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Medical Geology and its relevance in Africa

Medical Geology

Medical Geology is a relatively new discipline that is growing in importance. It is the field of science that deals with the impacts (positive or negative) of the geo-environment (including factors, processes and materials) on the health of humans and the ecosystem in general.[1] It is based on multi-, cross- and inter-disciplinary approaches bringing together experts from various fields of science including epidemiology, toxicology, geoscience, the environmental disciplines and public health. Only by understanding the geological history and background of our environment will we be able to contribute towards a better and deeper insight into the range of natural hazards that can (directly or indirectly) affect our health and that of the ecosystem. This understanding may result in the mitigation or minimisation of impacts and in preventing some of the widespread and serious health problems, and may even save lives. For these reasons, Medical Geology is a highly significant field of research that contributes to the well-being of our community in line with the 2030 United Nations Agenda for Sustainable Development.[2]

The link between geology and health in brief

Rocks are made of minerals, and minerals are composed of chemical elements that can be released into our environment (soil, air and water) by natural processes, such as volcanic activity, earthquakes, weathering of rocks and rock–water interaction. Furthermore, mining activities can play a significant role in enhancing the release of chemical elements and minerals into the environment. Some minerals, such as talc, and certain forms of quartz and fibrous forms classified under the commercial name 'asbestos', can be harmful if they are present in the air as breathable particles. These minerals can cause serious pulmonary health problems including silicosis, talcosis and mesothelioma. Some chemical elements are, of course, essential for our well-being, among them calcium, magnesium, iron, iodine, fluoride and lithium for example. However, deficiency or excess of these elements in food or water can be detrimental to health. Some other elements such as arsenic, lead, cadmium and mercury, and radioactive elements such as uranium, thorium and radon are toxic, and their presence in the environment can be detrimental to human health.

The relevance of Medical Geology in Africa

Although Africa is rich in natural resources, poverty and disease levels are high when compared to some other regions in the world.[3] Certainly, communicable diseases are among the leading causes of morbidity and mortality. However, we should not continue to underestimate the real and potential risks associated with the geogenic as well as the anthropogenic factors related to the exploitation of natural resources. These can contribute dramatically to the high rate of non-communicable diseases and mortality on the continent. The sections below on the geology of Africa and the health of its population outline the importance of developing the field of Medical Geology in Africa.

Geology of Africa

Africa has a complex and dynamic geological evolution, which is characterised by frequent earthquakes and volcanic activity in regions like the East African Rift Valley. Throughout the continent, there are also pervasive dust storms and water toxicity due to interaction with the geo-environment. These geological processes, factors and materials can have negative impacts on the natural environment as well as on human and animal health. Our continent also has enormous geological wealth, which is subjected to anthropogenic activities, such as widespread mining activities and abandoned open mining sites. While mining is important for economic growth and sustainable development, if not properly managed, it can enhance the release of naturally occurring harmful minerals and elements into the environment, which in turn can have deleterious impacts. Geological research in Africa has been dominated by studies on geological evolution and on the identification and exploration of potential natural resources. However, very little attention is given to the possible impacts on health and ecosystems in general.

Health in Africa

Globally, Africa has the highest neonatal mortality rate and the highest maternal mortality.[3] It is worth noting that non-communicable diseases, such as diabetes, cancer and chronic respiratory tract and cardiovascular diseases, are the leading causes of morbidity and mortality in Africa, accounting for more than 50% of all deaths in some countries such as the Seychelles (59%) and Algeria (56%).[3] Unfortunately, the primary causes of such diseases and mortality in general remain unclear in many cases and attention is instead focused on risk factors and treatment.

Medical Geology initiative at the University of Johannesburg

For the reasons above, in 2013 an attempt was made to develop Medical Geology at the postgraduate level at the University of Johannesburg in South Africa in collaboration with researchers from national and international institutions and industry. Since then, 16 students from different African countries, namely Nigeria, Ghana, Kenya, Namibia and South Africa, have registered for either an MSc or PhD on Medical Geology related research projects. Student support has come mainly from the National Research Foundation of South Africa through the Collaborative Postgraduate Training Programme and the University of Johannesburg's prestigious Global Excellence and Stature Programme and University Research Committee funds. In addition, the initiative has benefitted from support by international organisations such as the International Union of Geological Science and the International Medical Geology Association in organising symposia and workshops in the field.

Recently completed research projects

So far, the projects within this initiative have mainly dealt with establishing a relationship between environmental geochemistry/mineralogy and human and animal health in specific African countries. More than 30 research

papers in international, peer-reviewed journals and conference abstract volumes have been published since the start of the initiative. Selected examples follow:

- High fluorine and dental fluorosis prevalence from the Nakuru area, Kenyan Rift. For the first time, this study established a clear link between the high fluorine content in water and dental fluorosis as well as the spatial distribution of fluorine concentrations in this area.[4,5]
- Impact of toxic elements present in geophagic material on pregnant women in Onangama village, northern Namibia. This is the first detailed geochemical and mineralogical study of this kind in Namibia, despite the high prevalence of the geophagic practice amongst pregnant women especially. This study enabled the discovery that the consumed materials contain high concentrations of several toxic elements including arsenic and mercury, which are detrimental to the health of consumers and unborn babies.[6,7]
- The uranium and radon gas concentration and their impacts on human health with reference to a case study from abandoned gold mine tailings in the West Rand area, Krugersdorp, South Africa. This study demonstrated that mine tailings in the area have high uranium concentrations (up to 149.76 ppm) and high levels of radon (up to 1068.8 Bq/m^3) – more than 10-fold the recommended value of 1 mSv/y proposed by the National Nuclear Regulator of South Africa and the International Commission on Radiological Protection. These high levels are a serious health risk to the people of the area where there is a high percentage of deaths from lung cancer.[8]

Concluding remarks

Medical Geology is a relatively developed field in some regions of the world. However, in Africa it is still developing, although it is on this continent that the application of this research would be most relevant. Considering the significance of the geo-environmental materials, factors and processes including geogenic and anthropogenic activities and the frequency of the occurrence of non-communicable diseases, it is important to develop this field through collaborative research projects as well as through training of a new generation of researchers to investigate possible correlations.

The development of Medical Geology at the University of Johannesburg has attracted several postgraduate students from Africa. Furthermore, the results obtained from completed research projects show promising and interesting correlations between geo-environmental factors, materials and processes and certain common non-communicable diseases. The programme clearly demonstrates that Medical Geology has a broad and strong pan-African appeal and is an essential part of African development. With dedicated leadership and financial support, this field of research can be attractive to students and contribute to the health and well-being of our society as well as the economic growth of the continent.

This Commentary draws on my unpublished Professorial Inaugural Lecture at the University of Johannesburg on 15 October 2019[9] and a chapter[10] accepted for publication in an upcoming book on the practical application of Medical Geology.

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