The Medical Geology revolution—The evolution of an IUGS initiative

**Introduction**

In December 2001 Episodes published an article entitled “Medical Geology: New Relevance in the Earth Sciences” by Bow- man, Bohmowski, and Selinus. This paper was just one early example of the interest and excitement sparked by the emerging field of medical geology—the impacts of geologic materials and geologic processes on animal and human health. Medical geology attempts to bring together geoscientists and biomedical/ public health researchers to address a range of environmental health problems. Much of the impetus for the resurgence of interest in medical geology was a direct result of support and encouragement from the International Union of Geological Sciences (IUGS) and its former Commission on Geologic Sciences for Environmental Plan- ning (COGEOENVIRONMENT); this munificence will review the recent evolution of medical geology, from its initial inception as a COGEOENVIRONMENT Working Group to its current status as a global Association with thousands of proponents worldwide. We will also briefly speculate about the future of this exciting new field stimulated by the IUGS.

**A brief history**

Although geologic factors play key roles in a range of environmental health issues that impact the health and well-being of billions of people worldwide (Bowman et al., 2003), there is a general lack of under- standing of the importance of these factors on animal and human health amongst the general public, the biomedical public health community, and even within the geoscience community. The limited extent of interdisciplinary cooperation and communication among these areas has restricted the ability of scientists and public health workers to solve a range of complex environmental health problems. In response to this situation, in 1996 the IUGS commission COGEO- ENVIRONMENT established an International Working Group on Medical Geology led by Olle Selinus from the Geological Survey of Sweden (SGU). The primary aim of the Medical Geology Working Group was to increase the awareness of this issue among geoscientists, medical specialists, and the general public. Since the establishment of the COGEOENVIRONMENT Working Group in 1996, there has been a rapid development of this field. In October 1997 the Working Group met in Vale, Colorado, USA during the Fourth International Symposium on Geoinformatics and Geobiology. At this meeting the term “Medical Geology” was adopted by the participants as a descriptor for this environmental health sub- discipline. The next meeting of the Working Group took the form of a workshop in Upps- sala, Sweden in 1998. Discussions focused on the feasibility of preparing a new textbook on medical geology. In September 2000, about 50 people participated in a meeting and workshop again in Uppsala. A two-day sem- inar was held on medical geology “The Geo- chemical Environment and Human Health” resulting in a proceedings volume (Skinner and Berge, 2002). The workshop partici- pants discussed the future work of the group, newsletters, an internet home page, generat- ing other informational material, and publish- ing an interdisciplinary book on medical geology for a broad multidisciplinary audi- ence.

In 2000, the International Geologic Correlation Programme (IGCP) established a new project “IGCP 454 Medical Geology”. IGCP projects are jointly sponsored by UNESCO (United Nations Education, Science- and Cultural Organization) and IUGS. The IGCP 454 project was chaired by Olle Selinus with co-chairs Peter Bohmowski (Canada) and Ed Darbyshire (UK). The pri- mary aim of the IGCP project was to bring together scientists working in developing countries working on medical geology issues with their colleagues in other parts of the world. The project focused on capacity building, provid- ing training as well as exchange of informa- tion, research and laboratory experiences. This initiative provided, for the first time, the opportunity for scientists (geoscientists, physicians, geographers, veterinarians, etc.) from developing and developed countries to come together in a truly international and inter-disciplinary forum and to identify and tackle significant environmental health prob- lems.

In 2006 Ron Finkelman, a geoscientist then with the U.S. Geological Survey (USGS) and Jose Centeno, a chemical toxicologi- st with the U.S. Armed Forces Institute of Pathology (AFIP), joined the COGEO- ENVIRONMENT Working Group and the IGCP 454 project. Since 1996 Jose and Bob had been working independently on medical geologi- ng issues that paralleled and complemented the objectives of the IUGS working group. Their work on arsenic (Centeno et al., 2002) and lead, Zelenin et al., 2001, and Mortimer et al., 2006, examination of residential coal combustion (Belkis et al., 1977 and 2003, Wang et al., 2004), in China and Balkan endemic Nephropathy (Fedir et al., 1991), Otem et al.
The aim of the short courses is to share the most recent information on the relationship between toxic metal ions, trace elements, minerals, and their impact on the environment and public health issues. The scientific topics of the course include environmental toxicology, environmental pathology, geochemistry, geosystemic epidemiology, extent, patterns and consequences of exposure to toxic metal ions, and analyses of geologic and biologic materials. The courses, generally 2 to 3 days in length, are intended for anyone interested in the effects of natural materials and natural geological events on animal and human health. An important objective of the courses is to provide an opportunity for forming contacts and networks between professionals working in different countries and in different aspects of environmental health issues.

We have produced a 300-page syllabus and a CD containing the lecture materials used in the short course as well as supplementary material such as reprints of relevant articles for participants to use in their regions and on their respective disciplines. The use of the course material by participants to conduct their own regional courses in medical geology is highly encouraged (Figure 3).

Medical Geology—A global affair

One of the first activities of the IUGS Medical Geology Working Group was to establish and maintain communications with an audience dispersed throughout the world, many scientists in developing countries with limited access to communication capabilities. The Working Group established a Medical Geology web site (http://www.medicalgeol.org). This website is regularly updated and is a key source of information on the subject. The Working Group also produces a newsletter twice a year edited by Dave Elliott, from Canada. The newsletter is distributed to all members of the working group. Currently, all issues of the newsletter can be accessed by visiting the Medical Geology web site.

Nearly 1,000 people signed up as corresponding members of the Medical Geology Working Group from more than 90 countries around the globe.

Publications

Information and news on the working group has been published in different journals. The November, 2001 issue of Geotimes featured the growing area of Geosciences and Human Health and contained several articles authored by members of the IUGS Medical Geology Working Group (Finkelstein et al. 2001).

Several papers and special journal issues have also been published, drawing national and international attention to medical geology. Some key examples of these publications are:

- Environmental Medicine, a book published in 2000 at the Karolinska Institute, Uppsala, Sweden. One chapter is on Medical Geology. This book is now used for courses for medical students at the Karolinska Institute and elsewhere (Selimus, Frank 1999).
- A paper was published in 1999 on medical geology in tropical countries (Dranzakaye, Chandrakjha 1999).

Medical Geology
Short Course Syllabus CD

Figure 3 Frontpage of a short course syllabus CD.

Figure 2 Short course in Egypt.

The following short courses have been carried out partially or fully funded by the IUGS and the ICSU grant:

<table>
<thead>
<tr>
<th>Year</th>
<th>Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>Zambia, South Africa</td>
</tr>
<tr>
<td>2002</td>
<td>Chile, Russia, Peru, Japan, China</td>
</tr>
<tr>
<td>2003</td>
<td>Lithuania, Great Britain, Uruguay, Brazil, Australia, Malaysia</td>
</tr>
<tr>
<td>2004</td>
<td>South Africa, Mozambique, Hungary, Canada, Australia, India</td>
</tr>
<tr>
<td>2005</td>
<td>Romania, Brazil, Uruguay, Argentina, USA, Ireland, Puerto Rico, Turkey, Egypt, Sweden</td>
</tr>
<tr>
<td>2006</td>
<td>Portugal, USA, China</td>
</tr>
<tr>
<td>2007</td>
<td>Mexico, Brazil</td>
</tr>
</tbody>
</table>

Requests for courses
Jamaica, Kenya, Norway, Taiwan, Nigeria, Ghana, Pakistan, India, Spain, Russia, Poland, Thailand, Iraq, Iran, Israel, Indonesia, Mexico, Trinidad & Tobago, Haiti, Cyprus, England, Turkey, Bangladesh

December 2007

For the first time there was a paper on medical geology in Scientific American. This was published in January 2002, covering the health effects of coal burning. Bob Finkel- man was active in this.

Recently, two books on Medical Geol- ogy have been published, one from India (Workshop on Medical Geology, 2004) and the other from Brazil (Roberto da Silva et al., 2006). They are based on medical geological meetings in these countries and cover all aspects of medical geology in South America and the Indian subcontinent.

Symposia and congresses

The working group and GCG project has been involved in promoting medical geology at meetings around the world by organizing and/or sponsoring special ses- sions of symposia on medical geology. The working group has also provided financial support for students and professionals for developing countries to participate in scient- ific and public health events. The following list contains a few selected examples of the sponsored sym- posia (for a complete list see the Medical Geology web site at http://www.medicalge- ology.org).

- 2000 The International Geological Con- gress, Rio de Janeiro. A symposium on Geoscience and Health was organized in cooperation with the Brazilian Geologists. We also held a meeting of the Working Group and GCG 454.
- 2001 Geological Society of America, Boston, Paide Symposium on "The Emerging Disciplines of Medical Geol- ogy".
- 2002 Washington DC: Healthy Ecosys- tems—Healthy people. Linkages between biodiversity, ecosystem health and human health was organized to collaboration with the National Academy of Sciences.
- 2002 we presented the project at the XXIV International Congress of the International Academy of Pathology. A special sympo- sium on environmental pathology/medical geology was organized. This was a very important meeting since this was the first time medical geology had been presented for this large audience of medical and health professionals.
- 2002 FogSOG meeting in Helsinki. This was a great assembly meeting for all director generals for all geological surveys in Europe (about 40 countries participates). Medical Geology was introduced and dis- cussed among this group of director gener-
- 2002 Quebec, ISTERL, Indstitutional Society for Travel Elements in Humans.
- 2002 IUGS International Symposium on geopatrolisation and medical geology, Tokyo, Japan.
- 2002 we received a special invitation from the Royal Norwegian Academy of Sci- ences to present a lecture on medical geol- ogy.
- 2002 GSA symposium on Human Health Science & Geoscience: Bridging the Gap, Boston.
- 2003 Ankar, Turkey, Congress on Med- ical Geology and Cancer.
- 2003 A special symposium on medical geology was organized at the 7th Interna- tional conference on biochemistry of trace metals in Sweden.
- 2003 by Edinburgh, at the Sixth Inter- national Symposium on Environmental Geo- chemistry, there was an official meeting, a short course and special sessions on medical geology.
- 2004 The sixth International Conference on Asbestos Exposure and Health Effects, San Diego, USA.
- 2004 XXV Congress of the International Academy of Pathology, Brisbane, Aus- tralia.
- First Henippicshire Conference on Medical Geology, University of Turku in Gaurabo, PuertoRico.

In addition, Working Group members have been invited to talk about Medical Geology at numerous universities, colleges, research hospitals, science clubs, etc. in more than 30 countries.

Medical geology—global impacts

The activities of the IUGS Medical Geology Working Group has had, and will continue to have, profound impacts around the world. The following items are just some of the outcomes from this initiative.

UN Year of Planet Earth

The International Year will be pro- claimed through the United Nations, and has been adopted by the UNESCO Division of Earth Sciences as one of its core activities.

Figure 4 Earth and Health, one of the topics of International Year of Planet Earth.

The aim of the International Year of Planet Earth is to demonstrate new and exciting ways in which Earth sciences can help future generations meet the challenges involved in ensuring a safer and more pros- perous world (www.yearearthplanetforlife.org).

The achievement of this goal will be supported by two major programs:

- Outreach/Promotion including educa- tional ventures at all levels.
- Science Programme concentrating on "big issues" of complex interactions within the Earth system and its long-term sustain- ability.

The initiative will seek to raise the awareness of the contribution to, and role of the Earth sciences in society in the minds of politicians, decision-makers, the media and the general public. One of the topics will be "Earth and Health", that is medical geology (Figure 4).

Interdisciplinarity Book on Medical Geology

A book on Medical Geology has been published by Elsevier (Academic Press) in 2003 (Sedgley et al. 2003). O. Selimus is chief editor and there are 8 associate editors: Brian Alloway, June Centeno and Bob Finkelman, Ron Foxe, Ulf Lindh, and Pauline Smith. There are almost 60 distinguished authors from all around the world. About 50% are geoscientists and about 50% are medicine, environ- ment and earth scientists. The book con- tains more than 800 pages with illustrations in full color. The audience of the book will be teachers and undergraduate and gradu- ate document-makers. The main objective is to emphasize the importance of geology in health and disease in humans and animals (Figure 5).

Essentials of Medical Geology was at November 2005 recognized as a "Highly Cited" title in the Public Health cate- gory by the British Medical Association. As many likely know, this is a very prestigious acknowledgment. The book is one of the best of all published books in Public Health in 2005. They bestow awards upon publications which are deemed to best fulfill the criteria of clinical accuracy and currency and which

Figure 4 Earth and Health, one of the topics of International Year of Planet Earth.
Figure 5 Essentials of Medical Geology.

maintain a high standard of design and production*.

Essentials of Medical Geology was also won a second prestigious award in January 2006.

It was one of two winners in the "Geology Geography" category of the 2005 Awards for Excellence in Professional and Scholarly Publishing. The PSP awards recognize both editorial standards as well as design and production standards. PSP is the Professional Scholar Publishing division of the Association of American Publishers. The book has now been recognized in both communities for which it was intended (first by the British Medical Association, and then as a Geology resource).

A third award by Choice was won in 2007. Every year Choice publishes a list of Outstanding Academic Titles that were reviewed during the previous calendar year. This prestigious list reflects the best in scholarly titles reviewed by Choice and includes in the extraordinary recognition of the academic library community. The list was known as Outstanding Academic Books until 2000.

Medical Geography Region

The Armed Forces Institute of Pathology (AFIP), Washington DC, 15A, has established a registry on medical geology. The Registry on Medical Geology serves as a liaison between the medical/pathology community and the earth sciences, environmental and public health professionals. The aims of the Registry on Medical Geology are:

1. To facilitate the interactions between the medical/public health community and the earth sciences, environmental and public health professionals.

2. To provide a centralized facility for the sharing of information, materials and research projects on medical geology.

3. To provide opportunities for training (i.e., postdoctoral, postgraduate, visiting scientist, professor, etc.) on medical research with particular emphasis on medical geology, environmental and environmental epidemiology research; and

4. To develop educational materials, publications and activities including workshops, symposia, conferences on medical geology research topics.

The Medical Geography Region supports the International Medical Geology Association by providing information on environmental risk factors including dust composition, toxic elements, and background data. The studies conducted at this Registry use the capabilities of the AFIP on archival identification, and relevant pathologic, toxicologic and epidemiologic investigations.

The National Museum of Health and Medicine in Washington, DC, has also unveiled at exhibit highlighting the developing science of medical geology used by its organization, the AFIP, to study health problems associated with arsenic. The exhibit will run indefinitely.

U.S. National Research Council on "Earth Materials and Health"

A key report entitled "Earth Materials and Health - Research Priorities for Earth Sciences and Public Health" was recently released by the U.S. National Research Council (NRC). Working in close collaboration with several environmental, public health and geosciences organizations, the U.S. NRC was asked to undertake a study to explore avenues for interdisciplinary research that would further knowledge at the interface between the earth sciences and public health disciplines (i.e., medical geology). To fulfill this task, the NRC set up a study committee composed of geoscientists, toxicologists, epidemiologists, and public health professionals. The committee was charged with the task of advising on the high priority research activities that should be undertaken for optimum societal benefit, describing the most profitable areas of communication and collaboration between the earth sciences and public health communities. On its final report, the NRC study committee was asked to:

- Describe the present state of knowledge in the emerging field of medical geology.
- Describe the connections between earth science and public health, addressing both positive and negative societal impacts over the full range from large-scale interactions to micro-scale biogeochemical processes.
- Evaluate the need for specific support for research in medical geology and identify any basic research needs in bioscience and geoscience required to support medical geology research.
- Identify mechanisms for enhanced collaboration between the earth science and medical/public health communities.
- Suggest how future efforts should be directed to address the need to respond to public health needs and threats, particularly as a consequence of environmental change.

New, Division For Geology and Health at the Geological Society of America

At the Fall, 2004 annual meeting of the Geological Society of America (GSA), the GSA's Board of Directors approved the creation of a new Division dedicated to medical geology. More than 100 people signed the petition requesting the creation of the Geology and Health Division. The Division's activities were evident at the 2006 GSA annual meeting where it sponsored two symposia and technical sessions.

Medical geology is an exciting interdisciplinary field that, thanks to the critical support of the EUSSG will continue to grow rapidly. Several geological surveys are integrating medical geology in their work and medical geology materials is now included in university courses and research for medical and public health students. In the future it will be important to improve communication among the various disciplines concerned with diseases caused by geological factors which influence the well being of humans and animals. To advance interdisciplinary research at the interface of public health and environmental health, it is important to facilitate the formation of a consortium of government, industry and academia working together towards the creation of funding opportunities in medical geology. Geological surveys, universities and geological societies should take a more active role in providing useful information on geologic conditions in medical geology and encourage the development of a working group of multidisciplinary medical geology experts. It would be most useful for interdisciplinary research in the area of producing more effective methodologies for the study of geological factors in environmental medicine and formulate recommendations for mitigation of effects of natural and man-induced hazards geohazard conditions. Finally, for medical geology to be widely accepted, it is also of extreme importance to develop public outreach programs, conferences, and technical exhibits aimed at enhancing community involvement and dialogue, improving risk communication concepts to better inform the public about ways to proactively prevent public health crises.

Figure 6 International Medical Geology Association, I.M.G.A.

December 2007

*For detailed information, please refer to the original source.
International Medical Geology Association (IMGA)

Our organisation has now reached the stage of development in which a formal structure is necessary for it to function effici-
ently (Finkelman et al. 2004) as a result of the work to date, in International Medical Geology Association, perio-

The structure will enable us to better respond to the opportunities, to rapidly pass information to those interested in Medical Geology Issues, and to make criti-
ical decisions that will benefit the discipline. The name adopted for this new Association is "International Medical Geology Associa-
tion" (IMGA). The Dissociation of the associa-
tion is: Ole Selinus (Geochimie, Sweden), Bob Finkelman (Geology, USA), and Jose Contero (Biomedical Research scientist, USA). David Elliott continues his work as president of the book. Secretary is Kim-
berley Chisholm in Australia and treasurer is David Stanley in New Zealand. We have appointed six Councils to represent the broad geographic distribution of the Medical Geology and the wide range of disciplines that are embarked by this topic. The Counci-
lors are: Bernhard Röhrs, Dieter Ginter (Geologists, Brazil), Nina Fjordly (Ge-
chemist, UK), Zheng Boshan (Geochimie, China), Colin Tait (Medical researcher, Ireland), and Michael Wilmot (Veterinary Bio-
chemist, South Africa). The association will be the umbrella for regional divisions around the world. These divisions include South America, Sub-Saharan Africa, Indian subcontinent, two subdivisions covering Central and South America, Australia, Asia, Russia, and USA. North America, Europe, South-Eastern Mediterranean and Central America and Caribbean Basin.

The Future

It is always risky to anticipate the future. Nevertheless, we are confident that the future of medical geology is still prom-
ising, notwithstanding the already rapid growth of the sub-discipline. The book, Essentials of Medical Geology, has received an overwhelmingly positive response. This can be seen by the fact that the pri-
mary source of information on the subject, being translated now into Chinese. The book has been very popular and the first printing has nearly sold out in less than two years. We anticipate that the book will stimu-
late the teaching and research practice of medical geology in colleges and universities. The medical geology course should con-
tinue to attract enthusiastic adherents and practitioners of medical geology. The Interna-
tional Medical Geology Association will continue to provide a stable platform for the exchange of ideas and dissemination of information. Theraft of other medical geology ac-
tivities enumerated above will continue to stimulate enthusiasm and momentum for the next few years. After that medical
geologists will have to demonstrate that what we have to offer will indeed benefit society by helping to improve the quality of life for people around the world.

References

chemistry and Mineralogy of Arsenic in Miner-
alized Caves from Endemic Arsenicism in Guangdong Province, P.R. China. Proceedings of the Fourth Annual International Pittsburgh Coal Conference and Workshop. CD-ROM P-120.

007. Updated.


Easterbrook, M. J. 2003. Geology and Health. British Geolog-

Easterbrook, M. J. 2003. Geology and Health. British Geolog-

Easterbrook, M. J. 2003. Geology and Health. British Geolog-

Easterbrook, M. J. 2003. Geology and Health. British Geolog-

Easterbrook, M. J. 2003. Geology and Health. British Geolog-

Easterbrook, M. J. 2003. Geology and Health. British Geolog-

Easterbrook, M. J. 2003. Geology and Health. British Geolog-

Easterbrook, M. J. 2003. Geology and Health. British Geolog-

Easterbrook, M. J. 2003. Geology and Health. British Geolog-

Easterbrook, M. J. 2003. Geology and Health. British Geolog-