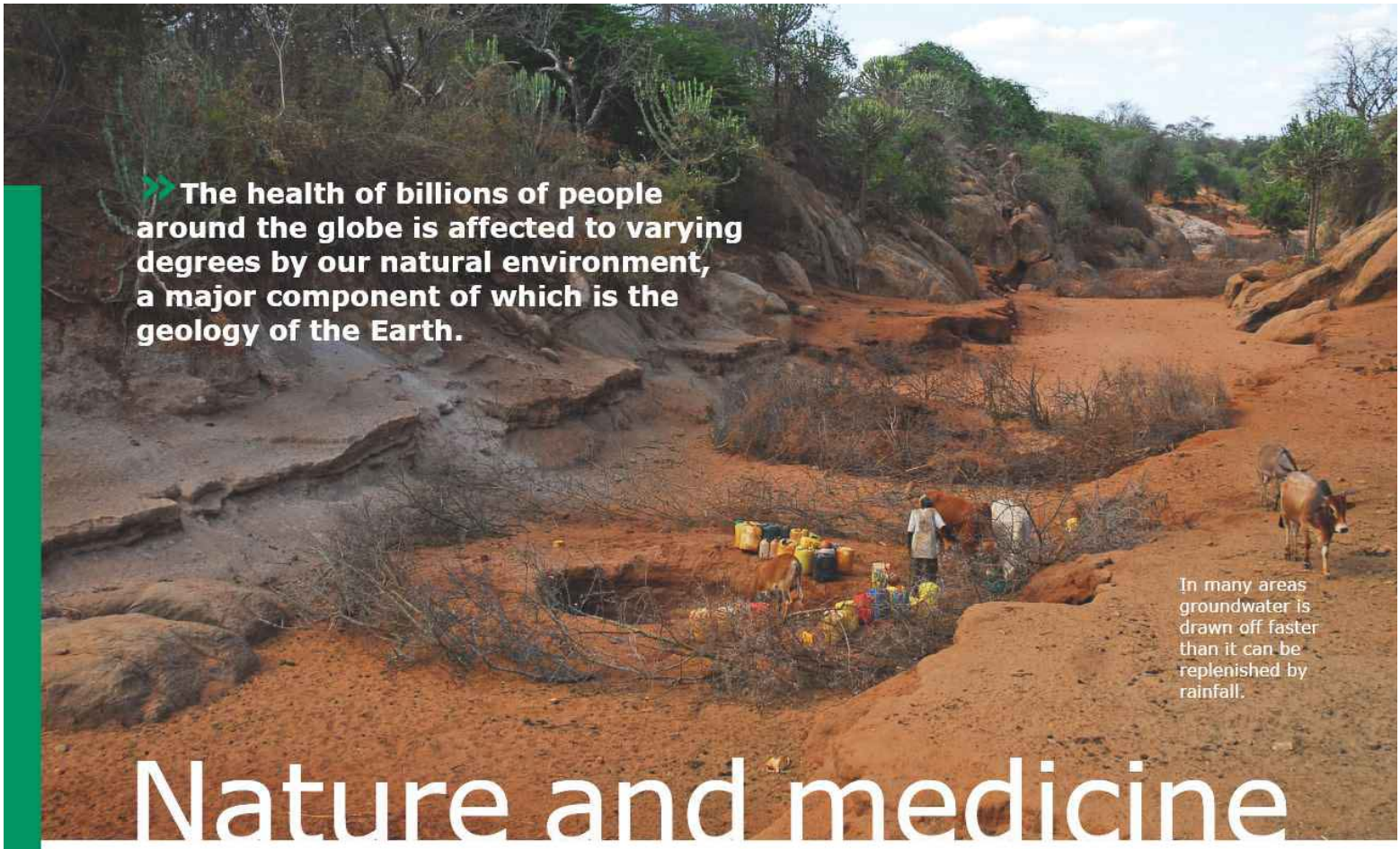


The health of billions of people around the globe is affected to varying degrees by our natural environment, a major component of which is the geology of the Earth.

In many areas groundwater is drawn off faster than it can be replenished by rainfall.

Nature and medicine a breakthrough for human health

The cause of many global health problems can be attributed to our natural environment, which is best understood through the relatively new science of medical geology. This scientific approach aims to uncover how we are affected by the Earth, by looking at its detrimental effects as well as its benefits for our overall wellbeing. By PROFESSOR PHILIP WEINSTEIN and OLLE SELINUS

Planet Earth provides our life-sustaining environment and so has a crucial bearing on our health and wellbeing. We sometimes take it for granted that nature provides a clean environment that does not affect human health, but this is far from the truth. The health of billions of people around the globe is affected to varying degrees by our natural environment, a major component of which is the geology of the Earth.

Medical geology is a science at the intersection of two major fields – medicine, which aims to keep people healthy, and geology, which aims to understand most of our natural environment. The overlap lies in understanding ways in which our natural geological environment can make us sick, and finding ways to avoid or compensate for those problems to keep people healthy.

The fact that geological materials affect human health is nothing new. Ancient Chinese, Egyptian, Islamic and Greek texts describe the many therapeutic applications of various rocks and minerals as well as the health problems that they may cause. Recent years have seen a greatly increased interest in the effects that the natural

environment can have on our health, the results of which have been dramatic. Disease rates have dropped significantly; one good example of such an advance is the virtual elimination of cretinism in the developed world, and ongoing efforts to do the same in the developing world.

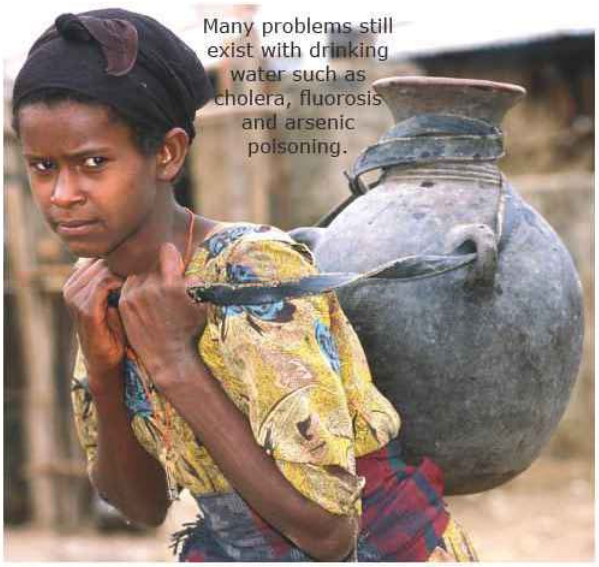
Around 100 years ago, severely mentally retarded and stunted individuals were very common in some parts of the world. People with these characteristics – a syndrome described by the term "cretin" used in its original sense – had an extremely poor quality of life, being shunned and sometimes even ending up in sideshows as "freaks." These people simply lacked a naturally occurring element, iodine, in their diet. Iodine is found in the soil and in fish, so people generally get enough from crops or seafood to use this iodine in their bodies to make thyroid hormone. This hormone regulates growth and development (including the brain) so, without it, mental retardation and stunting is common.

Medical geologists observed that there was a pattern to the geographical distribution of cretinism – away from the ocean, and often in isolated glacial valleys. Snowmelt can leach the soil heavily, washing out trace nutrients such as iodine. People whose diet was largely derived from food grown on iodine deficient soils, and lacking trade with coastal communities for fish, were therefore particularly at risk of cretinism and other iodine-deficiency diseases.

Having identified the problem, based on an understanding of both geology and medicine, it was then up to medical geologists to make recommendations for solving the problem, and this they did by suggesting that salt be iodized. The salt trade has thrived for millennia along very extensive distribution routes so even before the appearance of our modern food distribution networks and supermarkets, iodized salt started reaching many of the isolated communities that were at risk. In most of these areas, the disease was virtually eliminated – a medical geology success story worth remembering when you next reach for the iodized salt which we now all take for granted.

Drinking dangers

Medical geology has also enlightened us to some of the problems in our drinking water. An excess of fluorine has been associated with endemic dental and skeletal fluorosis in several world regions. In addition, hundreds of millions of people are affected by chronic arsenic poisoning, and well-documented cases are known in southern Taiwan, Chile, Argentina, Mexico, China, and recently in West Bengal and Bangladesh. In most cases, this is caused by contaminated well water. To avoid the surface waters full of dangerous micro-organisms like cholera, wells were sunk to draw up groundwater to supply these populations. Unfortunately, there was insufficient involvement of medical geologists in the planning and implementation of this well-meaning exercise. Where the groundwater was drawn from shallow wells in ancient river deltas with high arsenic levels, poisoning occurred at an unprecedented scale with entire villages at risk of skin disorders and cancers. These and many more cases arise from ingestion of naturally occurring elements derived from our "clean" natural environment.



Many problems still exist with drinking water such as cholera, fluorosis and arsenic poisoning.

Many other severe health problems are attributable to geological processes. For example, ash ejected from volcanic eruptions can travel many times around the world, and recent satellite images have shown that dust picked up from the Sahara, North China and Australian deserts may travel up to 20,000km before being deposited. There is growing recognition that we live in a dusty world, and that the dust that falls in our backyard may have originated thousands of miles away. Dust storms from Africa are regularly tracked across the Atlantic and into the Alps, and Asian dust outbreaks can reach California in less than a week. Thus, the impact of such mineral dust is global because exposure to these dusts can cause a wide range of respiratory problems. Similarly, the burning of coal containing arsenic and other elements is a risk for hundreds of millions of people, an issue of great importance in many developing countries including parts of China.

While the exposure to certain natural elements can be detrimental to our health, many other diseases result from a lack of essential nutrients and minerals in the human diet. Selenium deficiency has been linked to cases of muscular dystrophy as well as the induction of endemic cardiomyopathy (heart muscle disease). Other well-known examples include anemia from lack of iron in the diet, and rotting teeth from lack of natural fluoride in drinking water sources. In fact, it is estimated that some 5% of all disease on a global scale is the result of elemental (micronutrient) deficiencies in the diet, predominantly from zinc and iron deficiency. Importantly though, an excess of such elements can also cause disease.

Advances

Having thus illustrated both historical success and the current failures of medical geology, we might ask next, "what of the future?" It is likely that the role of medical geologists will continue to grow in solving increasingly complex local, regional and global health problems. For example, a current problem with the global shortage of freshwater is that, in many places, groundwater is being drawn off faster than it can be naturally replenished by rainfall. The result is a fall in the water table and many rocks and minerals that were previously under water are now being exposed to the atmosphere for the first time. A series of chemical reactions can ensue in areas that are rich ▷

in iron sulphides, with sulphur dioxide being generated. This gas can, in turn, be oxidized to sulphuric acid, making the soil acidic. Such an altered geochemical environment can cause other metals to leach out, including lead and aluminum. Lead causes mental retardation in children and aluminum may be associated with some forms of dementia. Both can enter the human food chain if there are elevated concentrations in the soil or water.

So would more sustainable approaches to freshwater use result in fewer cases of metal poisoning? Only the medical geologists of the future will be able to help answer such complex questions. They may even deal with the issue of ensuring the safety of future Mars crews from the high chromium levels in Martian soils. Should the siting of eventual habitation modules be determined, in part, by the potential health effects of different geological environments on Mars or other planets. Now is the time to train more experts in medical geology – an exciting field that can literally save lives through multidisciplinary understanding. Geoscientists and medical scientists together have the instruments to make use of and display the secrets of nature for the benefit of humankind. We must listen to nature – and listen hard! ■

Ash from volcanic eruptions can travel thousands of miles, and may cause severe health problems.

Philip Weinstein *is Professor and Head of School of Population Health at the University of Western Australia.* ***Olle Selinus*** *is the Vice President for the 33rd International Geological Congress and President of the International Medical Geology Association.*

Effects of global freshwater shortage