

# Medical Geology: the emergence of a new discipline

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## Introduction

The earth (terra firma) sustains all living things but the Earth (the natural environment) sometimes extracts a steep price for its generosity by causing or contributing to serious and locally widespread health problems. This is the domain of Medical Geology - the impact of geological materials and processes on animal and human health. Few years ago *Terræ* published an article by Olle Selinus entitled *Medical Geology: an emerging specialty*. In that article Selinus gave an historical perspective of Medical Geology and provided several examples of how the natural environment impacts the health of hundreds of millions of people. He concluded with a description of Medical Geology activity in 2002 and a perceptive look into the future of Medical Geology. In the short time since that article appeared the specialty of Medical Geology has indeed emerged. As Selinus pointed out, Medical Geology is not a new field of study, so one may say that it has been experiencing a renaissance. In these years since the *Terræ* article appeared, numerous other journal articles as well as technical sessions and symposia at scientific meetings have helped to focus attention on the health problems caused by geological materials such as exposure to toxic elements including arsenic, mercury, lead, fluorine, selenium and uranium; hazardous minerals such as asbestos, quartz and pyrite; and geologic processes such as earthquakes and volcanic eruptions. There has also been a surge in collaboration between

geoscientists and biomedical/public health researchers addressing environmental health issues in every corner of the earth. Some of these collaborations have identified previously unknown health problems; other collaborations have resulted in potential solutions to severe problems that affect the health of many millions of people.

Concern about natural environmental health issues, or what we are calling Medical Geology, did not emerge for the first time in the past decade. Awareness of the beneficial health effects of rocks and minerals may have occurred more than two million years ago. Abrahams (2005) cites the discovery of powdered clays at a *homo habilis* site in Africa that is about two million years old. The most logical explanation for this discovery is that these early hominids used the powdered clays to aid in digestion or as a treatment for upset stomachs – the same uses that these clays are put to today! For eons primitive tribes throughout the world have used various types of clays for nutritional and therapeutic purposes (Price 2004) and written records of medicinal use of rocks and minerals date back more than 2,000 years in China, India, Egypt, Africa, Mesopotamia, and elsewhere. Undoubtedly, the deleterious effects of rocks, minerals, dust, and some natural water were also recognized in ancient times.

### Why is Medical Geology experiencing a renaissance at this time?

There is no simple answer to this question. Certainly, for the past several decades there has been a growing awareness of environmental health issues. More and more people in developed and developing countries have been becoming aware of the potential health impacts of environmental pollution. By and large these concerns used to be focused on industrial contamination – the pollution spewing into our environment from irresponsible businesses and organizations. However, there has long been a small but active group of researchers who have recognized that natural materials and processes could be as dangerous as the pollution from anthropogenic materials and processes. Perhaps the success in improving air and water quality in many developed countries has given us confidence that we can now tackle nature and mitigate or eliminate the environmental health issues caused by natural materials.

### Why do we think that Medical Geology will be more successful now than it has been in the past?

There are several reasons that justify confidence in the sustainability of Medical Geology.

- **Organizational support** – National and multinational organizations are now taking an active interest in Medical Geology in contrast to the largely individual interest driven activities of past decades. Since 1998 funding for Medical Geology activities has come from the International Union of Geological Sciences, the International Commission of Scientific Unions, UNESCO, the U.S. Geological Survey, the Geological Survey of Sweden, the U.S. Armed Forces Institute of Pathology, National Institute of Health, etc. Under the aegis of the International Commission of Scientific Unions, five geoscience unions (geology, geography, soils, geophysics and remote sensing) have jointly identified Medical Geology as one of five topics for future collaboration. The U.S. Congress has recently allocated funds to establish a Medical Geology research center in China. The ultimate example of an organizational support may be the United Nation's proclamation in December 2005 of "The International Year of Planet Earth". The aim of the International Year of Planet Earth will be to demonstrate new and exciting ways in which Earth Sciences can help future generations meet the challenges involved in ensuring a safer and more prosperous world. The initiative will seek to raise the awareness of the contribution and role of Earth Sciences in society in the minds of politicians, decision-makers, the media and the general public. A significant component of this important initiative will be promoting awareness, providing education and supporting research on a Medical Geology theme referred to as Earth and Health.
- **Multidisciplinary interest** – Biomedical/public health organizations have demonstrated interest equal to that of the geoscience community. In the United States several federal agencies such as the National Institute of Health, Centers for Disease Control and Prevention, Environmental Protection Agency, Department of Defense, Department of State, World Health Organization, etc. are engaged in various aspects of Medical Geology. In addition, universities,

medical schools, research hospitals and bio-medical professional organizations in the U.S. and many other countries have shown interest in this field as have chemists, engineers, environmentalists, geographers, etc.

- **Global recognition** – Interest in Medical Geology has been demonstrated in virtually every country. During the past few years scientific organizations in Argentina, Australia, Brazil, Canada, China, Chile, Egypt, Great Britain, India, Ireland, Hungary, Japan, Lithuania, Malaysia, Mexico, Monaco, New Zealand, Romania, Russia, South Africa, Sweden, Turkey, U.S., Uruguay, Venezuela, and Zambia have sponsored one or more short courses in Medical Geology. In many of these countries multiple organizations have sponsored the courses and many of these organizations have provided financial or logistical support to ensure their success. Similar courses have been requested by organizations in Cyprus, Nigeria, Portugal, Italy, Kenya, Tanzania, Pakistan, Thailand, Taiwan, and Indonesia. Organizations and individuals around the world are taking initiatives to develop Medical Geology programs and activities. This is particularly apparent in Brazil, Turkey, Australia, Canada, East and South Africa, and Russia.

### What has stimulated these changes in attitude and awareness of Medical Geology?

We believe that the internet has played a major role in the resurgence of Medical Geology. The internet has provided the ability to instantly disseminate information throughout the world. Graphic color images, announcement of upcoming conferences and new books, publication of research reports, etc. are now within reach for every person concerned with these issues even in the most remote parts of the planet. These are commonly the places where these environmental health problems are most evident and most severe. An indication of the power of the internet and the rapid growth of Medical Geology can be gleaned from the number of Medical Geology ‘hits.’ As of January 1, 2006 ‘Medical Geology’ produced more than 20,000 hits on the Google search engine and almost 12,000 hits on Yahoo, where just a few years ago the hits were measured in the hundreds.



**Figure 1** – Hyperkeratosis caused by exposure to arsenic mobilized by burning arsenic-rich coal in a residential environment in China. Photograph by Zheng Baoshan

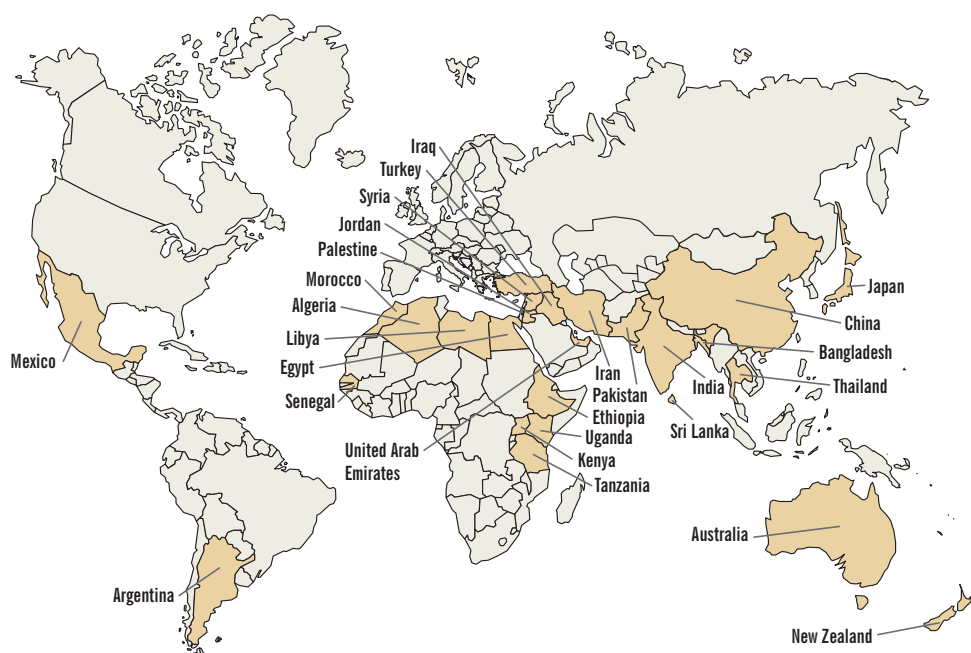
Internet images such as those depicted in Figure 1 illustrating the plight of Chinese villagers suffering from exposure to high levels of arsenic and fluorine have been effectively used to convince managers, politicians, and other decision makers that these environmental health problems are severe, widespread, and that tools are available to help solve them. Maps such as Figure 2 have been appearing that convincingly show that many of these problems are not just local but are truly global in scope.

Is it simply ironic that interest in Medical Geology is growing just as there are strong pressures on geoscience organizations worldwide to downsize? We don't think so. One of the major justifications given for the pressures on geoscience is that decision makers question its relevance to current societal issues. This may or may not be true but everyone agrees that in Medical Geology geoscientists can make immediate, meaningful contributions to society.

### What has been accomplished?

The following list provides a sampling of what has been accomplished in Medical Geology during the first few years of this decade.

- A new organization has formed to serve those interested in Medical Geology. The International Medical Geology Association (IMGA) was launched in Florence in 2004 at 32<sup>nd</sup> International Geologic Congress. It has attracted nearly 1,000 corresponding members from about 70 countries. A Constitution and By-laws for the IMGA has been developed and submitted to the members for ratification. In the interim, several committees and working groups have been empanelled and are functioning. Regional



**Figure 2** – Countries with endemic fluorosis due to excess fluoride in drinking water

Divisions are being formed in South America, Southern Mediterranean, Asian Subcontinent, Sub-Saharan Africa, North America, etc. A dynamic website ([www.medicalgeology.org](http://www.medicalgeology.org)) contains information on current activities in Medical Geology. Current and past issues of the organizational newsletter can be downloaded from the site.

- Other national and international organizations have created committees or divisions dedicated to Medical Geology. The latest is the Geological Society of America, which, at its annual meeting in the Fall of 2005, created the Geology and Health Division.
- Several books on Medical Geology have been published in the past few years. In 2002 Catherine Skinner and Tony Berger published *Geology and Health*, the proceedings of a Medical Geology conference that was held a few years earlier in Uppsala, Sweden. In 2005 Elsevier published *Essentials of Medical Geology* edited by Olle Selinus and six associate editors: Brian Alloway, Jose Centeno, Bob Finkelman, Ron Fuge, Ulf Lindh and Pauline Smedley. There are nearly 60 distinguished authors from all around the world. About 50% are geoscientists and about 50% are medical professionals, veterinarians and other scientists. The book contains more than 800 pages with illustrations
- in full color. The book received recognition from the British Medical Association as a major contribution to public health. Elsevier had also published a book on Medical Geology by M. Komatina, 2004. During this period there has been an upsurge in the number of papers on Medical Geology issues appearing in scientific and technical journals. Several examples of these articles are listed in the references.
- During the past five years there have been at least six technical sessions and symposia devoted to Medical Geology at annual meeting and regional meetings of the Geological Society of America and dozens of similar sessions at local, regional, and international meetings around the world. The USGS has also sponsored several conferences devoted to Medical Geology issues. The proceedings of one of the conferences were published as a USGS Open-File Report (2003). Medical organizations such as the Armed Forces Institute of Pathology, the International Academy of Pathology, and the USA Force Health Protection Conference have incorporated sessions on Medical Geology. The prestigious Royal Swedish Academy of Sciences is sponsoring a large Medical Geology symposium in Stockholm in May, 2006.
- A series of popular short courses on Medical Geology has been presented to more than 2,000

people in about 25 countries. Funding for the courses has been provided by the International Commission of Scientific Unions, the International Union of Geologic Societies, COGEO-ENVIRONMENT, the USGS, AFIP, SGU, and the host countries. The aim of the short courses is to share the most recent information on the relationship between toxic metal ions, trace elements, minerals, etc. and their impact on the environmental and public health issues.

- Colleges and universities in several countries (Sweden, Egypt, U.S.) have begun to offer credit courses in Medical Geology. Students in many countries have expressed interest in attending such courses and even in majoring in Medical Geology. Scores of graduate students in many countries are currently researching a wide range of Medical Geology issues and students are studying Medical Geology issues for masters and doctorates in Turkey, Sweden, the U.S., Russia, China and elsewhere. Research Fellowships in Medical Geology have been offered by the U.S. Armed Forces Institute of Pathology, the U.S. Geological Survey and the U.S. Department of State.
- The UN has recently proclaimed the International Year of Planet Earth. The UNESCO Division of Earth Sciences has already adopted the concept as one of its core activities. 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 prosperous world. A major component of the Year of Planet Earth will be an initiative to raise the awareness of the effect that the Earth's materials have on human and animal health.
- The U.S. Geological Survey, the U.S. Armed Forces Institute of Pathology, Western Kentucky University, and several other U. S. organizations in collaboration with Chinese counterparts have proposed the creation of a research center in China that will seek practical solutions to a range of Medical Geology issues. The proposal has been included in the U.S. Federal Government budget and it is anticipated that the U.S. Agency for International Development will begin funding the Center in 2006. The Center will focus on health and environmental issues related to karst region water quality and coal use by funding collaborative research projects

and providing training in China and in the U.S. By focusing on training and research the Center will not only try to resolve Medical Geology problems but will work to create a system enabling scientists in China to better deal with such issues in the future.

- The Armed Forces Institute of Pathology has created a Medical Geology Registry that contains information, diagnoses, tissue and body fluid samples on a range of health problems caused by geologic materials.
- At the behest of the U.S. Geological Survey, the National Science Foundation, and the National Aeronautics and Space Administration, the US National Research Council has empanelled a committee tasked with accessing the status of research at the interface between medicine and Earth Science. The committee will advise research activities that should be given a high priority for optimum societal benefit and report on the most profitable areas for communication and collaboration between the Earth Sciences and medical communities.

These examples are all solid indications of a very healthy, growing interest in the subject of Medical Geology.

### What still needs to be done?

Despite the substantial advances that have been made in Medical Geology during the past few years much more needs to be done to maintain the momentum. Many of the needs identified by Selinus in the 2004 *Terrae* article are still valid today. Listed below are several important short-term goals for Medical Geology.

- **Degree programs:** There needs to be more degree or certificate programs at colleges and universities around the world.
- **Common multidisciplinary outlet for journal articles and conferences:** Adding yet another journal or another far off scientific conference is not the answer, yet we must encourage people to meet and communicate.
- **Success stories:** It is imperative that medical geologists clearly demonstrate the value of their input to the biomedical and public health communities.
- **Jobs:** Employers need to be made aware of the benefits of Medical Geology. For example,

research on the sources and composition of dust that cause health problems in mines could save the mine operator significant costs in health benefits and lost time.

- **Recognition and acceptance by politicians, decision makers and the public:** It is equally imperative that medical geologists clearly demonstrate the value of their input to the public and to decision makers at every level.
- **Generate sources of funding for researchers and internships and pre- and postdoctoral training opportunities:** The future of Medical Geology is in the hands of young scientists and enthusiastic students. We must encourage them to stay the course.

The biggest challenge facing Medical Geology is the integration of geoscience and biomedical public health research and funding activities. By and large these disciplines are housed in different governmental agencies, in different buildings, on separate campuses and have different funding sources. The researchers attend separate conferences, subscribe to different journals, and to some degree have different philosophical approaches, and speak different languages. A concerted effort by these two communities will bring Medical Geology to its full potential.

## What does the future hold?

It is always risky to attempt to predict what the future holds. Nevertheless, we are confident that the future for Medical Geology looks promising considering the already rapid growth of the sub-discipline. The book *Essentials of Medical Geology* has received an overwhelmingly positive response. The reviews have been uniformly positive and the first printing has nearly sold out in less than a year. We anticipate that the book will stimulate the teaching of Medical Geology in colleges and universities. The short course in Medical Geology will continue to attract enthusiastic adherents and converts. The International Medical Geology Association should provide a stable platform for the exchange of ideas and dissemination of information. The Medical Geology activities mentioned above should maintain 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.

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