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Environmental Geology

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Abstract
The article presents an overview of the applied branches of geology, namely, engineering and environmental geology, and their importance in our life. It also includes a discussion of some of the newer sub-specialties or new applications of geoscience, such as medical geology, forensic geology, use of underground space for human occupancy, and geoindicators. It then presents an historical review of the evolution of engineering geology, leading to the introduction of degree programs offered at American universities, and the current prospects and employment trends of geoscience graduates in the United States and other countries. The difference between engineering geology and geological engineering is explained. The controversy relating to inclusion of environmental geology within the engineering geology specialty is discussed at length and it is concluded that, despite some overlaps, environmental geology is different from engineering geology and should be treated as such. Readers are introduced to the newly emerging field of medical geology and its relevance in human health and well-being. It seems likely that geological factors will emerge as one of several factors responsible for the occurrence of diseases such cancer, heart ailments, and other sicknesses that may be related to the excess or deficiency of certain trace elements whose occurrence and distribution are controlled by geological processes. The suggestion is made for inclusion of the relationship between geologic factors and diseases in health education curricula.

Introduction
Long before geology came to be recognized as a branch of physical science in 1786, humans had been attempting to gain an understanding of how the planet earth—our home—was formed, how it has evolved through time, why are there mountains at one place and valleys and rivers at another, where to find useful minerals and fuel materials, and why the earth "gets angry" and brings misery to us in the form of floods, earthquakes, and volcanic eruptions. For a long time in the early history of human civilization, these hazardous processes were linked with supernatural forces that were respected, revered, and even worshipped. About 800,000 years ago when our ancestors learned the use of fire, and much later when the practice of agriculture started around 7,000 B.C. (Keller, 2000), we initiated a process of long-term exploitation of the earth to meet our need of metals, non-metals, and fuels. The onset of the Industrial Revolution around 1760 gave us an unprecedented ability and power to excavate and move earth materials at a much faster pace than we had ever done before. This new capability helped us to explore many uncharted territories and enabled us to harness the energy available from flowing water by building large dams and, since the early twentieth century, power plants. The second half of the twentieth century witnessed a tremendous increase in industrialization and urbanization and we began to realize, for the first

time, the danger and harm associated with careless use and exploitation of the earth and its resources. Finally, the last four decades have brought to the fore the threat to the earth and its environment, leading to an awakening followed by a conscientious effort toward environmental preservation. The overall content of this theme relates to what may be considered "non-traditional geoscience," in that it focuses on topics that, until the past few decades, had been either non-existent in conventional geoscience textbooks or curricula, or were covered in a cursory manner. While some of the topics, such as environmental geology, have been around for thirty to thirty-five years, and engineering geology for several decades, forensic geology, geoindicators, and medical geology are "newcomers" to the geoscience discipline. The various applications of geoscience have become important to our daily lives and play a critical role in the maintenance and preservation of human health and environmental quality. Engineering and environmental geology are applied branches of geology. Engineering and environmental geologists, unlike traditional practitioners, bear a greater responsibility for their professional work and may be held liable for any mistake they make. In recent years geoscientists specializing in environmental geology, waste management, groundwater pollution, and hazard mitigation

Engineering Geology

Engineering geology is applied geology and deals with the application of geologic principles and concepts to engineering construction projects such as dams and reservoirs, tunnels and other subsurface structures, highways and airport runways, power plants, waste disposal facilities, and engineered construction to mitigate effects of hazardous earth processes, such as flooding, landslides, earthquakes, and coastal erosion. The American Geological Institute defines engineering geology as "geology applied to engineering practice, especially mining and civil engineering" (Bates and Jackson, 1987). However, when environmental concerns became paramount and attracted worldwide attention, many well-known professional engineering geology societies redefined engineering geology to include environmental and hydrological work within the scope of application of engineering geology. For example, the Association of Engineering Geologists (AEG) in the United States, by far the largest organization serving the needs of engineering geologists with a current membership of about 2,700 (Mathewson, 2001), now uses the following definition for engineering geology:

Environmental Geology

Yet another applied branch of geology, environmental geology, became popular during the last three decades of the twentieth century. The American Geological Institute defines environmental geology as: [the] application of geologic principles and knowledge to problems created by man's occupancy and exploitation of the physical environment. It involves problems concerned with construction of buildings and transportation facilities, safe disposal of solid and liquid wastes, management of water resources, evaluation and mapping of rocks and mineral resources, and long-range physical planning and development of the most efficient and beneficial use of the land. (Bates and Jackson, 1987) everyone's attention and began to experience unprecedented popularity in the United States and other industrialized countries. By the early 1970s it achieved academic recognition when the Beliot College at Beliot in Wisconsin started a Bachelor of Science (B.Sc.) degree program in environmental geology. In the same year, the Western Washington University at Bellingham in Washington, also introduced a bachelor's degree program in environmental geology. These two academic institutions have the distinction of being the first to envision the importance and growth potential of the new specialty of environmental geology and introduce degree programs in this field. Boston University in Massachusetts was the next to offer a B.Sc.

degree in this field. Yet, despite the fact that courses in environmental geology were added in existing geosciences offerings at a large number of geoscience departments all across the United States, formal degree programs in this field were slow to come during the later half of the decade of 1970, with one notable exception: The University of Missouri-Kansas City in 1979 introduced a master's degree program in Urban Environmental Geology, achieving the distinction of being the first educational institution in North America and probably in the entire world, to offer a postgraduate degree in environmental geology, a distinction that has not been repeated by any other university during the past twenty-two years

Is environmental geology the same as engineering geology? In its early years when environmental geology had just been recognized as a new specialty within the geosciences discipline, many scholars and practitioners of engineering geology argued that environmental geology is the same as engineering geology. Ever since the middle 1960s, when terms such as geoecology, urban geology, envirogeology, and environmental geology, were being proposed for the emerging specialty in the geologic literature, debate continued on the identity of the new specialty. George Kiersch, a reputed professor and practitioner of engineering geology, in 1974 and again in 1993 argued that there is no difference between engineering geology and environmental geology. John Ivey, in an article published in 1975 expressed the same view and argued that the two specialties are the same. Jeff Keaton and Greg Hempen (1993) also argued in favor of treating the two specialties the same. Hasan (1993), however, took a different stand and argued that despite some overlap in the scope and application of engineering and environmental geology, the two are not the same. Using a basic definition to clarify the difference in the scope and application of engineering and environmental geology, Hasan pointed out that engineering geology emphasizes the application of geology in civil engineering projects and groundwater resource development only, whereas environmental geology, besides involving hydrogeology, engineering geology, process geology, and so on, also deals with waste disposal, land use planning, environmental health, pollution prevention, and environmental law.

Hasan presented a comparison of the contents of textbooks in both engineering and environmental geology to prove that topics such as hazard evaluation and mitigation, waste management, pollution control, environmental health, land use planning, and environmental laws are either totally excluded or covered in a very cursory manner in popular works on engineering geology but constitute the bulk of the discussion in environmental geology textbooks. Another argument put forth by Hasan relates to the interaction of engineering and environmental geologists with other experts: whereas engineering geologists traditionally had to deal with civil engineers only, environmental geologists interact with a large number of experts including civil engineers, land use planners, public policy officials and administrators, chemists, biologists, toxicologists, health care professionals, and others. He concluded that environmental geology is not the same as engineering geology and should be recognized as such. Since the mid-1990s not much has been written on the issue, and it appears that the debate has now died and it has been accepted that engineering and environmental geology are two separate specialties.

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