

PHYSICAL GEOLOGY EARTH REVEALED

Fourth Edition

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Physical Geology
EARTH REVEALED

Fourth Edition

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Physical Geology
EARTH REVEALED

Free Plate Tectonics CD-ROM Inside

Preface

Physical Geology: *Earth Revealed* is a straightforward, easy-to-read introduction to geology both for nonscience majors and for students contemplating majoring in geology. This book contains the same text and illustrations as the updated version of the eighth edition of *Physical Geology* by Plummer, McGeary, and Carlson. The chapter order has been changed so that internal processes (plate tectonics, earthquakes, etc.) are covered in the first part of the book and external process (rivers, glaciers, etc.) are described toward the end of the book. This ordering is favored by many geology instructors. *Physical Geology: Earth Revealed* is featured as the companion text to *Earth Revealed Introductory Geology*, a PBS television course and video resource produced in collaboration with the Annenberg/CPB Project. *Earth Revealed* is a series of twenty-six half-hour video programs organized around the chapters of this text. The television programs document evidence of geologic principles at geographically diverse sites, often using a case study approach. Videocassettes can be purchased individually or as a thirteen-tape set. A *Study Guide* and *Faculty Guide* are also available to supplement the programs. For information regarding the use of *Earth Revealed Introductory Geology* as a television course, or to purchase videocassettes for institutional or classroom use, contact The Annenberg/CPB Multimedia Collection at 1-800-LEARNER.

The book contains more information than can normally be covered during a college term. This provides flexibility for the instructor who wishes to emphasize some topics while covering other topics superficially. It is also useful to the student who wants to pursue topics beyond what is covered in the classroom.

This edition greatly expands and improves upon the use of electronic resources. Also integrated into this edition is David McConnell's *The Good Earth*, an Internet Resource for Introductory Geology. This digital method of teaching will give students a more "hands-on" approach to learning geology. *The Good Earth* is organized into chapters, with animations used to explain certain processes. Chapter summaries, quizzes, exercises, and web links to related websites are also included. With the purchase of a new textbook, the student will gain access to this resource, which can be found at <http://www.mhhe.com/earthsci/geology/mcconnell/>. Look for the Post-it notes on chapter opener pages to find out how *The Good Earth* can help you understand geology.

Journey Through Geology (the two CD-ROMs that accompany this book) is an exciting supplement. This was produced in partnership with The Smithsonian Institution. "Interacting with *Journey Through Geology*" at the end of each chapter has questions to help the student get the maximum benefit from use of the CDs.

The Internet section at the end of each chapter should make it easy and meaningful for the student to enrich his or her knowledge through the World Wide Web. We have listed websites that we personally checked for usefulness. The universal resource locators (URLs) are printed in blue and easy to read. However, typing in a lengthy URL will not be necessary as we have the sites listed as links on the book's website. The user need only click on the link. Appropriate new websites that are discovered after publication will be added to this book's website.

Obsolete or defunct websites will be so noted. To help students effectively and efficiently use the Internet from the website, we include step-by-step procedures and pose questions. The primary purpose of the questions is to guide students through thinking about the topic at hand. We expect that many students will explore topics beyond where we have let them.

Some of the changes we made for the fourth edition follow. Recent major disasters, such as the devastating earthquake in Turkey and the tsunami in New Guinea are described. We have taken a number of descriptions and examples of geologic resources from the final chapter of the book and integrated them into appropriate chapters elsewhere in the book. The rock cycle (in chapter 9) has been expanded to include a plate tectonic example. The discussion of the origin of magmas at convergent boundaries (chapter 11) places more emphasis on the current view by researchers that mafic magmas are generated in the asthenosphere above the subducted oceanic crust. All diagrams showing magma generation at convergent boundaries were redone. In the chapter on geologic time we have introduced the term "actualism" and discussed why it might be preferable to "uniformitarianism." Lateral continuity and inclusions have been added to the principles used for determining relative time relationships. In the metamorphic chapter we have related foliation to the modern concept of gravitational collapse and spreading. We moved unconformities from the structural geology chapter to the geological time chapter. We now use "numerical age" rather than "absolute age" in the geologic time chapter. A section on changing concepts of the age of the earth has been added. The relationship between isotopic dating and the geologic time scale has been expanded. The 1996 (and 1999) rockfall at Yosemite is used as an example of mass wasting. The stream chapter underwent a major revision and now includes an expanded discussion of flooding with examples from the 1997 floods in the upper Midwest and California. In the glaciation chapter we clarify and expand on the conversion of snow to glacier ice. In the structure chapter, the section on stress and strain and the behavior of rocks was rewritten and new examples and figures are included to clarify these difficult concepts. Love and Rayleigh waves are now discussed and illustrated in the earthquake chapter. In the chapter on mountains and the continental crust we added a section on the disparity of the height of the Rocky Mountains and the thickness of the crust and describe recent work that indicates that the Basin and Range Mountains were three kilometers higher than at present. An appendix listing commonly used prefixes, suffixes, and root words was added. The geologic map of North America was moved from the appendix to the inside front cover.

We added new boxes on water and ice—molecules and crystals, flight hazards associated with volcanoes, the eruptions on Montserrat compared to the disastrous eruption that destroyed St. Pierre on Martinique in 1902, the Bingham Canyon copper mine, highlights of biological evolution through time, and the meteorite from Mars with possible signs of former life. A box on water beneath glaciers describes the recently discovered lake beneath the East Antarctic Ice Sheet, surging glaciers, and subglacial volcanism and flooding in Iceland. The stream chapter includes boxes on the planned flood in the Grand Canyon

and how the recurrence interval of large floods is calculated. The structure chapter includes a box on how to find oil and the salt dome box has been expanded. The interior of the earth chapter now includes a box on the spinning inner core. In the mountains chapter we added a box on a systems approach to understanding mountains and expanded a former box, retitling it "Dance of the Continents (with SWEAT)."

The fourth edition has a new look with many of the diagrams redone or replaced. New photos have also been added and include the volcanic eruption at Soufriere, Montserrat, the 1997 Yosemite rockfall, glacially carved features in the Teton range, and giant stream ripples. Photos of many rocks and minerals and geologic structures have been replaced.

Supplements to Accompany *Physical Geology: Earth Revealed, Fourth Edition*:

- *Journey Through Geology* two CD-ROM set
- *Instructor's Manual*
- *computerized testing software*
- *224 transparencies and 350 slides*
- *Visual Resource Library CD-ROM*
- *Student Study Guide*
- *Physical Geology and Journey Through Geology websites*

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Additional classroom tools include:

- *The American Geological Institute's Videodisc*
- *JLM Visuals Physical Geology Photo CD*
- *Interactive Plate Tectonics CD-ROM, Annual Editions: Geology 98/99*
- *Student Atlas of Environmental Issues*
- *McGraw-Hill Learning Architecture*

For additional information on *Physical Geology: Earth Revealed*, or *Journey Through Geology CD-ROM*, please visit our Websites at <http://www.mhhe.com/earthsci/geology/plummer> or www.mhhe.com/jtg.

We have tried to write a book that will be useful and exciting to students (and instructors). We would be grateful for any comments by users, especially regarding mistakes within the text or sources of good geological photographs.

We would like to thank Susan Slaymaker for writing the original boxed material on planetary geology, and Judi Kushick for writing the questions to accompany The Smithsonian Institution's *Journey Through Geology* CD-ROM.

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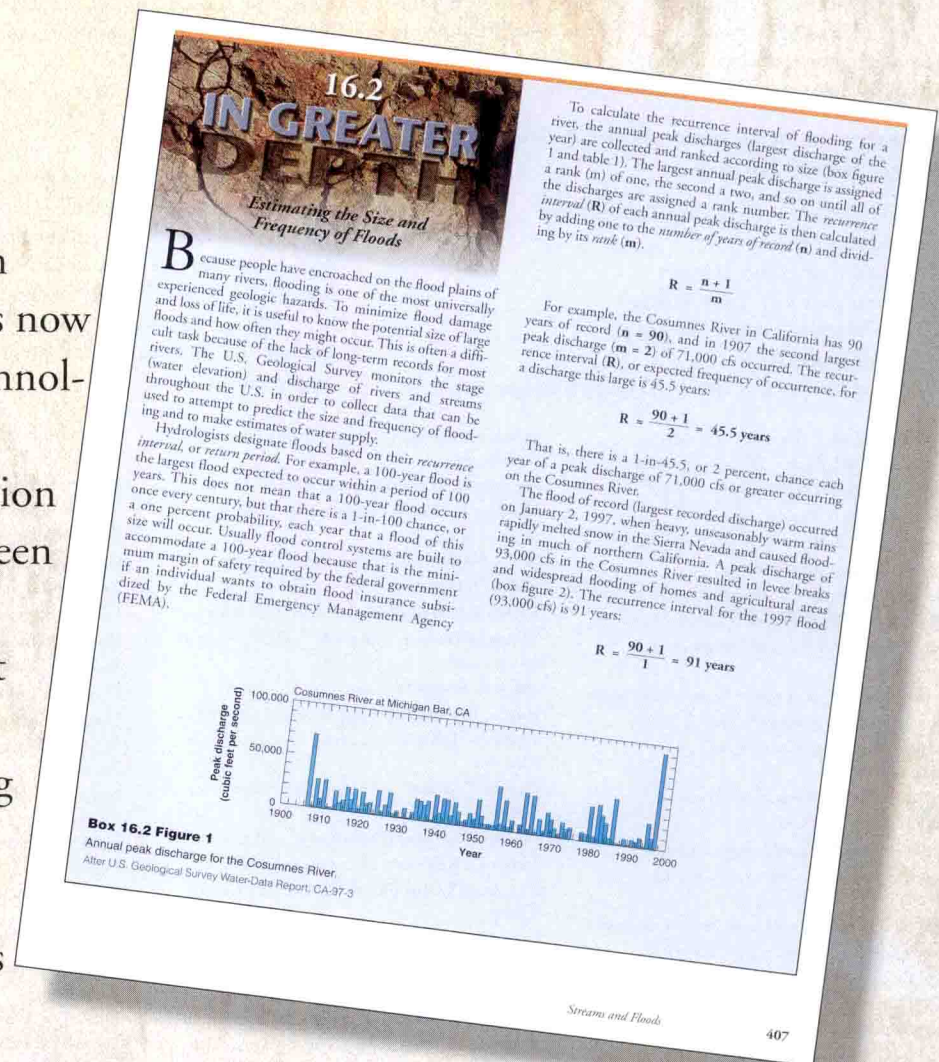
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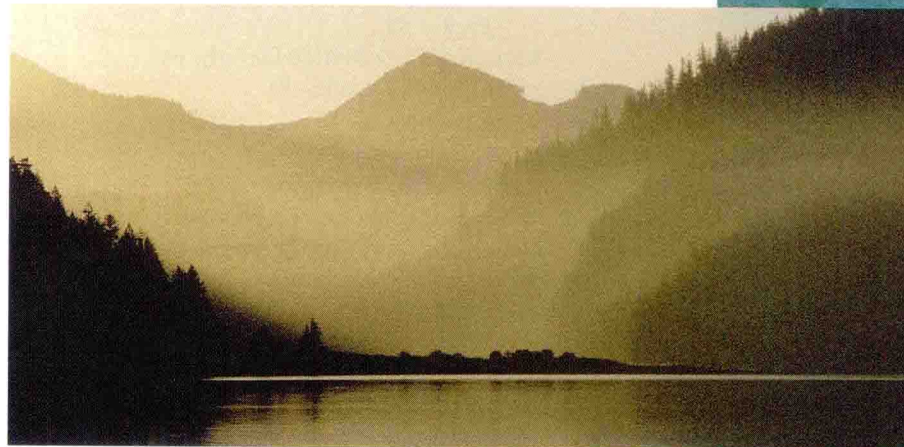
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Additional support helps you make the grade.

Use these helpful end-of-chapter learning aids to prepare for tests and quizzes.


Summary—overviews of chapter content.

Terms to Remember—important terms to review and remember.

Testing Your Knowledge—realistic sample tests you can use to prepare for exams and improve your grades.


Expanding Your Knowledge—questions that help you develop critical thinking skills.

Exploring Resources—Supplemental references in a number of different media.

 Textbook reference

 CD-ROM

 Videotape

 World Wide Web addresses

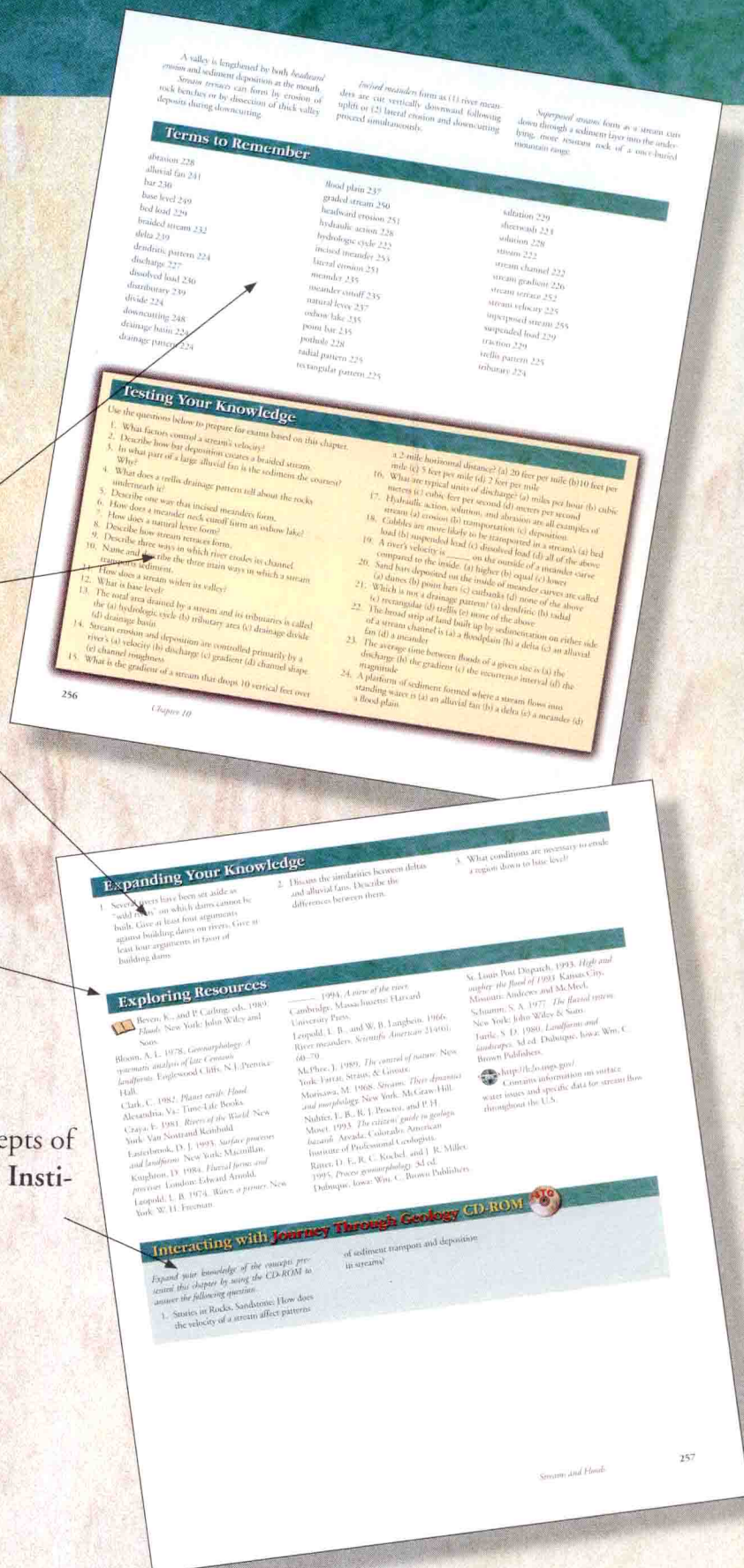
Interacting with Journey Through Geology

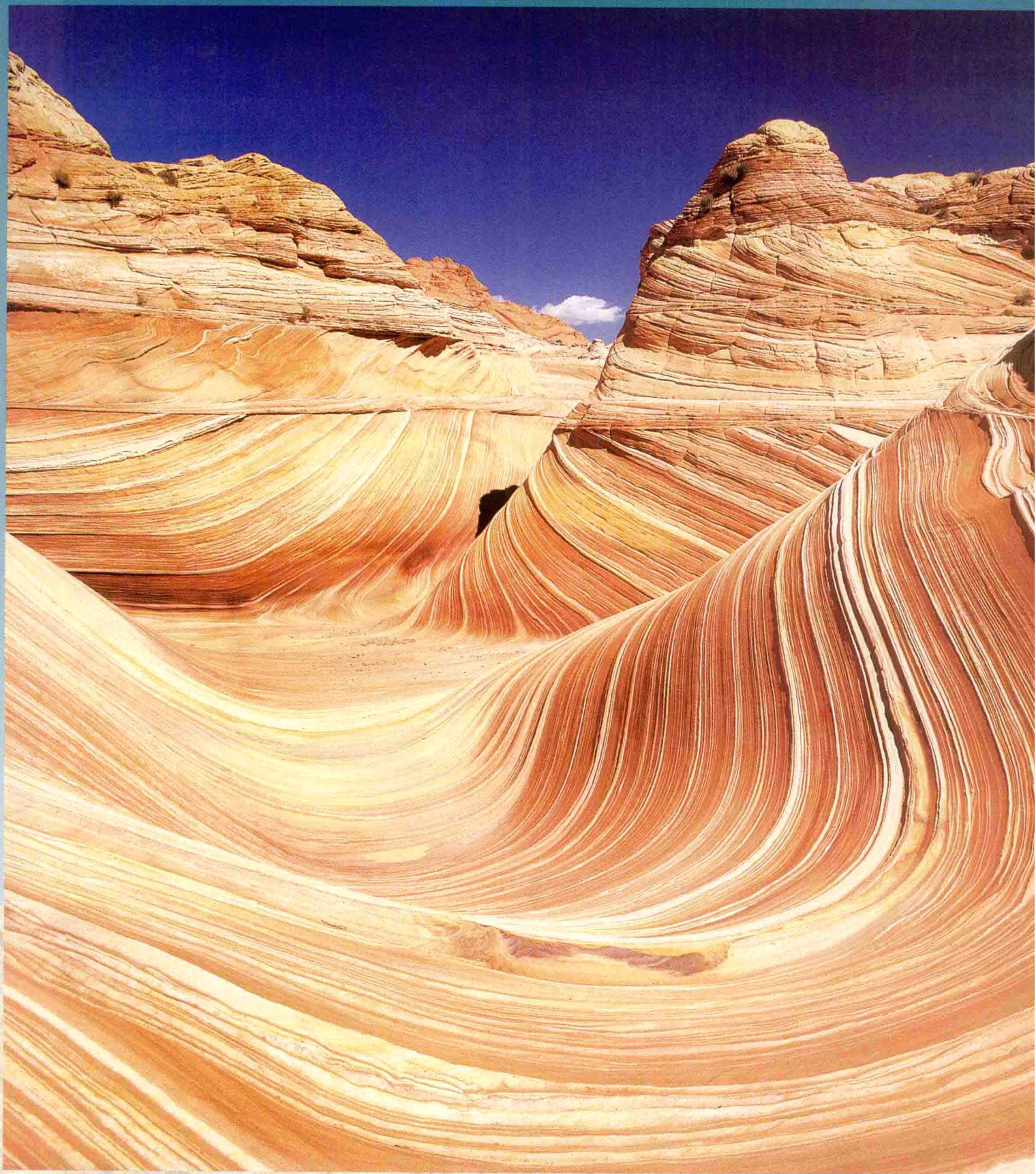
CD-ROM—questions that help tie the concepts of the chapter to modules of **The Smithsonian Institution's Journey Through Geology** two CD-ROM set.

Learn more about this text.

Visit the *Physical Geology* Website:

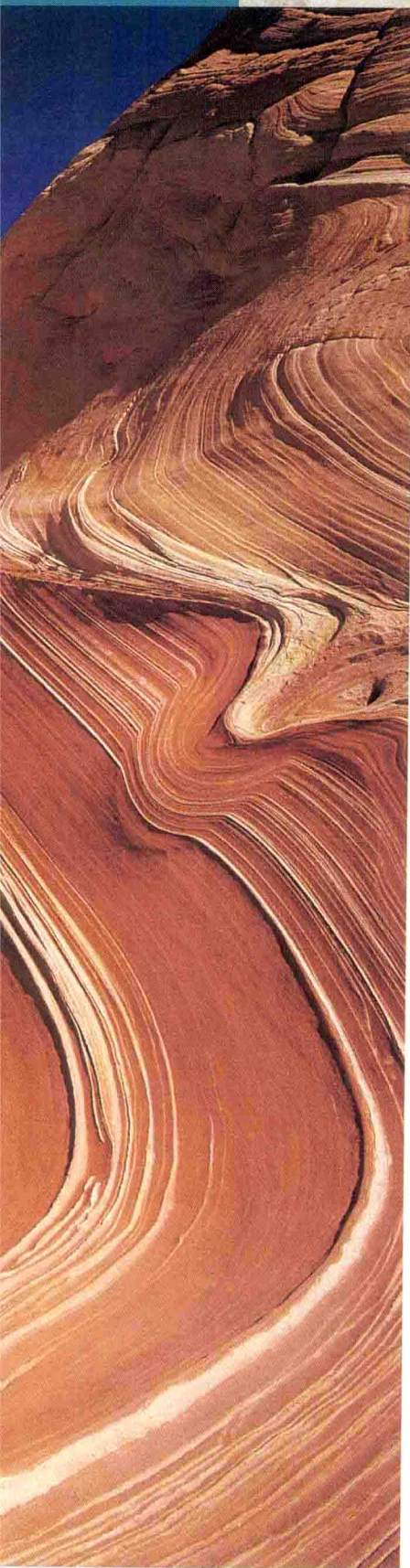
www.mhhe.com/plummer





Natural rock sculpture in Paria Plateau, Arizona. Sandstone formed from ancient sand dunes. Running water has eroded the rock into the present distinctive shapes.

Photo © Kerrick James



CHAPTER 1

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Introduction to Physical Geology

Geology uses the scientific method to explain natural aspects of the earth—for example, how mountains form or why oil resources are concentrated in some rocks and not in others. This chapter briefly explains how and why the earth's surface, and its interior, are constantly changing. It relates this constant change to the major geological topics of interaction of the atmosphere, water and rock, the modern theory of plate tectonics, and geologic time. These concepts form a framework for the rest of the book. Understanding the “big picture” presented here will aid you in comprehending the chapters that follow.