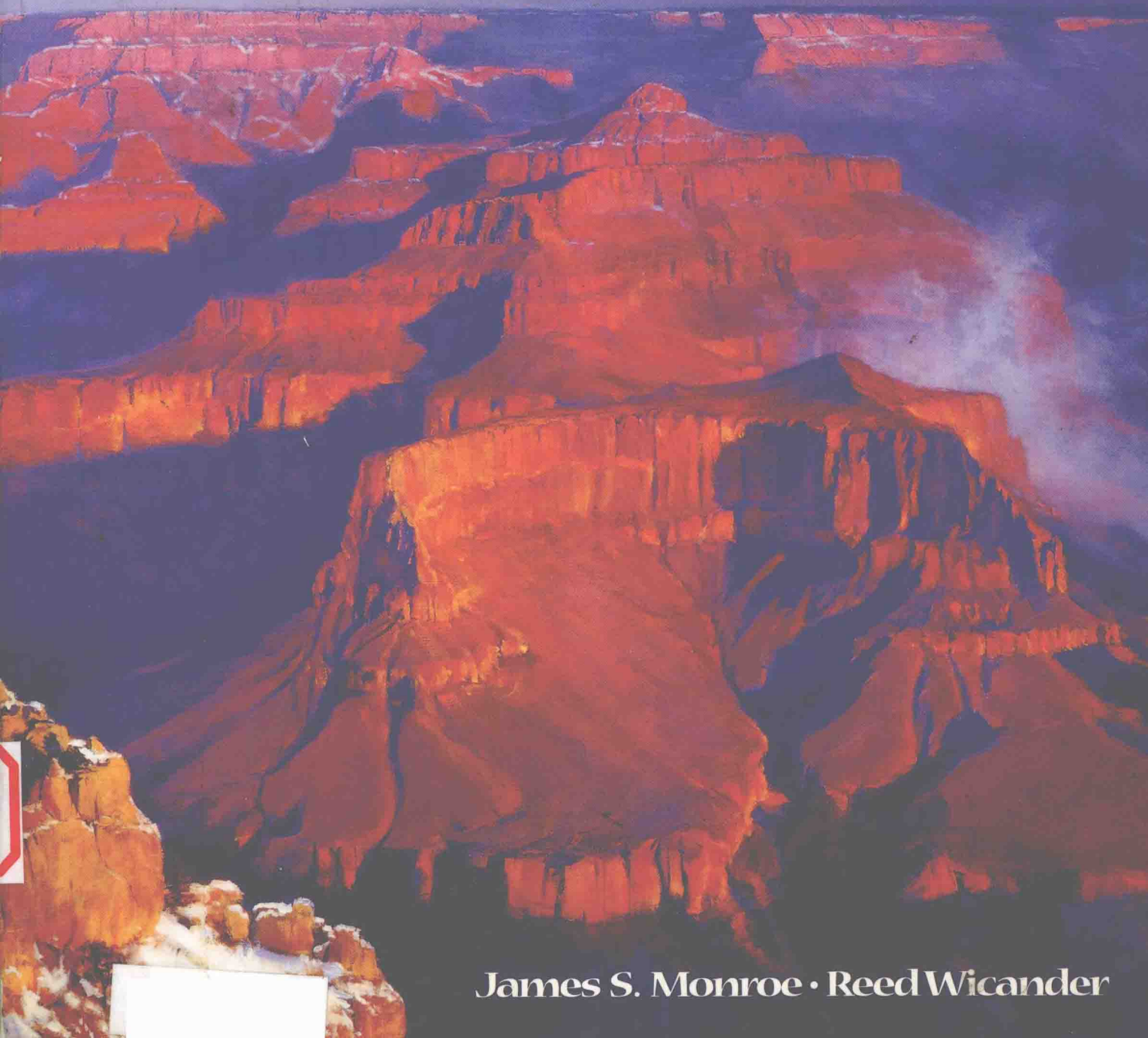
Physical Geology

Exploring the Earth

4th Edition



James S. Monroe · Reed Wicander

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Fourth Edition

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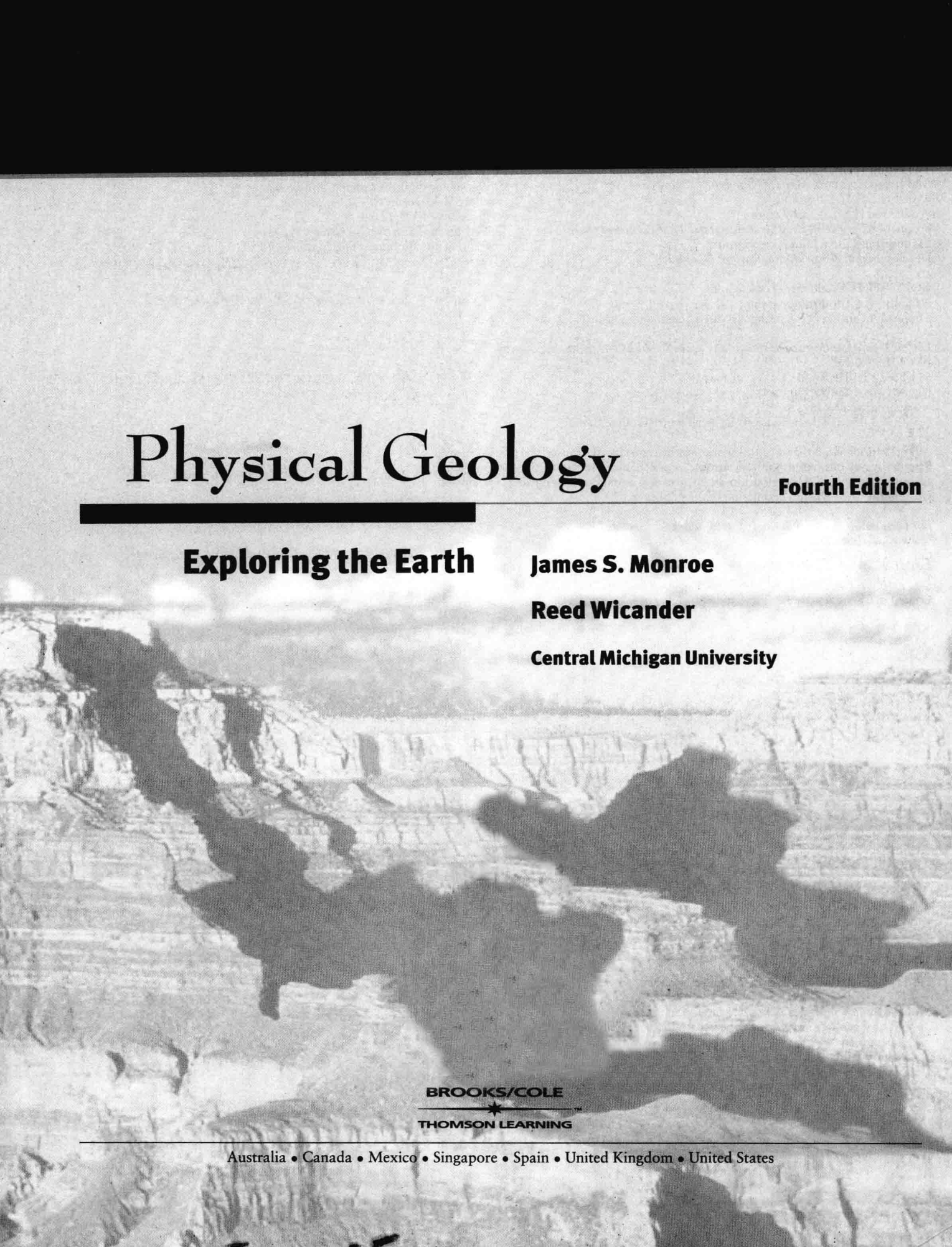
James S. Monroe

Reed Wicander

Central Michigan University



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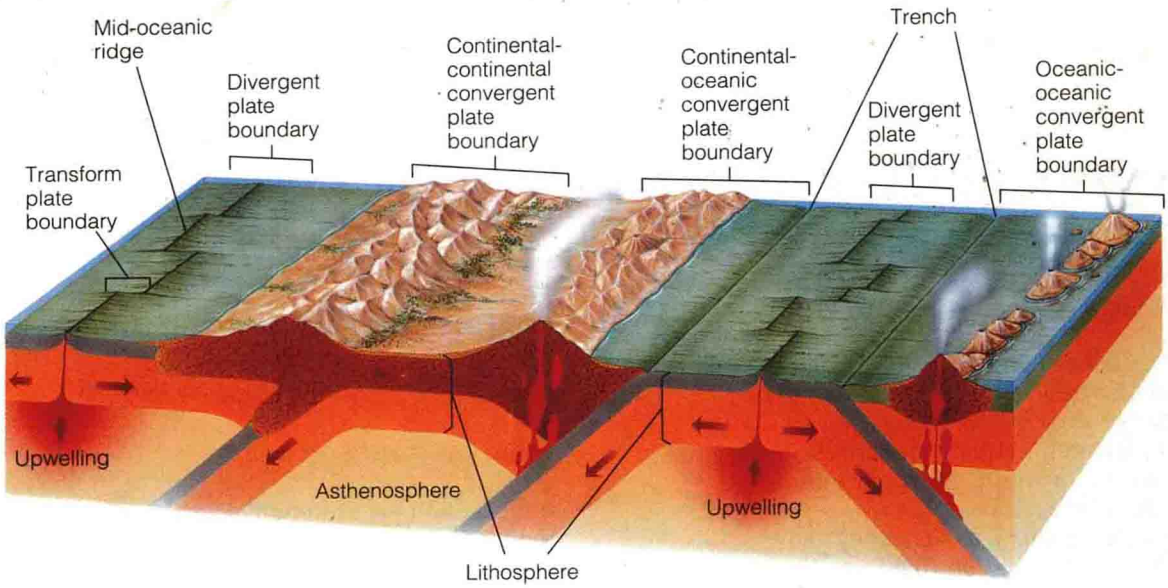
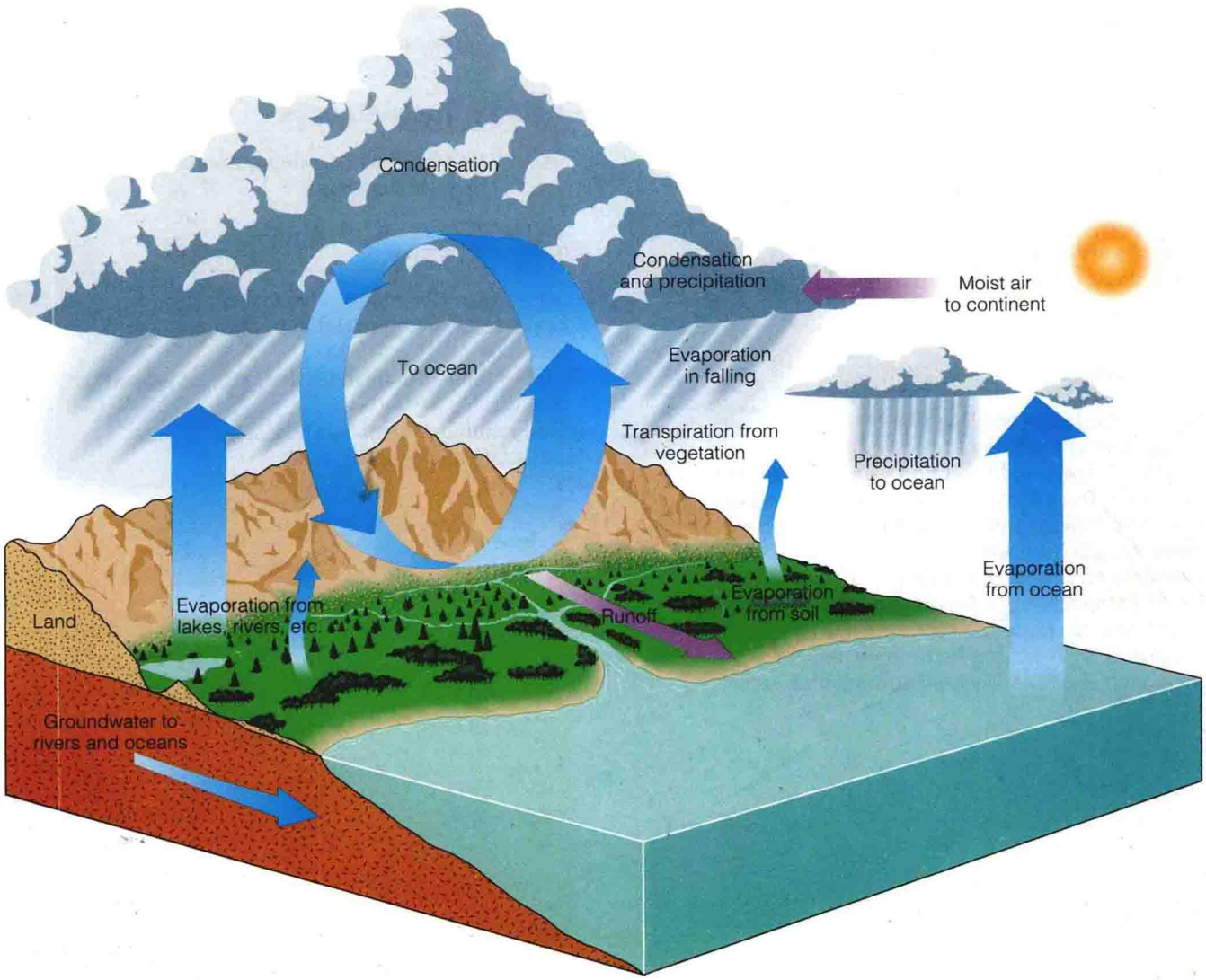


Three Principal Types of Plate Boundaries (Figure 1.16)



The Hydrologic Cycle (Figure 15.6)

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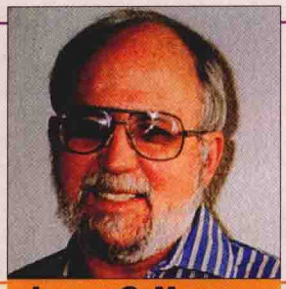

James S. Monroe

James S. Monroe is professor emeritus of geology at Central Michigan University where he taught physical geology, historical geology, prehistoric life, and stratigraphy and sedimentology since 1975. He has co-authored several textbooks with Reed Wicander and has interests in Cenozoic geology and geologic education.

Photo courtesy of Melanie Wicander

Reed Wicander

Reed Wicander is a geology professor at Central Michigan University where he teaches physical geology, historical geology, prehistoric life, and invertebrate paleontology. He has co-authored several geology textbooks with James S. Monroe. His main research interests involve various aspects of Paleozoic palynology, specifically the study of acritarchs, on which he has published many papers. He is a past president of the American Association of Stratigraphic Palynologists and currently a councillor of the International Federation of Palynological Societies.

About the Cover

Your textbook cover features a painting of the Grand Canyon by William Scott Jennings called *The Awakening*. We chose this painting for the cover because the Grand Canyon is not only symbolic of geology, but many of the basic principles of geology can be illustrated within its walls. The Grand Canyon is also linked to human experience in many different ways, which is an important theme of this book. (The Grand Canyon also serves as a background photo for all the chapter openers.)

Major John Wesley Powell, a Civil War veteran who lost his right arm in the battle of Shiloh, was the first geologist to explore the Grand Canyon region, leading a group of hardy explorers in fragile wooden boats down the uncharted Colorado River through the Grand Canyon in 1869. President Theodore Roosevelt named the Grand Canyon a national monument in 1908, and Congress upgraded it to a national park in 1919. The Grand Canyon has become such a popular tourist site that cars are now banned from many of the roads in an attempt to reduce pollutants.

When we stand on the rim and look down into the Grand Canyon, we are really looking far back in time, all the way back to the early history of our planet. More than one billion years of history are preserved in the rocks of the Grand Canyon, indicating episodes of mountain building as well as periods of transgressions and regressions of shallow seas. Three of the six fundamental principles of relative dating are also illustrated by the sequence of rocks exposed in the Grand Canyon. The Grand Canyon did not come into being by some catastrophic event, but rather by the simple action of the Colorado River eroding its channel over millions of years.

Considering the importance of the Grand Canyon to geology and its role in human history, it thus seems most appropriate that the cover of this book should be a painting of the Grand Canyon in all its grandeur.

Preface

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 biota. 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.

Physical Geology: Exploring the Earth is designed for a one-semester introductory course in geology that serves both majors and nonmajors in geology and the Earth sciences. One of the problems with any introductory science course is that students are overwhelmed by the amount of material that must be learned. Furthermore, most of the material does not seem to be linked by any unifying theme and does not always appear to be relevant to their lives.

The goals of this book are 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. 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 to enable them to see how the various systems of 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.

NEW FEATURES IN THE FOURTH EDITION

The fourth edition has undergone considerable rewriting and updating to produce a book that is easier to read with a high level of current information and many new photographs, figures, prologues, and perspectives. Drawing on the comments and suggestions of reviewers, we have incorporated many new features into this edition.

New material in this edition of *Physical Geology: Exploring the Earth* includes an expanded section on Earth Systems and an added emphasis on the systems approach throughout the book. There is updated information in every chapter, particularly such recent events as the volcanic eruptions on Montserrat Island (Chapter 1), the earthquakes in Turkey (Chapter 9), and the flooding and landslides in Venezuela (Chapter 14). The chapters on surface processes (Chapters 14–19) are still largely descriptive, but many of the sections of these chapters have been rewritten to emphasize the systems approach in discussing the dynamic nature of these processes.

Updated information on mineral and energy resources and environmental issues has been added to many chapters, such as a perspective on the precious metals (Chapter 2), chemical reactions in the atmosphere that yield sulfuric acid (Chapter 5), additional information on oil shales and tar sands (Chapter 6), and dam failures and their resulting floods (Chapter 15).

Other important changes include a number of new Prologues, such as the volcanic eruptions on Montserrat Island (Chapter 1), granitic rocks and their occurrence at various national parks (Chapter 3), the rocks and fossils in John Day Fossil Beds, Oregon (Chapter 6), the earthquakes in Turkey (Chapter 9), and flooding and landslides in Venezuela (Chapter 14). New Perspectives also appear, such as columnar jointing and unusual volcanoes (Chapter 4), geologic time and climate change (Chapter 8), the opening and closing of oceans (Chapter 11), paleogeographic reconstrucitons and maps (Chapter 12), the geologic evolution of San Francisco (Chapter 13), Waterton Lake National Park, Alberta, and Glacier National Park, Montana (Chapter 17), the geologic history of Uluṟu and Kata Tiju̱ta, Australia (Chapter 18), and the Outer Banks of North Carolina (Chapter 19).

Many photographs in the third edition have been replaced, including many of the chapter opening photographs. In addition, a number of photographs within the chapters have been enlarged to enhance their visual impact.

We feel the rewriting and updating done in the text as well as the addition of new photographs greatly improves the fourth edition by making it easier to read and comprehend, as well as a more effective teaching tool. Additionally, improvements have been made in the ancillary package that accompanies the book.

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 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 introduced in Chapter 1 and is discussed in most subsequent chapters in terms of the subject matter of that chapter.

Another theme of this book is that Earth is a complex, dynamic planet that has changed continually since its origin some 4.6 billion years ago. We can better understand this complexity by using a systems approach in the study of Earth. As mentioned earlier, we have expanded the section on Earth Systems in Chapter 1 and emphasized this approach throughout the book.

We have organized *Physical Geology: Exploring the Earth* into several informal categories. Chapter 1 is an introduction to geology and Earth Systems, 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. Chapters 2–7 examine 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. Chapter 8 discusses geologic time, introduces several dating methods, and

explains how geologists correlate rocks. Chapters 9–13 deal with the related topics of Earth's interior, the seafloor, earthquakes, deformation and mountain building, and plate tectonics. Chapters 14–19 cover Earth's surface processes. Chapter 20 discusses the origin of the universe and solar system and Earth's place in the evolution of these larger systems.

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 that relates to the chapter material, a detailed outline that engages the students by having many of the headings as questions, a Chapter Objectives outline, followed by a Prologue, which is intended to stimulate interest in the chapter by discussing some aspect 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 at least one Perspective that presents a brief discussion of an interesting aspect of geology or geological research. What Would You Do? boxes are a new feature in each chapter. These boxes are designed to encourage critical thinking by the students as they attempt to solve a hypothetical problem or issue on the local, national, and global level. Each chapter has at least two What Would You Do? boxes. Mineral and energy resources are discussed in the final sections of a number of chapters to provide interesting, relevant information in the context of the chapter topics.

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 answer and essay questions, and thought-provoking and quantitative questions under the Points to Ponder heading. Many new multiple-choice, short answer, essay, and Points to Ponder questions have been added in each chapter for this edition. Each chapter concludes with World Wide Web Activities that list World Wide Web sites students can visit to get additional information about the topics covered in that chapter, and a CD-ROM Exploration. In the previous three editions, a list of Additional Readings appeared at the end of each chapter. In the fourth edition, however, this list has been deleted from the text and moved to the World Wide Web. For students interested in pursuing a particular topic, an up-to-date list of Additional Readings for each chapter is available at **http://www.brookscole.com/geo**

FOR STUDENTS

CURRENT PERSPECTIVES IN GEOLOGY, 2000 EDITION
Michael McKinney, Kathleen McHugh, and Susan Meadows (University of Tennessee, Knoxville)
This book of 42 current readings is designed to supplement any geology textbook and is ideal for instructors who include a writing component in their course. The articles are culled from a number of popular science magazines (such as *American Scientist, National Wildlife, Discover, Science, New Scientist,* and *Nature*). Available for sale to students or bundled at a discount with any Brooks/Cole geology text.
0-534-37213-9

ESSENTIAL STUDY SKILLS FOR SCIENCE STUDENTS
Daniel Chiras (University of Colorado–Denver)
Designed to accompany any introductory science text. It offers tips on improving your memory, learning more quickly, getting the most out of lectures, preparing for tests, producing first-rate term papers, and improving critical thinking skills. For just one dollar extra, it can be bundled with every student copy of the text.
0-534-37595-2

EARTH SYSTEMS TODAY™: THE BROOKS/COLE EARTH SCIENCES CD-ROM FOR STUDENTS
Create a landslide. Predict a volcanic eruption. Locate the epicenter of an earthquake. Or explore other key topics in geology through some 50 interactive exercises on CD-ROM. In each case, students can manipulate variables and data and view the results of their selections. Over 35 minutes of full motion video clips, plus animations, help illustrate difficult concepts. This CD-ROM offers an easy-to-use, graphically oriented interface, a searchable glossary, and user-tracking for professors to monitor student progress.
0-534-37733-5

GEOLOGY WORKBOOK FOR THE WEB
Bruce Blackerby (California State University–Fresno)
Over twenty chapters designed to encourage students to explore geology-related sites on the Internet. Chapter exercises, on topics from Minerals to Cenozoic Earth, focus most heavily on physical geology. The workbook comes three-hole punched with perforated pages for easy tearing, so worksheets can be handed in as assignments.
0-314-21072-5

EARTH ONLINE
Michael Ritter (University of Wisconsin–Stevens Point)
An inexpensive, hands-on Internet guide written for the novice. It provides a tool for students to get "up and running" on the Internet with homework exercises, lab exercises, Web searches, and more. To keep the book as useful as possible, the author maintains an Earth Online home page with exercises, tips, new links, and constant updates of the exercises and reference sites. Access it through the Brooks/Cole Earth Science Resource Center at http://www.brookscole.com/geo/.
0-534-51707-2

STUDY GUIDE
Christopher Haley (Virginia Wesleyan College)
A valuable tool to help you excel in this course! Filled with sample test questions, learning objectives, useful analogies, key terms, drawings and figures, and vocabulary reviews to guide your study.
0-534-37520-0

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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. Taking good notes does not mean you should try to write 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 about 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, which 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 if 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 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 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 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.
- Access the latest geologic information on the Internet. The end-of-chapter World Wide Web Activities will enhance your understanding of the chapter concepts and the way geologic information is disseminated today. Knowing how to search the Internet is an essential skill.

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 claimed to have produced cold fusion reactions using simple experimental laboratory apparatus, yet other scientists have never been able 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 despite 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 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, Campbell's Onion Soup Does Make Peter Pale, or the order of the Cenozoic Epochs (Paleocene, Eocene, Oligocene, Miocene, Pliocene, and Pleistocene) can be remembered by the phrase, Put Eggs On My Plate Please. 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 practice 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 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 the answers to all 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 types 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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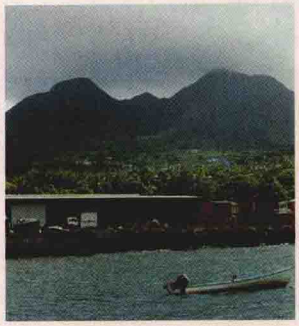

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