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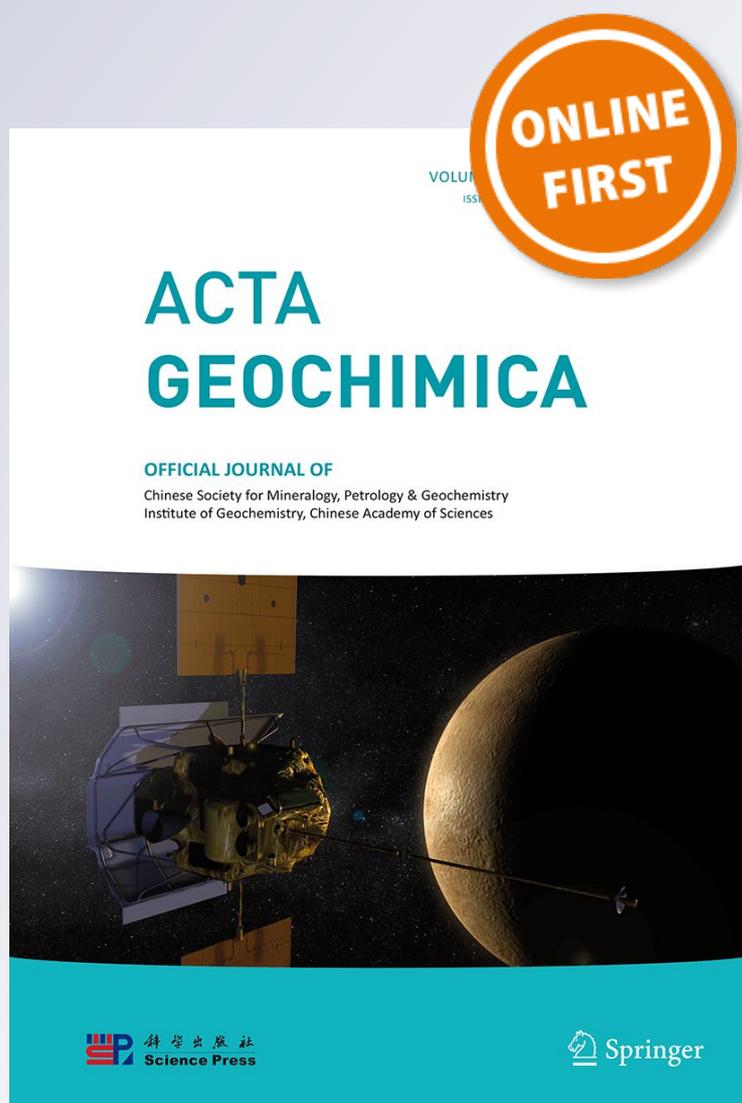
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Guizhou Province, China: the birthplace of modern Medical Geology

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Abstract Medical Geology, the emerging discipline that focuses on the health impacts of geologic materials and geologic processes, has its roots in Guizhou Province, China. In the 1980s Prof. Zheng Baoshan and his students recognized that a large number of people in Guizhou Province had clinical symptoms of arsenic poisoning, fluorine exposure, selenosis, and other diseases caused by exposure to potentially toxic trace elements or due to deficiency of essential elements. Their publications and invitations to scientists to visit the Province ultimately resulted in increased attention to the health impacts of the natural environment and the formation of scientific societies, the publication of at least a dozen books, and thousands of technical articles on what is now called Medical Geology.

Keywords Coal · Fluorosis · Arsenic poisoning · Selenosis · Health impacts · Environmental health

1 Introduction

It is not often that a scientific discipline can identify the location where the seeds of its development were planted, but Medical Geology might be an exception. The impetus for the current discipline of Medical Geology came from the soil of Guizhou Province, China. Medical geology is defined as the study of the impacts of geologic materials

and geologic processes on animal and human health (Selinus et al., 2013). Over the past 20 years Medical Geology has developed into a mature discipline with numerous adherents. Several international and national associations emerged devoted fully or partially to this new discipline. Numerous books on this subject have appeared in this time (Table 1). Dozens of short courses, workshops, lectures, journals, and countless journal articles have appeared in the past 20 years. International, national, and local conferences have been devoted to this topic. The most recent being the 8th MedGeo conference held in August 2019 in Guiyang, Guizhou Province.

2 The beginning

Why and where did all this begin? The seeds for this discipline were planted by Prof. Zheng Baoshan in the 1980s when he recognized that a large number of people in Guizhou Province had clinical symptoms of arsenic poisoning, fluorine exposure, selenosis, and other diseases caused by exposure to potentially toxic trace elements or due to deficiency of essential elements. Prof. Zheng then began a lifetime commitment seeking the causes of these environmental health problems, finding practical solutions to these problems and bringing these issues to the attention of the global scientific community (see Zheng references below). We fully acknowledge that many others have preceded Zheng Baoshan including Tan Jianan in China (see references) in pursuing what we now call Medical Geology but we maintain that none have had as broad and lasting impact as Prof. Zheng Baoshan has had.

In November of 1996 Prof. Zheng invited several American scientists to visit Guizhou Province to see the situation first hand. The group consisted of Robert B.

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Table 1 Medical Geology books that are, in part, derivative of the situation in Guizhou Province

Centeno, J. A., Finkelman, R. B., and Selinus, O., 2016, <i>Medical Geology: Impacts of the natural environment on public health</i> . MDPI, Basel, 238 p. (Printed Edition of the Special Issue Published in <i>Geosciences</i>)
Mori, I. and Ibaraki, H. (editors), 2017, <i>Progress in Medical Geology</i> . Cambridge Scholars Publishing. 329 p
Selinus, O., Alloway, B., Centeno, J. A., Finkelman, R. B., Fuge, R., Lindh, U., Smedley, P., eds., 2005, <i>Essentials of Medical Geology</i> , Elsevier, New York, 812 p
Selinus, O., Alloway, B., Centeno, J. A., Finkelman, R. B., Fuge, R., Lindh, U., Smedley, P., eds., 2006, <i>Essentials of Medical Geology</i> . Chinese Edition. Translated by Zheng Baoshan and Wang BinBin. Science Press, Beijing. 708 p
Selinus, O., Alloway, B., Centeno, J. A., Finkelman, R. B., Fuge, R., Lindh, U., Smedley, P., eds., 2013, <i>Essentials of Medical Geology</i> , Revised Edition, Springer. 805 p
Selinus, O., Centeno, J. A., and Finkelman, R. B., (editors.), 2010, <i>Medical Geology—A Regional Synthesis</i> . Springer, 392 p
Skinner, H. C. and Berger, A. R., (editors), 2003, <i>Geology and Health: Closing the Gap</i> . Oxford University Press, New York. 179 p

Finkelman, a geochemist with the U.S. Geological Survey, Jose A. Centeno, a toxicologist with the Armed Forces Institute of Pathology, Vas Aposhian, a pharmacologist with the University of Maryland, Richard Dart, a toxicologist with the Rocky Mountain Poison Control Center, and Judy Mumford, a scientist with the U.S. Environmental Protection Agency (Fig. 1). And Judy Mumford had been born in China and had previously conducted researches on an environmental health issue in nearby Yunnan Province.

For two weeks Prof. Zheng Baoshan guided the group through remote regions of Guizhou Province on dirt roads visiting a number of endemic villages and meeting with scores of people suffering from the various environmental health problems. The visitors were invited into homes to

observe the foods that the villagers ate, the water they drank, and the way they work and live. They interviewed the people at length and spoke with the local doctors who treated them. They observed the clinical symptoms—hypokeratosis, hyperkeratosis, Bowen's disease, squamous cell carcinoma (Figs. 2, 3), dental fluorosis, skeletal fluorosis, deformed limbs (Figs. 4, 5), hair and nail loss, etc. (Fig. 6) and agreed with Prof. Zheng Baoshan that many of the health problems could be traced to the coal and coal briquettes that was used to heat the houses and cook the food in this part of Guizhou Province. At the end of the visit, Bob Finkelman and Jose Centeno made a commitment to Zheng Baoshan that they would do whatever possible to help him alleviate the suffering of the villagers in Guizhou

Fig. 1 Guizhou Province 1996. From left to right: a student of Zheng Baoshan, Jose Centeno, Zheng Baoshan, Judy Mumford, a local doctor, Richard Dart, Vas Aposhian, local doctor. (Photograph taken by Prof. Bob Finkelman)





Fig. 2 The dark, scaly patches are hyperkeratosis caused by exposure to arsenic. The dark patch over the left breast was diagnosed as Bowen's Disease, a pre-cancerous growth attributed to arsenic exposure. (Photograph taken by Dr. Zheng Baoshan)



Fig. 3 Hyperkeratosis on the feet. The darker areas on both feet are squamous cell carcinoma attributed to arsenic poisoning. (Photograph taken by Prof. Zheng Baoshan)

Province and to try to minimize or even prevent further occurrences of these preventable environmental health problems. However, this was easier said than done.



Fig. 4 Dental fluorosis. (Photograph taken by Prof. Zheng Baoshan)



Fig. 5 Skeletal fluorosis. (Photograph taken by Prof. Zheng Baoshan)

3 The follow-up

Upon returning to the United States, Bob and Jose quickly found out that there were no mechanisms that allowed geoscientists and medical scientists to work together. Geologic organizations were enjoined from working on human health issues and medical funding agencies insisted that they did not have sufficient funds to provide for medical research and would not divert any money to geoscientists. Jose and Bob felt that the only recourse open to them was to educate the disciplines about the benefits of interdisciplinary collaboration to address these and other environmental health problems.

To do this, they organized workshops bringing together scientists and decision makers from the U.S. Geological Survey, the Armed Forces Institute of Pathology, the U.S.



Fig. 6 Loss of hair attributed to selenium poisoning. (Photograph taken by Prof. Zheng Baoshan)

Environmental Protection Agency and other organizations. They gave talks describing the situation in Guizhou Province at geoscience, public health, and other scientific and technical conferences. They published articles in conference proceedings and scientific journals and they also developed a short course on the Health Impacts of Trace Elements and Metal Ions that they presented in Pedras Negras, Mexico in 1997 and later that year in Mexico City and subsequently in Puerto Rico (three times), New Zealand (twice), Jackson, Mississippi, Caracas, Venezuela, and Johannesburg, South Africa. In 2000 Bob Finkelman met Olle Selinus of the Geological Survey of Sweden in Uppsala, Sweden at the International Geologic Congress in Brazil. Olle had acquired funding from the International Union of Geosciences (IUGS) and the International Commission of Scientific Unions (ICSU) to promote a concept called Medical Geology. Bob described what he and Jose saw in Guizhou Province and what they had been doing to try and bring the geoscience and public health disciplines together. He also described the popular short course they had presented and suggested that they join forces to jointly promote Medical Geology. Olle agreed and invited them to present their short course at an ICSU meeting in Lusaka, Zambia in 2001. There Bob and Jose again graphically described the Medical Geology situation in Guizhou Province and all in attendance agreed that joining forces to promote Medical Geology was the right thing to do.

4 The results

Over the next 15 years Olle, Jose, and Bob presented the Medical Geology short courses at least 60 times in about 50 countries, including several times in China. In each short course the medical geology situation in Guizhou Province was given prominent emphasis as the situation illustrated four important aspects of Medical Geology: (1) How widespread medical geology issues are. Several million people in Guizhou Province were suffering from dental fluorosis; (2) How severe medical geology issues can be. Hundreds of people in Guizhou Province have died from cancer possibly caused by excess exposure to arsenic; (3) How complex medical geology issues can be. In Guizhou Province the geology, geologic processes, the terrain, the climate, the food preferences, the culture, and the fuel used all played a critical role resulting in the medical geology problems; (4) And, most importantly, despite the complexity, breath, and severity of the medical geology problem, there are relatively simple solutions once the cause is identified.

In addition to the short courses a number of books have been published that, in part, can be traced back to the Medical Geology situation in Guizhou Province (Table 1). Furthermore a number of international and national associations have been created in recent years devoted fully or partially to Medical Geology and, like the books their origin can be trace back to Guizhou Province. These include the International Medical Geology Association (IMGA; http://www.medicalgeology.org/pages/public/imga/page_imga.htm), the Geological Society of America's Geology and Health Division (<https://community.geosociety.org/geologyhealthdivision/home>), the American Geophysical Union's GeoHealth Section (<https://connect.agu.org/geohealthconnect/home>), and a number of national organizations (e.g. Iran, India, Turkey).

A series of Medical Geology conferences have been held in various countries since 2005. These included the Hemispherical Conferences in Puerto Rico (2005), Sao Paulo, Brazil (2007), Montevideo, Uruguay (2009), Bari Italy (2011), Washington, D. C. (2013), Aviero, Portugal, (2015), Moscow, Russia (2017), and Guiyang, China (2019) The next conference is scheduled Alicante, Spain in 2021. At all of the conferences the medical geology issues in Guizhou were highlighted.

5 The present

Bob Finkelman and Zheng Baoshan recently re-visited the endemic villages in Guizhou Province that they had visited 23 years earlier. There were many changes evident. Where

there had been shacks there are now high-rise buildings. Where there were dirt roads there are now modern highways. And where coal was burned for heat and light there is now electricity. Many elderly villagers still have clinical signs of exposure—keratosis and mottled teeth. But they claim that there have been no new cases of medical geology issues since the central government banned local coal use about 20 years ago.

The classic medical geology problems in Guizhou Province are now largely history but the importance of Guizhou Province to the development of Medical Geology is now etched in time.

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References

- Selinus O, Alloway B, Centeno JA, Finkelman RB, Fuge R, Lindh U, Smedley P (eds) (2013) *Essentials of medical geology*, Revised edn. Springer, Berlin
- Tan J (1989) *The atlas of endemic diseases and their environments in the People's Republic of China*. Science Press, Beijing
- Tan J, Peterson PJ, Ribang L, Wuyi W (eds) (1990) *Environmental life elements and health*. Science Press, Beijing
- Zheng B (1992) Research on endemic fluorosis and industrial fluorine pollution. *Chinese Environmental Science Press*, Beijing, pp 151–194
- Zheng B, Hong Y-T, Zhao W, Zhou H, Xia W, Su H, Mao D, Yan L-R, Thornton I (1992) The Se-rich carbonaceous siliceous rock and endemic selenosis in southwest Hubei, China. *Chin Sci Bull* 37(20):1725–1729
- Zheng B, Yu X, Zhang D (1996) Environmental geochemistry of coal and endemic arsenism in Southwest Guizhou, China. In: 30th international geologic congress, Beijing, China. Abstract
- Zheng B, Zhang J, Ding Z, Yu X, Zhou D, Mao D, Su H (1999) Issues of health and disease relating to coal use in southwestern China. *Int J Coal Geol* 40:119–132
- Zheng B, Wang B, Finkelman RB (2010) Medical geology in China: then and now. In: Selinus O, Finkelman RB, Centeno JA (eds) *Medical geology: a regional synthesis*. Springer, Berlin, pp 303–327