Third Edition

Physical Geology

Plummer / McGeary

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California State University, Sacramento

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Wm. C. Brown Publishers
Dubuque, Iowa

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Cover: Monument Valley, Utah, by Wolfgang Klein/ The Image Bank, Chicago

Library of Congress Catalog Card Number: 84-71808

ISBN 0-697-05046-7

Printed in the United States of America
10 9 8 7 6 5 4 3

Physical Geology

Preface

This third edition of *Physical Geology* is a straight-forward, easy-to-read introduction to geology for both geology majors and nonmajors. The organization of the book is traditional and matches the organization of most lab manuals. Each chapter has been written to be as self-contained as possible so that the instructor can reorganize the chapter sequence if desired.

Most of the changes in this edition are in the illustrations. The artwork and labels for many of the line drawings have been improved and several new line drawings have been added. These changes should be particularly noticeable in the chapters on geologic time, rivers, beaches, and mountains and continents. We have changed many photographs and added several new ones. The introductory chapters on rocks contain many new photos of hand specimens. New photos of landscape features (including several photos by John S. Shelton) improve many chapters, especially those on geologic time, mass wasting, rivers, glaciers, deserts, and beaches.

We have rewritten several sections of the book to make them more readable and have reduced the number of boldface "terms to remember."

We have changed the order of three chapters near the end of the book at the request of many of you who use the book. Chapter 18 now describes sea-floor features and sedimentary processes but does not discuss sea-floor spreading. Chapter 19 shows how plate tectonics was derived from the concepts of continental drift and sea-floor spreading. It discusses the *origin* of those sea-floor features *described* in the previous chapter. Chapter 20 describes mountains and continental crust as a result of plate tectonics, including the accretion of "suspect terranes." Also in this chapter is a new box on the thin-skinned tectonics of the southern Appalachians, as interpreted from recent COCORP profiles. We (and several adopters) feel that this new organization presents relatively difficult material in a new, logical sequence.

The boxes within the text are of two types: (1) topics of special human or environmental concern, such as the dangers of living in river cities or the amount of fresh water stored in glacial ice; and (2) topics slightly more difficult than the rest of the text, such as the electrostatic charge on clay minerals. The boxed material, while informative and interesting, should be considered supplemental to the text.

Physical Geology is accompanied by an instructor's manual, student study guide, and a laboratory manual. The Instructor's Manual, written by the authors of the text, gives specific learning objectives for the twenty-two chapters in the text as well as numerous suggestions for demonstrations, discussions, lab experiments, and exam questions. The manual also suggests course outlines and a lab schedule and provides lists of suppliers of films, slides, rocks and minerals, and information for the course as a whole.

The Student Study Guide provides a solid foundation for a beginning geology student. Written by Esther Tuttle, a science editor, and Sherwood D. Tuttle, professor of geology at the University of Iowa, the guide stresses the fundamentals of geology, the vocabulary of the science, and the techniques for successful learning in the field of geology.

The Laboratory Manual, by James Zumberge and Robert Rutford, has been especially designed to be used with *Physical Geology*. It presents a good selection of experiments for use in the laboratory.

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

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Acknowledgments
Susan Clark Slaymaker, of the Geology Department of California State University, Sacramento, wrote chapter 22, "Astrogeology," in *Physical Geology.* We are grateful for her assistance.

The successful completion of *Physical Geology* is largely due to the efforts of our reviewers, who gave us invaluable advice and guidance throughout the writing and revision of the manuscript. We extend our special thanks and appreciation to those who reviewed all or part of the manuscript, including Richard Smosna, West Virginia University; Greg S. Conrad, Sam Houston State University; Stephen H. Watts, Sir Sandford Fleming College; Barry Haskell, Los Angeles Pierce College; and Charles R. Singler, Youngstown State University.

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Boxes

1

Introduction to Physical Geology

Purpose

Geology uses the scientific method to explain natural aspects of the earth—for example, how mountains form and valleys develop, 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 the modern theory of plate tectonics, the rock cycle, and geologic time. These concepts form a framework for the rest of the book. Understanding them will aid you in studying the chapters that follow.

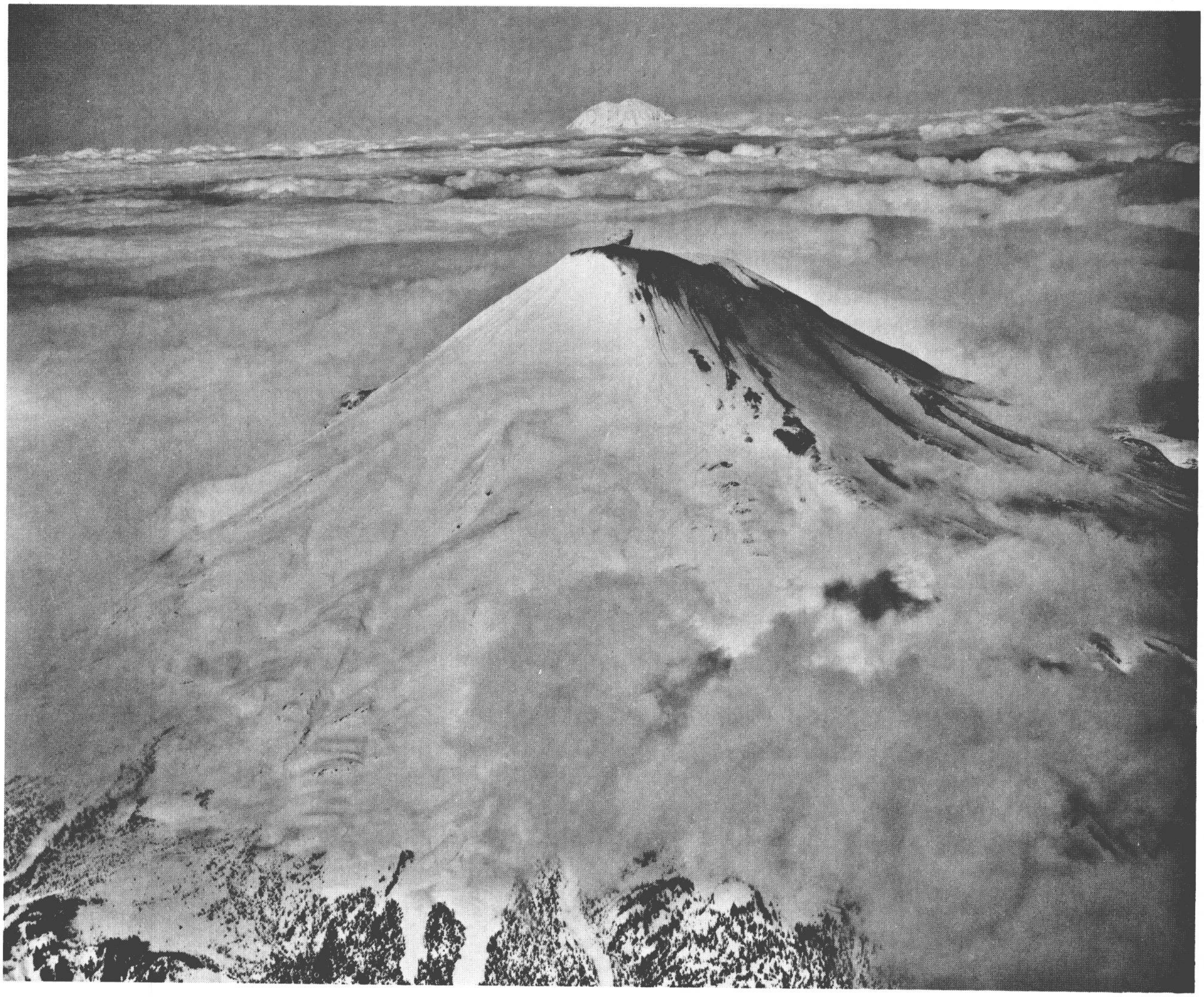

Figure 1.1 Mount St. Helens before May 18, 1980. A minor eruption is taking place.
Photo by U.S. Geological Survey.

The Earth: A Giant Machine

In March 1980, after over a century of inactivity, Mount St. Helens in the state of Washington came to life. For six weeks the eruptions were relatively minor (figure 1.1). A series of steam explosions puffed out fragments of old rock. Then on May 18, 1980, the once beautifully symmetrical, snow-capped cone blew apart with a force equal to about 10 million tons of dynamite exploding—500 times the energy released by the first atomic bomb (figure 1.2).

As the north flank of the peak disintegrated, a huge avalanche composed of volcanic ash and searingly hot gases roared downward. This was followed by a tremendous lateral blast of steam and ash from the flank of the volcano, destroying about 600 square kilometers of forest. Great volumes of volcanic debris billowed into the atmosphere to be carried eastward by the prevailing winds (figure 1.3). During the next few days large parts of Montana, Idaho, and eastern Washington were blanketed by volcanic ash

Figure 1.2 Mount St. Helens, June 4, 1980. View of what once was the northern flank of the volcano.
Photo by U.S. Geological Survey.

fallout. Volcanic dust in the very high atmosphere was carried completely around the world.

Heat from the eruption melted the snow and glacial ice on Mount St. Helens. Mudflows (slurries of volcanic debris and water) sped down stream channels (figure 1.4). A particularly large mudflow topped the banks of the Toutle River, destroying bridges and paralyzing traffic on major highways. Debris carried by the Toutle River was dumped into the Columbia River, blocking ship traffic between Portland, Oregon, and the Pacific Ocean.

The awesome energy released in this spectacle was a product of the earth's machinery, machinery driven by forces both within and on the earth. Mount St. Helens is only a small part of the constant, ordinarily slow, changing of the earth. Ocean basins open and close. Mountain ranges rise and are worn down to plains. Studying how the earth's machinery works can be as exciting as watching a great theatrical performance. Understanding the changes that take place in and on the earth, and the reasons for those changes, is the challenging objective of **geology,** the scientific study of the earth.

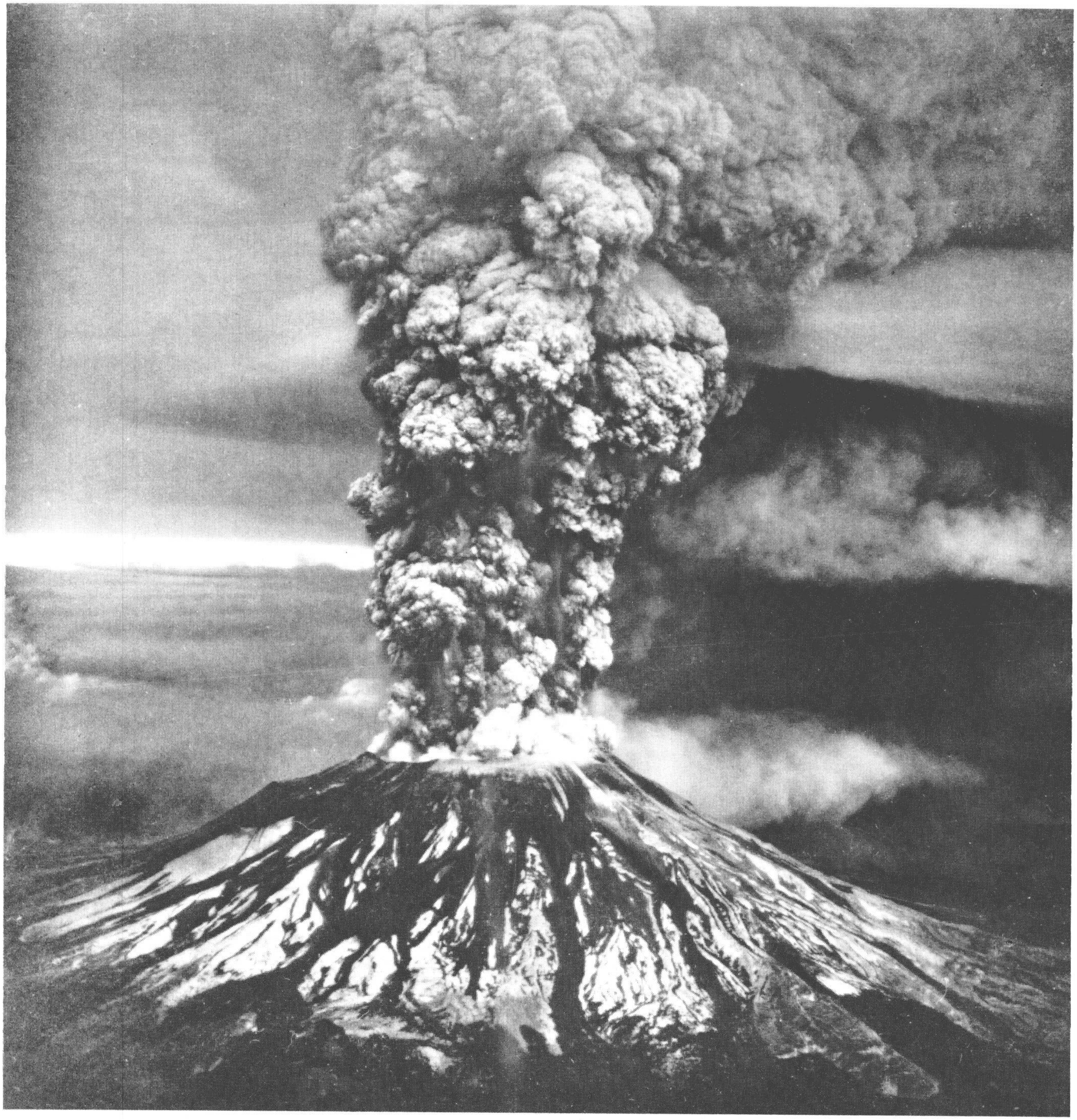

Figure 1.3 Mount St. Helens, May 18, 1980.
Photo by U.S. Geological Survey.