

GEOLOGY

AND
THE ENVIRONMENT



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GEOLOGY

and the Environment

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PREFACE

■ OUR CHANGING PLANET

Environmental geology is the study of the relationship between humans and their geologic environment. An underlying assumption is that this relationship is an interactive one. Not only do naturally occurring geologic phenomena affect the lives of people on a daily basis, but the activities of humans can induce or aggravate geological processes, with sometimes tragic consequences. Historian Will Durant noted that our physical environment "... exists by geological consent, subject to change without notice." We may interpret this to mean that during our lifetimes, we will probably be subject to a significant geologic hazard—an earthquake, a coastal or riverine flood, a landslide, volcanic activity, and so on. If for no other reason than this, we need to become informed about our geological environment and these hazards.

Environmental geology is dynamic—that is, it is the geology of "now" and not of some distant past. It is constantly in action. For example, during the period when this textbook was in press, a significant earthquake occurred in southern Oregon and a tragic one in the interior of India that took more than 20,000 lives. In addition, volcanoes in Hawaii, Central America, and the Mediterranean have continued to erupt and to cause property damage. Such ongoing, widespread geologic activity serves to remind us that no continent, country, or area is free from geologic hazards.

In a technological society where science is interwoven with economics and political action, an understanding of how science and scientists operate takes on increased importance. The National Center for Earth Science Education, the National Science Foundation, and a number of other distinguished scientific societies have adopted the goal of earth-science literacy for U.S. students at all levels, elementary school through college. The hope is that through education, today's students will become better stewards of our planet than their predecessors have been,

working toward careful management of the land and its population, and controlling the reckless exploitation of earth resources that has been occurring. A fringe benefit is that by coming to understand the earth, our lives are enriched because we can better appreciate the earth's beauty and complexity as well as recognize its limitations. To achieve earth-science literacy goals, an understanding of the following concepts is essential:

- The planet earth is unique in our solar system.
- The Earth as a planet is old. It has existed for at least 4.6 billion years, and it has undergone many cycles of mountain building and erosion, ocean-basin formation and destruction, continental accretion and separation, and recycling of gases and liquids.
- Five earth systems—water, air, ice, solid earth, and life—all interact with each other in a complex manner.
- Earth's resources are limited, and their extraction and use must be controlled and judicious.

One fact is certain—the earth can sustain just so much life, and it is fast approaching that limit. The fragility of earth has been described very eloquently by *Apollo 14* astronaut Edgar Mitchell:

"It is so incredibly impressive when you look back at our planet from out there in space and you realize so forcibly that it's a closed system—that we don't have unlimited resources, that there's only so much air and so much water. You get out there in space and you say to yourself 'That's home. That's the only home we have, and the only one we're going to have for a long time.' We had better take care of it, we don't get a second chance."

■ ABOUT THIS BOOK

Most of my professional and academic career has been devoted to the study of geologic hazards and their

mitigation—more specifically, to the safe siting of engineering works ranging from large dams to subdivisions for single-family dwellings. It seemed natural that I should combine my professional experience, my love of teaching, and my interest in preserving the environment into a textbook. *Geology and the Environment* is intended to fulfill the needs of a one-semester college course for students with little or no science background. It examines geologic principles, processes, and phenomena and relates them to humankind and human endeavors. What you learn in this course will be useful to you throughout your life. It will serve you as you form opinions about environmental issues and legislation, select a home site, or evaluate real property in a business venture. At the very least, when you understand how the earth “works,” any fears and anxieties you have about such things as earthquakes, hurricanes, or volcanic eruptions should be lessened.

The emphasis in this textbook is to present geology that can be applied to improving the human endeavor. Chapter 1 presents an overview of the underlying cause of many of our present environmental problems. The stress of overpopulation on the environment has resulted in water and air pollution, land degradation, occupation of lands subject to geological hazards, and uncontrolled extraction of resources. The impact of overpopulation and the relatively new awareness of the environment are reasons that colleges are adding courses in environmentally related issues (such as environmental geology) to their curricula.

Because this textbook is intended for non-science majors, Chapters 2 and 3 offer some basic information useful for “getting around in geology.” No attempt has been made to try to cover all or even most of what we currently know about our planet and its origin. Instead, the focus is on presenting the subset of information that will prove most useful to us in our subsequent examinations of geological hazards, processes, and resources. These basic tools of geology include topics such as the origin of the earth, the nature of the materials composing it, and how the present disposition of continents and oceans came about (plate tectonics, the subject of Chapter 3).

Following these groundwork chapters, the focus shifts to various types of geologic processes and hazards. Earthquakes and volcanoes are two of the most spectacular examples of the energy contained *within* the earth, and Chapters 4 and 5 examine how this energy is transferred to the earth’s surface—where we live—and how we can learn to recognize the signals that “something’s up” and work to minimize the damage when the inevitable occurs. While the focus in these chapters is on the hazardous nature of earthquakes and volcanoes, we also look at some benefits, such as geothermal energy.

The next three chapters focus on geologic processes on or very near the surface of the earth. Much of the soil that

we build our homes on and grow our food in today is the bedrock of the far distant past, chemically and physically altered through the processes of weathering (Chapter 6). Present-day rocks and soils continue to undergo such processes, in some cases assisted by means of human activities such as construction, mining, and water extraction from the earth. The results—mass wasting (landslides) and ground subsidence and collapse—cause loss of lives and millions of dollars of damage each year. These ground-failure problems are examined in detail in Chapters 7 and 8.

Earth is sometimes described as the water planet, and the presence or absence of water is essential in defining the geological and biological environments in which we live. The next four chapters focus on the many ways in which this most essential of all substances affects us. Streams and rivers are vital resources that sustain life along their banks and can serve as important transportation systems, but they also pose hazards to those they serve through the threat of flooding (Chapter 9). Of course, not all water is on the surface of the earth, and in fact, in many areas the most important sources of water come from underground. Ground water is a finite resource, however, and one that can easily be wasted through excessive use or contamination. These problems are examined in Chapter 10. We next look at the effects that the largest bodies of water on our planet—the oceans—have on human life. These include creation and destruction of coastal environments (Chapter 11) and a central role in producing world climate and, thus, in establishing the ground rules for all species’ continued existence (Chapter 12).

Geology and the Environment closes with a look at our energy and mineral resources (Chapters 13 and 14), and how the wastes generated by industrial societies are disposed of (Chapter 15). Along with overpopulation, the safe disposal of solid and liquid waste products may be one of the greatest problems facing humankind. The discussion illustrates that a “no deposit, no return” society is no longer tenable.

It is reasonable that the college course in which this textbook is used falls into the category of a general education course. General education, whether it be science, humanities, or social science, is meant to enrich our lives and minds beyond the specialization of our major interest. To this end, there are galleries of photos at the end of most chapters that illustrate geologic wonders and some geologic “oddities”, which often result from the process or hazard discussed in the text. For example, at the end of Chapter 5 (Volcanoes and the Environment), there are photographs of often-visited scenic volcanic features with explanations of how they formed. It is hoped that this kind of presentation will stimulate you to learn more and give you a greater appreciation of natural geologic wonders.

Numerous Case Studies throughout the text highlight specific events or topics directly related to the text discussion. These cover a broad spectrum of topics, with many focusing on the causes and aftereffects of “textbook cases” of bad environmental and geological planning. Other Case Studies range from a geological walking tour of the famed “Magnificent Mile” in downtown Chicago to a first-hand account by an Egyptian student of a recent devastating earthquake that struck her country. At the end of each chapter can be found a list of Key Terms introduced in the chapter, a Summary in outline form of the chapter, Study Questions that test understanding of the key concepts of the chapter, and a list of supplemental readings.

■ INSTRUCTOR ANCILLARY MATERIALS

West Publishing Corporation has prepared a complete supplemental package to support instructors and their students using this text:

- **Instructor’s Manual with Test Bank** by Dee D. Trent of Citrus College includes 650 test questions in multiple choice, matching, true-false, and essay formats. Test Bank questions also available on the WestTest 3.0 computerized testing program.
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Bernard W. Pipkin
Los Angeles, California

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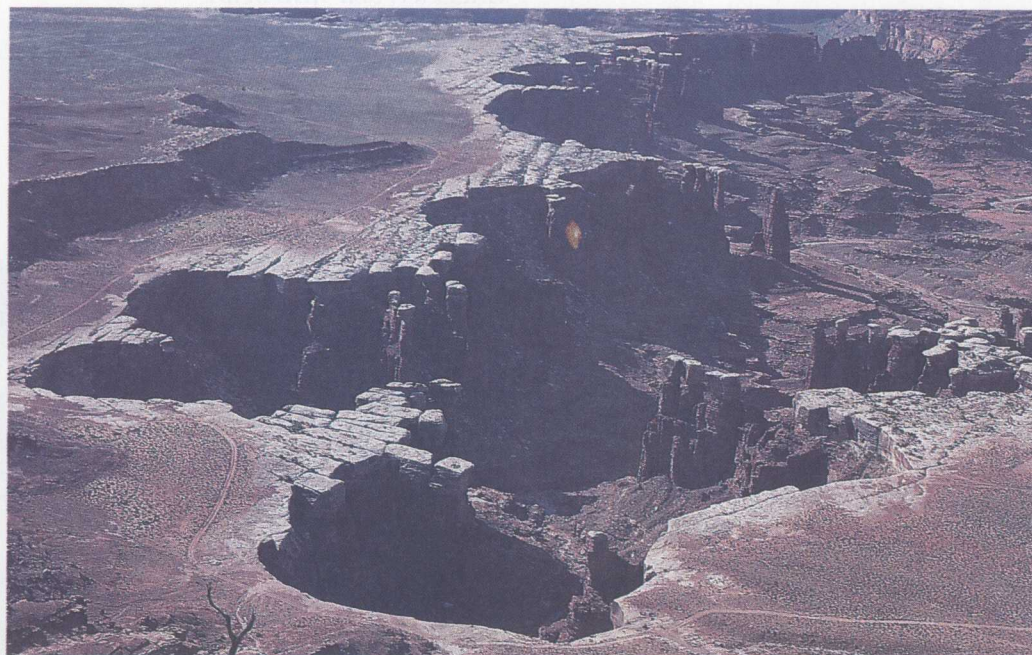
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