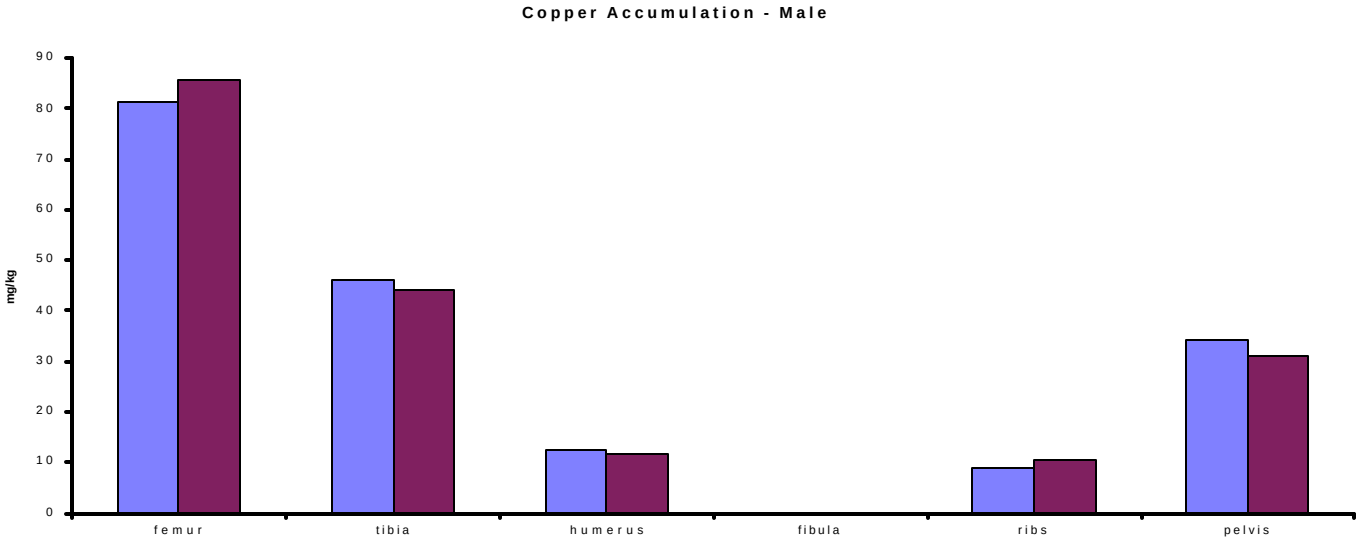


Figure 1 Cu Accumulation in Two Male Byzantine Copper Miners, Wadi Feinan

of copper (and perhaps lead), occurred here. The legacy of such extensive metallurgical enterprises remains today in the form of huge spoil tips containing 80 - 100 000 tons of slag, inevitably enriched in cations including copper and lead (Table 1). In close proximity to the ruins are over 250 copper mines, associated waste tips, and extensive slag heaps. In addition to this industrial archaeology the ruins are closely associated with a complex and extensive irrigated field system, which must have been designed to support the workforce in this remote area. Geochemical analyses of the sedimentary rock of the study area have yielded figures of 0.41 - 5.95% Cu and 0.01 - 0.1% Pb.

Preliminary results indicate bioaccumulation of metals in people plants and animals. Research continues to trace in detail the pollution pathways and their impacts in the past and in the present.

Table 1. Lead and copper contents (in mg/kg^{-1}) of goat skeletal material. Results derived from 24 samples

Sample	Pb	Cu
Molar	163	21
Lower mandible (symphysial end)	405	39
Lower mandible (articular/inner end)	366	65
Femur (middle)	192	25
Femur (upper region)	355	61
Tibia (lower portion)	223	45
Tibia (upper portion)	219	44
Hair	326	124
Faeces	590	143

Table 2: Accumulation of metals (in mg/kg^{-1}) in plants and in snails at the spoil tip and at the control site.

	Spoil tip		Control	
	Pb	Cu	Pb	Cu
Acacia				
Root	1025	406	124	196
Stem	325	196	54	109
Leaf	209	71	72	40
Urginea maritima				
Bulb	540	95	87	46
Gymnarrhena micrantha				
Roots	386	102	43	58
Leaves	248	96	40	60
Haloxylon salicornicum				
Roots	516	96	96	67
Stems	410	83	65	64
Ephedra alte				
Roots	578	603	94	100
Branches	309	520	82	89
Plantago coronopus				
Roots	622	243	51	57
Leaves	594	211	37	38
Asphodelus fistulosa				
Roots	485	126	36	64
Leaves	116	94	30	42
Snail *Theba pisana*				
Body Tissue	698	257	121	96

MEDICAL GEOLOGY ACTIVITIES AT THE U.S. GEOLOGICAL SURVEY

Bob Finkelman, USGS

Medical Geology is experiencing resurgence in the U.S. with one significant difference. This time the U.S. Geological Survey (USGS) is strongly supporting the effort. In previous years the interest and enthusiasm of individual scientists, primarily in the academic community, drove medical geology research in the U.S. However, during the past 3 years the USGS has accepted research on geologic materials and processes that affect human health as being an integral part of its mission and is encouraging USGS scientists to enter the field.

For example, the USGS has signed memoranda of understanding with the Armed Forces Institute of Pathology, the Environmental Protection Agency, the National Institute of Environmental Health Sciences, and the Centers for Disease Control and Prevention. The USGS is developing a funding initiative on environmental health for fiscal year 2003 and will soon brief Congress on this issue. A very substantial proportion of this year's Post Doctoral Fellowships has gone to applicants with biomedical or public health backgrounds. USGS scientists are currently engaged in research on the health impacts of toxic metals (As, Hg, F, Se, Al, Zn), dusts from Africa, vermiculite and coal mining, organic compounds, radionuclides, microbes and other pathogens, and the general issue of global climate change. USGS scientists have helped to organize workshops and symposia around the world on these and other health-related issues.

Most of these research projects are collaborations with biomedical researchers from federal, state, and county agencies, universities, and research hospitals in the U.S. and in other countries. Prominent among the other federal agencies that have joined with the USGS in promoting Medical Geology is the Armed Forces Institute of Pathology. Both agencies are convinced that Medical Geology will continue to grow and will be an visible and important part of their missions for years to come.

CONFERENCE NOTICES

Natural Ionizing Radiation and Health, International Symposium, The Norwegian Academy of Sciences and Letters. 5 - 6th June 2001, Oslo, Norway. See http://www.dnva.no for details.

International Conference on Environmental Toxicology of Metals and Metalloids. 1 - 5th July 20001, Great Barrier Reef, Australia. See website http://www.uq.edu.au/nrcet/metals2001

17th World Congress of Soil Science, 14—21 August, 2001, Bangkok, Thailand, includes a special symposium on Soils and Geomedicine. E-mail the convener Eiliv Steinnes (Eiliv.Steinnes@chembio.ntnu.no) or the coconvenor Suradej Jintakanont (agrsd@nontro.ku.ac.th) for details.

Arsenic in the Asia-Pacific Region Workshop. "Managing Arsenic for Our Future". 20 - 23rd November, 2001, Adelaide, South Australia. Organised by CSIRO, see website http://www.clw.csiro.au/conferences/arsenic/

The Emerging Discipline of Medical Geology, Geological Society of America annual meeting this November in Boston. For further information contact Dennis Goldman at dgoldman@geosociety.org

Bioavailability Workshop. 18 - 20th November 2001, Adelaide, South Australia. See http://www.csiro.au/conferences/bioavialability/ for details.

MEDICAL GEOLOGY

Earth Science in Support of Public Health Protection

A new book to be published in 2003

"Medical Geology" is defined as the science dealing with the relationship between natural geological factors and health problems in man and animals, and understanding the influence of ordinary environmental factors on the geographical distribution of such health problems. Medical Geology is therefore a broad and complicated subject which requires interdisciplinary contributions from different scientific fields if the problems are to be understood, mitigated or resolved. The International Working Group on Medical Geology has taken an initiative in publishing a book on Medical Geology. The book will be written by a very interdisciplinary team, geoscientists, medics, veterinarians, biologists, epidemiologists and pathologists. The book is planned to be published in 2003 by Academic Press, USA. Readers of *Medical Geology* will include undergraduate and graduate students, scientists and professionals in both geology and the health sciences, instructors and administrators at universities and observatories, and government and private agencies. The book will also be used as a reference book on the subject.

Overview of the chapters (responsible Associate Editors in blue):

Introduction, historical development

Section 1 (Background) Ulf Lindh

Geology, natural backgrounds, anthropogenic sources

Biology of the elements, Nutrition and diet, Biological responses

Section 2 (Pathways, exposures) Ron Fuge

Volcanic emissions

Water **Pauline Smedley**

Soils **Brian Alloway**

Animals and medical geology

Radon

Section 3 (Epidemiology, pathology) Jose Centeno

Epidemiology, Environmental medicine

Environmental pathology,

Environmental toxicology, Clinical assessment

Section 4 Bob Finkelman

Techniques and tools

Summary

Appendix (Reference values)

Editor in Chief

- Olle Selinus, Geological Survey of Sweden
olle.selinus@sgu.se

Associate editors:

- Ulf Lindh, Centre for Metal Biology, Sweden
ulf.lindh@bms.uu.se
- Ron Fuge, University of Aberystwyth, UK
rrf@aber.ac.uk
- Brian Alloway, University of Reading, UK
b.j.alloway@reading.ac.uk
- Pauline Smedley, British Geological Survey, UK
pls@bgs.ac.uk
- Jose Centeno, US Armed Forces of Pathology, USA
centeno@afip.osd.mil
- Bob Finkelman, USGS, USA

For additional information see http://home.swipnet.se/medicalgeology