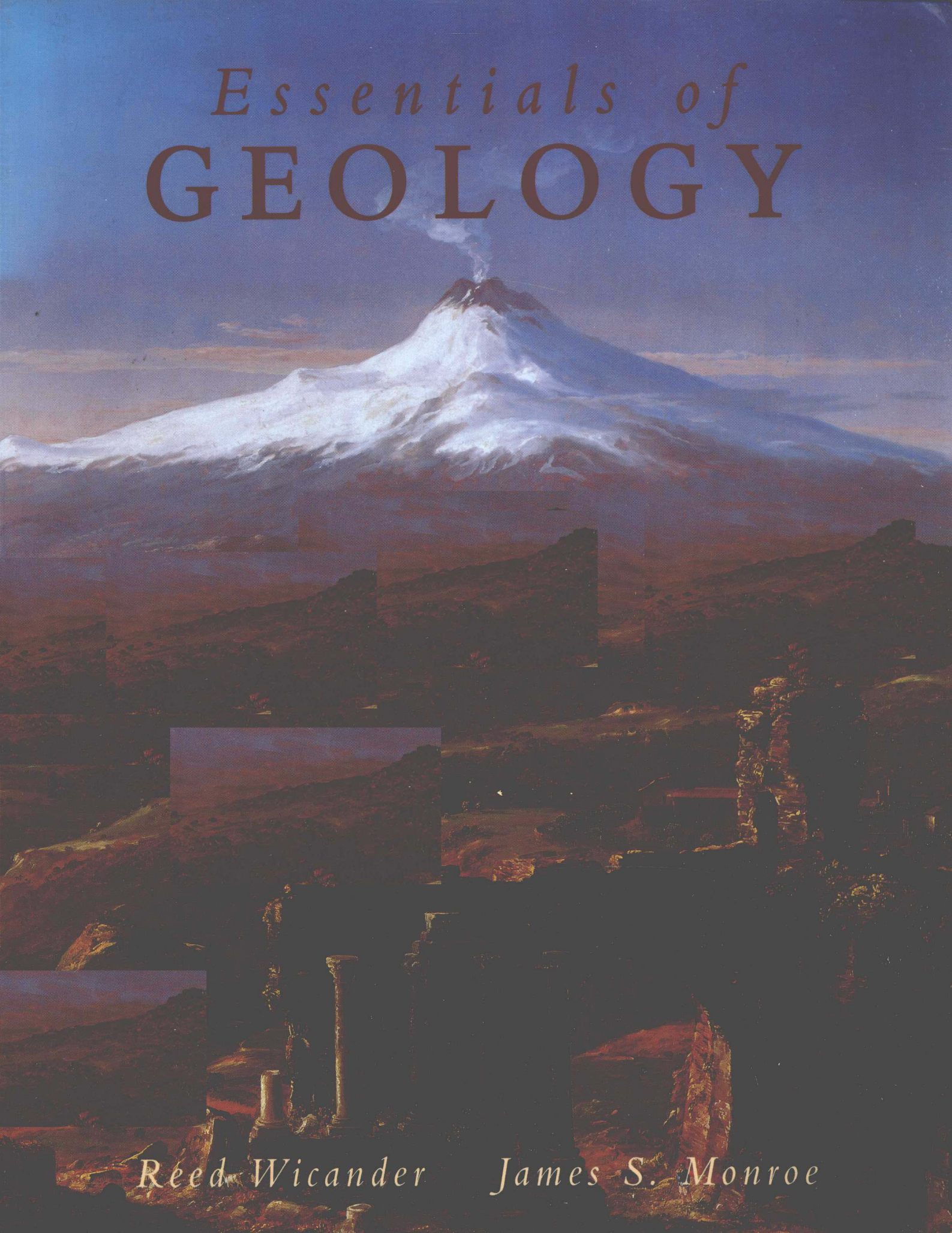
Essentials of GEOLOGY



Reed Wicander *James S. Monroe*

Essentials of
GEOLOGY

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Mount Aetna from Taormina, Thomas Cole, Oil on Canvas, 78⅝ × 120⅝ inches. Wadsworth Atheneum, Hartford, CT, dated 1843.

PREFACE

The Earth is a dynamic planet that has changed continuously during its 4.6 billion years of existence. The size, shape, and geographic distribution of the continents and ocean basins have changed through time, as have the atmosphere and the organisms that inhabit the Earth. Over the past 20 years, bold new theories and discoveries concerning the Earth's origin and how it works have sparked a renewed interest in geology. We have become increasingly aware of how fragile our planet is and, more importantly, how interdependent all of its various systems are. We have learned that we cannot continually pollute our environment and that our natural resources are limited and, in most cases, nonrenewable. Furthermore, we are coming to realize how central geology is to our everyday lives. For these and other reasons, geology is one of the most important college or university courses a student can take.

Essentials of Geology is designed for a one-semester introductory course and is written with the student in mind. One of the problems with any introductory science course is that students are overwhelmed by the amount of material they must learn. Furthermore, much of the material may not seem to be linked by any unifying theme or appear to be relevant to their lives.

One of the goals of this book is to provide students with a basic understanding of geology and its processes and, more importantly, with an understanding of how geology relates to the human experience; that is, how geology affects not only individuals, but society in general. It is also our intention to provide students with an overview of the geologic and biologic history of the Earth, not as a set of encyclopedic facts to memorize, but rather as a continuum of interrelated events that reflect the underlying geologic and biologic principles and processes that have shaped our planet and life upon it. With these goals in mind, we introduce the major themes of the book in the first chapter to provide students with an overview of the subject and enable them to see how the various systems of the Earth are interrelated. We also discuss the economic and environmental aspects of geology throughout the book rather than treating these topics in separate chapters. In this way students can see, through relevant and interesting examples, how geology impacts our lives.

TEXT ORGANIZATION

Plate tectonic theory is the unifying theme of geology and this book. This theory has revolutionized geology because it provides a global perspective of the Earth and allows geologists to treat many seemingly unrelated geologic phenomena as part of a total planetary system. Because plate tectonic theory is so important, it is covered in Chapter 2 and is discussed in most subsequent chapters as it relates to the subject matter of that chapter.

We have organized *Essentials of Geology* into several informal categories. Chapter 1 provides an introduction to geology and discusses its relevance to the human experience, plate tectonic theory, the rock cycle, geologic time and uniformitarianism, and the origin of the solar system and Earth. Chapter 2 deals with plate tectonics, while Chapters 3–8 examine the Earth's materials (minerals and igneous, sedimentary, and metamorphic rocks) and the geologic processes associated with them including the role of plate tectonics in their origin and distribution. Chapters 9 and 10 deal with the related topics of the Earth's interior, earthquakes, and deformation and mountain building. Chapters 11–16 cover the Earth's surface processes, and Chapter 17 discusses geologic time, introduces several dating methods, and explains how geologists correlate rocks. Chapter 18 and 19 provide an overview of the geologic history of the Earth and its biota.

We have found that presenting the material in this order works well for most students. We know, however, that many instructors prefer an entirely different order of topics depending on the emphasis in their course. We have therefore written this book so that instructors can present the chapters in any order that suits the needs of their course.

CHAPTER ORGANIZATION

All chapters have the same organizational format. Each chapter opens with a photograph relating to the chapter material, a detailed outline, and a Prologue, which is designed to stimulate interest in the chapter by discussing relevant aspects of the material.

The text is written in a clear informal style, making it easy for students to comprehend. Numerous color diagrams and photographs complement the text, providing a visual representation of the concepts and information presented. Each chapter contains a Perspective that briefly discusses an interesting aspect of geology or geological research. Mineral and energy resources are discussed in the final sections of several chapters.

The end-of-chapter materials begin with a concise review of important concepts and ideas in the Chapter Summary. The Important Terms, which are printed in boldface type in the chapter text, are listed at the end of each chapter for easy review, and a full glossary of important terms appears at the end of the text. The Review Questions are another important feature of this book; they include multiple-choice questions with answers as well as short essay questions. More challenging questions appear under the Points to Ponder heading.

Special Features

This book contains a number of special features that set it apart from other geology textbooks. Among them are a critical thinking and study skills section, the chapter Prologues, the integration of economic and environmental geologic issues throughout the book, and a set of multiple-choice questions with answers for each chapter. A separate section entitled "Points to Ponder" contains thought-provoking and quantitative questions.

Study Skills

Immediately following the Preface is a section devoted to developing critical thinking and study skills. This section offers hints to help students improve their study habits, prepare for exams, and generally get the most out of every course they take. While these tips can be helpful in any course, many of them are particularly relevant to geology. Whether you are just beginning college or about to graduate, take a few minutes to read over this section as these suggestions can help you in your studies and later in life.

Prologues

Many of the introductory Prologues focus on the human aspects of geology such as the eruption of Krakatau (Chapter 1), the Northridge earthquake (Chapter 9), and the Flood of '93 (Chapter 12).

Economic and Environmental Geology

The topics of environmental and economic geology are discussed throughout the text. Integrating economic and environmental geology with the chapter material helps students see the importance and relevance of geology to their lives. In addition, several chapters close with a section on resources, further emphasizing the importance of geology in today's world.

Figures

Many of the illustrations depicting geologic processes or events are block diagrams rather than cross sections so that students can more easily visualize the salient features of these processes and events. Our color paleogeographic maps in Chapter 18 are designed to illustrate clearly and accurately the geography during the various geologic periods. Full-color scenes showing associations of plants and animals in Chapter 19 are based on the most current interpretations. Great care has been taken to ensure that the art and captions provide an attractive, informative, and accurate illustration program.

Figure and Table Reference System

A color cue (➢) will be found in the text next to the first reference for each figure, and a (◉) appears beside the first reference for each table. This system is designed to help students quickly return to their place in the text when they interrupt their reading to examine an illustration or table.

Perspectives

The chapter Perspectives generally focus on aspects of environmental and economic geology such as asbestos (Chapter 8), radioactive waste disposal (Chapter 13), and radon (Chapter 17). The topics for the Perspectives were chosen to provide students with an overview of the many fascinating aspects of geology. The Perspectives can be assigned as part of the chapter reading, used as the basis for lecture or discussion topics, or even used as the starting point for student papers.

Ancillary Materials

To assist you in teaching this course and supplying your students with the best in teaching aids, West Publishing Company has prepared a complete package available to all adopters:

- The comprehensive instructor's manual and test bank includes teaching ideas, learning objectives, lecture outlines in the form of a point-by-point summary, discussions of common student misconceptions, a list of media sources, Consider This lecture questions, enrichment topics, lists of acetates and slides that accompany the text, and a test bank. The test bank contains approximately two thousand multiple-choice, true/false, fill-in-the-blank, matching, and short-answer questions.
- We can provide the entire text bank on diskette along with WESTEST, a computerized testing package. Using WESTEST 3.0, it is possible to generate examinations using either questions selected by the instructor or those randomly generated by the computer. The WESTEST 3.0 edit function makes it possible to modify these questions, add new questions, or delete existing questions. Additionally, West's Classroom Management Software allows student data to be recorded, stored, and used for various reports.
- The new CD-ROM disk, *In-TERRA-Active,* developed through West by Phil Brown (University of Wisconsin—Madison) and Jeremy Dunning (University of Indiana—

Bloomington), provides instructors and students with meaningful new ways to enhance the textbook. The illustrations, animations, photos, and video make this a teaching/learning tool of great value. Additionally, the interactive modules provide students with a new mode for mastering the material.

- West's Geology Videodisc allows instructors to display photographic images, illustrations, video segments, and computer animations in lecture or lab settings. Developed specifically for our larger text *Physical Geology: Exploring the Earth,* 2d ed., the disk contains more than 1,500 still photographs of geologic features organized by region. These can be used to show students examples of the formations discussed that are from the local area, from other regions of the country, or from around the world. The videodisc also includes illustrations and diagrams from the text.
- West's Geology Videotape Library includes the entire Planet Earth film series as well as additional programs that discuss earthquakes, mineral resources, and environmental geology topics. For a complete, up-to-date listing of the titles available, please contact your West representative.
- Three slide sets are available to qualified adopters. The first set includes approximately 150 of the most important and attractive illustrations and photographs from this text and our larger *Physical Geology,* 2d ed., and the second set contains over 450 slides illustrating important geologic features. The majority of these photographs are from North America, but the set also includes examples from around the world and the solar system. The third set includes images from the In-TERRA-Active CD, plus more photos of the 1994 Northridge earthquake.
- A new set of 225 full-color transparency acetates provides clear and effective illustrations of important artwork and maps from the text.
- A new ancillary containing all acetates printed and bound with perforated, three-hole-punched pages allows students to take notes as the acetates are shown in lecture. It also contains *Study Skills for Science Students* by Daniel Chiras, which is described below.
- *Current Issues in Geology: Selected Readings,* 2d ed., prepared by Michael L. McKinney and Robert L. Tolliver of the University of Tennessee—Knoxville, is a collection of approximately 65 very current articles that supplement material students will encounter in their coursework. The articles have been selected from a number of general interest and science magazines. West can make this supplement available with the text as a set, or it can be purchased separately.
- A copy of *Great Ideas for Teaching Geology* is available free to all adopters of the textbook. This 100-page book is a collection of lecture suggestions, demonstrations, analogies, and other ideas contributed by geology teachers from across the country. These ideas are intended to provide instructors with a variety of approaches to teaching some of the difficult concepts in geology.
- *The Changing Earth Update,* West's biannual geology newsletter, is provided to adopters twice each year to update the book with recent and relevant research news. This will ensure that your students have the most current information available.
- West Publishing also offers tutorial software for students' review and software for lecture presentations. For example, GeoTutor by Vicki Harder is a hypercard stack designed as a review program in the format of a question and answer game. Interactive Geoscience Tutorials take topics and figures in geology and illustrate them using full-color animation. Modules include the Rock Cycle, Igneous Rocks, Sedimentary Rocks, Plate Tectonics, Weathering and Erosion, Earthquakes, Minerals, and Mass Wasting, among others. Each tutorial begins with an introduction file that illustrates a concept related to the title for the tutorial. Three software programs are available from Micro-Innovations, Inc. *Quake* helps students understand the distribution of earthquakes. *Groundwater* allows students to manipulate several hydrologic variables simultaneously, then rapidly solve the modified program, and display the results graphically, and *Coastal* is an instructional program to simulate the effects of wave action on beach shape.
- *Perspectives in Canadian Geology,* prepared by I. Peter Martini and Ward Chesworth of the University of Guelph, is a collection of essays that expands upon topics in the text by highlighting the geologic features of Canada.
- Lastly, West has available *Study Skills for Science Students* by Daniel Chiras. This supplement emphasizes critical thinking and developing a positive lifestyle and provides students simple ways to improve memory, learn more quickly, get the most out of lectures, prepare for tests, produce top-notch term papers, and improve critical-thinking skills. West can make this supplement available with the text as a set, or it can be purchased separately.

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Our families were, as always, patient and encouraging when most of our spare time and energy were devoted to this book. We thank them for their continuing support and understanding.

Developing Critical Thinking and Study Skills

Introduction

College is a demanding and important time, a time when your values will be challenged, and you will try out new ideas and philosophies. You will make personal and career decisions that will affect your entire life. One of the most important lessons you can learn in college is how to balance your time among work, study, and recreation. If you develop good time management and study skills early in your college career, you will find that your college years will be successful and rewarding.

This section offers some suggestions to help you maximize your study time and develop critical thinking and study skills that will benefit you, not only in college, but throughout your life. While mastering the content of a course is obviously important, learning how to study and to think critically is, in many ways, far more important. Like most things in life, learning to think critically and study efficiently will initially require additional time and effort, but once mastered, these skills will save you time in the long run.

You may already be familiar with many of the suggestions and may find that others do not directly apply to you. Nevertheless, if you take the time to read this section and apply the appropriate suggestions to your own situation, we are confident that you will become a better and more efficient student, find your classes more rewarding, have more time for yourself, and get better grades. We have found that the better students are usually also the busiest. Because these students are busy with work or extracurricular activities, they have had to learn to study efficiently and manage their time effectively.

One of the keys to success in college is avoiding procrastination. While procrastination provides temporary satisfaction because you have avoided doing something you did not want to do, in the long run it leads to stress. While a small amount of stress can be beneficial, waiting until the last minute usually leads to mistakes and a subpar performance. By setting clear, specific goals and working toward them on a regular basis, you can greatly reduce the temptation to procrastinate. It is better to work efficiently for short periods of time than to put in long, unproductive hours on a task, which is usually what happens when you procrastinate.

Another key to success in college is staying physically fit. It is easy to fall into the habit of eating junk food and never exercising. To be mentally alert, you must be physically fit. Try to develop a program of regular exercise. You will find that you have more energy, feel better, and study more efficiently.

General Study Skills

Most courses, and geology in particular, build upon previous material, so it is extremely important to keep up with the coursework and set aside regular time for study in each of your courses. Try to follow these hints, and you will find you do better in school and have more time for yourself:

- Develop the habit of studying on a daily basis.
- Set aside a specific time each day to study. Some people are day people, and others are night people. Determine when you are most alert and use that time for study.
- Have an area dedicated for study. It should include a well-lighted space with a desk and the study materials you need, such as a dictionary, thesaurus, paper, pens and pencils, and a computer if you have one.
- Study for short periods and take frequent breaks, usually after an hour of study. Get up and move around and do something completely different. This will help you stay alert, and you'll return to your studies with renewed vigor.
- Try to review each subject every day or at least the day of the class. Develop the habit of reviewing lecture material from a class the same day.
- Become familiar with the vocabulary of the course. Look up any unfamiliar words in the glossary of your textbook or in a dictionary. Learning the language of the discipline will help you learn the material.

Getting the Most From Your Notes

If you are to get the most out of a course and do well on exams, you must learn to take good notes. This does not mean you should try to take down every word your professor says. Part of being a good note taker is knowing what is important and what you can safely leave out.

Early in the semester, try to determine whether the lecture will follow the textbook or be predominantly new material. If much of the material is covered in the textbook, your notes do not have to be as extensive or detailed as when the material is new. In any case, the following suggestions should make you a better note taker and enable you to derive the maximum amount of information from a lecture:

- Regardless of whether the lecture discusses the same material as the textbook or supplements the reading assignment, read or scan the chapter the lecture will cover before class. This way you will be somewhat familiar with the concepts and can listen critically to what is being said rather than trying to write down everything. Later a few key words or phrases will jog your memory as to what was said.
- Before each lecture, briefly review your notes from the previous lecture. Doing this will refresh your memory and provide a context for the new material.
- Develop your own style of note taking. Do not try to write down every word. These are notes you're taking, not a transcript. Learn to abbreviate and develop your own set of abbreviations and symbols for common words and phrases: for example, w/o (without), w (with), = (equals), $\wedge$ (above or increases), $\vee$ (below or decreases), $<$ (less than), $>$ (greater than), & (and), u (you).
- Geology lends itself to many abbreviations that can increase your note-taking capability: for example, pt (plate tectonics), ig (igneous), meta (metamorphic), sed (sedimentary), rx (rock or rocks), ss (sandstone), my (million years), and gts (geologic time scale).
- Rewrite your notes soon after the lecture. Rewriting your notes helps reinforce what you heard and gives you an opportunity to determine whether you understand the material.
- By learning the vocabulary of the discipline before the lecture, you can cut down on the amount you have to write—you won't have to write down a definition if you already know the word.
- Learn the mannerisms of the professor. If he or she says something is important or repeats a point, be sure to write it down and highlight it in some way. Students have told me (RW) that when I stated something twice during a lecture, they knew it was important and probably would appear on a test. (They were usually right!)
- Check any unclear points in your notes with a classmate or look them up in your textbook. Pay particular attention to the professor's examples. These usually elucidate and clarify an important point and are easier to remember than an abstract concept.
- Go to class regularly, and sit near the front of the class if possible. It is easier to hear and see what is written on the board or projected onto the screen, and there are fewer distractions.
- If the professor allows it, tape record the lecture, but don't use the recording as a substitute for notes. Listen carefully to the lecture and write down the important points; then fill in any gaps when you replay the tape.
- If your school allows it, and they are available, buy class lecture notes. These are usually taken by a graduate student who is familiar with the material; typically they are quite comprehensive. Again use these notes to supplement your own.
- Ask questions. If you don't understand something, ask the professor. Many students are reluctant to do this, especially in a large lecture hall, but if you don't understand a point, other people are probably confused as well. If you can't ask questions during a lecture, talk to the professor after the lecture or during office hours.

Getting the Most Out of What You Read

The old adage that "you get out of something what you put into it" is very true when it comes to reading textbooks. By carefully reading your text and following these suggestions, you can greatly increase your understanding of the subject:

- Look over the chapter outline to see what the material is about and how it flows from topic to topic. If you have time, skim through the chapter before you start to read in depth.
- Pay particular attention to the tables, charts, and figures. They contain a wealth of information in abbreviated form and illustrate important concepts and ideas. Geology, in particular, is a visual science, and the figures and photographs will help you visualize what is being discussed in the text and provide actual examples of features such as faults or unconformities.
- As you read your textbook, highlight or underline key concepts or sentences, but make sure you don't highlight everything. Make notes in the margins. If you don't understand a term or concept, look it up in the glossary.
- Read the chapter summary carefully. Be sure you understand all of the key terms, especially those in boldface or italic type. Because geology builds on previous material, it is imperative that you understand the terminology.
- Go over the end-of-chapter questions. Write out your answers as if you were taking a test. Only when you see your answer in writing will you know if you really understood the material.

Developing Critical Thinking Skills

Few things in life are black and white, and it is important to be able to examine an issue from all sides and come to a logical conclusion. One of the most important things you will learn in college is to think critically and not accept everything you read and hear at face value. Thinking critically is particularly important in learning new material and relating it to what you already know. Although you can't know everything, you can learn to question effectively and arrive at conclusions consistent with the facts. Thus, these suggestions for critical thinking can help you in all your courses:

- Whenever you encounter new facts, ideas, or concepts, be sure you understand and can define all of the terms used in the discussion.
- Determine how the facts or information was derived. If the facts were derived from experiments, were the experiments well executed and free of bias? Can they be repeated? The controversy over cold fusion is an excellent example. Two scientists claim to have produced cold fusion reactions using simple experimental laboratory apparatus, yet other scientists have as yet been unable to achieve the same reaction by repeating the experiments.
- Do not accept any statement at face value. What is the source of the information? How reliable is the source?
- Consider whether the conclusions follow from the facts. If the facts do not appear to support the conclusions, ask questions and try to determine why they don't. Is the argument logical or is it somehow flawed?
- Be open to new ideas. After all, the underlying principles of plate tectonic theory were known early in this century, yet were not accepted until the 1970s in spite of overwhelming evidence.
- Look at the big picture to determine how various elements are related. For example, how will constructing a dam across a river that flows to the sea affect the stream's profile? What will be the consequences to the beaches that will be deprived of sediment from the river? One of the most important lessons you can learn from your geology course is how interrelated the various systems of the Earth are. When you alter one feature, you affect numerous other features as well.

Improving Your Memory

Why do you remember some things and not others? The reason is that the brain stores information in different ways and forms, making it easy to remember some things and difficult to remember others. Because college requires that you learn a vast amount of information, any suggestions that can help you retain more material will help you in your studies:

- Pay attention to what you read or hear. Focus on the task at hand, and avoid daydreaming. Repetition of any sort will help you remember material. Review the previous lecture before going to class, or look over the last chapter before beginning the next. Ask yourself questions as you read.
- Use mnemonic devices to help you learn unfamiliar material. For example, the order of the Paleozoic periods (Cambrian, Ordovician, Silurian, Devonian, Mississippian, Pennsylvanian, and Permian) of the geologic time scale can be remembered by the phrase, *C*ampbell's *O*nion *S*oup *D*oes *M*ake *P*eter *P*ale, or the order of the Cenozoic epochs (Paleocene, Eocene, Oligocene, Miocene, Pliocene, and Pleistocene) can be remembered by the phrase, *P*ut *E*ggs *O*n *M*y *P*late *P*lease. Using rhymes can also be helpful.
- Look up the roots of important terms. If you understand where a word comes from, its meaning will be easier to remember. For example, *pyroclastic* comes from *pyro* meaning fire and *clastic* meaning broken pieces. Hence a pyroclastic rock is one formed by volcanism and composed of pieces of other rocks. We have provided the roots of many important terms throughout this text to help you remember their definitions.
- Outline the material you are studying. This will help you see how the various components are interrelated. Learning a body of related material is much easier than learning unconnected and discrete facts. Looking for relationships is particularly helpful in geology because so many things are interrelated. For example, plate tectonics explains how mountain building, volcanism, and earthquakes are all related. The rock cycle relates the three major groups of rocks to each other and to subsurface and surface processes (Chapter 1).
- Use deductive reasoning to tie concepts together. Remember that geology builds on what you learned previously. Use that material as your foundation and see how the new material relates to it.
- Draw a picture. If you can draw a picture and label its parts, you probably understand the material. Geology lends itself very well to this type of memory device because so much is visual. For example, instead of memorizing a long list of glacial terms, draw a picture of a glacier and label its parts and the type of topography it forms.
- Focus on what is important. You can't remember everything, so focus on the important points of the lecture or the chapter. Try to visualize the big picture, and use the facts to fill in the details.

Preparing For Exams

For most students, tests are the critical part of a course. To do well on an exam, you must be prepared. These suggestions will help you focus on preparing for examinations:

- The most important advice is to study regularly rather than try to cram everything into one massive study session. Get plenty of rest the night before an exam, and stay physically fit to avoid becoming susceptible to minor illnesses that sap your strength and lessen your ability to concentrate on the subject at hand.
- Set up a schedule so that you cover small parts of the material on a regular basis. Learning some concrete examples will help you understand and remember the material.
- Review the chapter summaries. Construct an outline to make sure you understand how everything fits together. Drawing diagrams will help you remember key points. Make up flash cards to help you remember terms and concepts.
- Form a study group, but make sure your group focuses on the task at hand, not on socializing. Quiz each other and compare notes to be sure you have covered all the

material. We have found that students dramatically improved their grades after forming or joining a study group.
- Write out the answers to all of the Review Questions. Before doing so, however, become thoroughly familiar with the subject matter by reviewing your lecture notes and reading the chapter. Otherwise, you will spend an inordinate amount of time looking up answers.
- If you have any questions, visit the professor or teaching assistant. If review sessions are offered, be sure to attend. If you are having problems with the material, ask for help as soon as you have difficulty. Don't wait until the end of the semester.
- If old exams are available, look at them to see what is emphasized and what type of questions are asked. Find out whether the exam will be all objective or all essay or a combination. If you have trouble with a particular type of question (such as multiple choice or essay), practice answering questions of that type—your study group or a classmate may be able to help.

Taking Exams

The most important thing to remember when taking an exam is not to panic. This, of course, is easier said than done. Almost everyone suffers from test anxiety to some degree. Usually, it passes as soon as the exam begins, but in some cases, it is so debilitating that an individual does not perform as well as he or she could. If you are one of those people, get help as soon as possible. Most colleges and universities have a program to help students overcome test anxiety or at least keep it in check. Don't be afraid to seek help if you suffer test anxiety. Your success in college depends to a large extent on how well you perform on exams, so by not seeking help, you are only hurting yourself. In addition, the following suggestions may be helpful:

- First of all, relax. Then look over the exam briefly to see its format and determine which questions are worth the most points. If it helps, quickly jot down any information you are afraid you might forget or particularly want to remember for a question.
- Answer the questions that you know the best first. Make sure, however, that you don't spend too much time on any one question or on one that is worth only a few points.
- If the exam is a combination of multiple choice and essay, answer the multiple-choice questions first. If you are not sure of an answer, go on to the next one. Sometimes the answer to one question can be found in another question. Furthermore, the multiple-choice questions may contain many of the facts needed to answer some of the essay questions.
- Read the question carefully and answer only what it asks. Save time by not repeating the question as your opening sentence to the answer. Get right to the point. Jot down a quick outline for longer essay questions to make sure you cover everything.
- If you don't understand a question, ask the examiner. Don't assume anything. After all, it is your grade that will suffer if you misinterpret the question.
- If you have time, review your exam to make sure you covered all the important points and answered all the questions.
- If you have followed our suggestions, by the time you finish the exam, you should feel confident that you did well and will have cause for celebration.

Concluding Comments

We hope that the suggestions we have offered will be of benefit to you not only in this course, but throughout your college career. Though it is difficult to break old habits and change a familiar routine, we are confident that following these suggestions will make you a better student. Furthermore, many of the suggestions will help you work more efficiently, not only in college, but also throughout your career. Learning is a lifelong process that does not end when you graduate. The critical thinking skills that you learn now will be invaluable throughout your life, both in your career and as an informed citizen.

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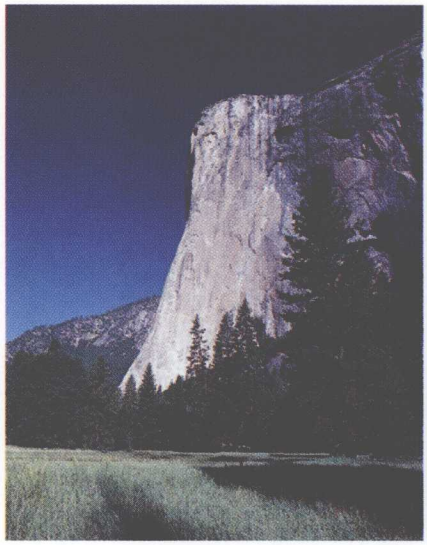

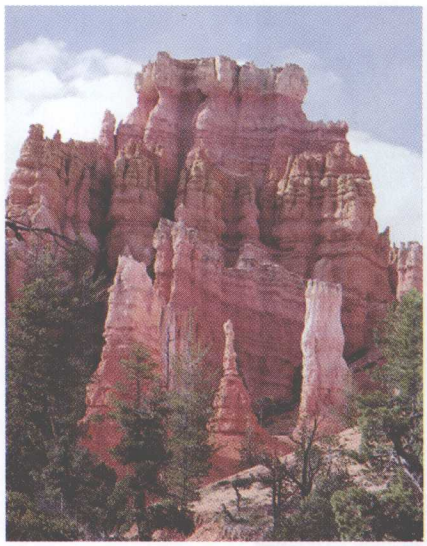

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