

Carla W. Montgomery

Physical Geology



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Carla W. Montgomery

Northern Illinois University

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A biologist colleague once remarked that everyone should take one course each in geology, botany, and astronomy, for everywhere one goes there are rocks, plants, and stars. A strong case could be made for physical geology as that one geology course. The broad subject of physical geology comprises the study of the various geologic features and materials of the earth as well as the nature of the processes by which they are formed and modified. It therefore gives us a greater understanding of the planet upon which we live. As humans have come increasingly to depend on geologic resources, knowledge of geology has been important in realizing the origins and the limitations of those resources. We have also come to recognize not only that we can anticipate—and therefore avoid—some of the disasters that are a natural consequence of certain geologic processes; in a few cases, we may even be able to modify those processes for our benefit.

In practice, most students who study physical geology fall into one of two groups. Some are prospective geology majors, for whom the wide perspective of physical geology is commonly the foundation on which more advanced coursework builds. A larger number are nonmajors, and indeed not prospective scientists of any kind, who are prompted to take the course by some mixture of interest in the subject and the need to satisfy a science distribution requirement. Although the needs of these two groups are not identical, every effort has been made to devise a text with sufficient versatility and appropriate learning aids so that it can serve both kinds of students.

About the Book

The book is intended for an introductory-level college course in physical geology. It assumes no prior exposure to college-level mathematics or science. For the most part, metric units are used throughout, except where other units are conventional within a discipline. For the convenience of students not yet comfortable with the metric system, a unit conversion table is given in Appendix C, and English-unit equivalents are occasionally given within the text also.

The subject matter is divided into four parts. In the first part, Fundamentals, the student is introduced to the nature of geology as a science; to the broad outline of the history of the earth by way of historical perspective; to minerals and rocks, the building blocks of geologic features; and to the concept of time in geology.

Once this groundwork has been laid, the second part, Internal Processes and Structures, explores the major features and processes of the earth's interior. It begins with plate tectonics, which provides the conceptual framework for understanding much about seismicity and volcanism. Chapters on earthquakes and volcanoes follow. The data of seismology and volcanology are the major source of information about the earth's interior, the subject of the next chapter. Part Two concludes with chapters on the continental crust, including crustal structures and mountain-building, and the ocean basins and crust.

Superimposed on these large-scale features are the effects of the Surface Processes, the subject of Part Three. These include the various ways in which water, ice, wind, and gravity act to modify the earth's surface features and forms. It is at the surface that we see the interaction between the internal heat that drives the internal processes discussed in Part Two and the solar energy that drives the winds and the water cycle.

The subjects of Part Four, Contemporary Topics, go somewhat beyond the traditional concerns of classical physical geology, yet they are closely linked to it. There is growing preoccupation with availability of resources. Mineral and many energy sources are formed or concentrated by geologic processes, and these are explored in chapters 20 and 21. The final chapter briefly surveys our fellow travelers in the solar system—other planets, moons, asteroids, meteorites, and comets. Advances in knowledge and understanding resulting from various space missions of the past two decades make it possible to compare many of the features of planetary objects with possible terrestrial counterparts. Appendix A presents a short introduction to the nature and interpretation of topographic and geologic maps and to satellite imagery. Appendix B provides an identification chart for common minerals and some guidelines for recognizing different rock types.

To the Instructor

The organization described above differs somewhat from most physical geology texts, primarily in the placement of internal processes ahead of surface processes, and the appearance of plate tectonics about a third of the way into the text. This organization puts discussion of the large-scale processes ahead of the more localized surface processes that act on the resulting features. The far-reaching concepts of plate tectonics are introduced in some detail as soon as the students have a background in rocks and time on which to draw for understanding. This allows plate-tectonic concepts to be reinforced by references in subsequent chapters, as relevant to the topics under discussion. There has also seemed to be a certain logic in building features by tectonic processes before tearing them down by surface processes. However, Parts Two and Three are relatively independent overall, so an instructor who prefers to do so can cover surface processes first with minimal difficulty. An effort has also been made to keep individual chapters within each part as self-contained as possible (without

undue repetition), so that, again, the order can be adjusted by the instructor if desired. The glossary should help to bridge any gaps arising from re-ordering of blocks of the text.

“Environmental geology” has been added to some texts as a separate chapter. However, there are environmental aspects to many of the topics in the text, from volcanoes to streams to resources. Therefore, in this book environmental and human-impact considerations are woven into various chapters as appropriate. This may help students to see the present relevance of the subject matter while mastering the corresponding facts, theories, and vocabulary.

A variety of pedagogical aids and features are included. Each chapter begins with an outline of the subject headings to follow, by way of overview. Terms are printed in boldface and defined at first encounter; these boldfaced terms are collected as Terms to Remember at the end of each chapter. These same terms are defined in the glossary for quick reference. At the end of each chapter are Questions for Review to help the study efforts of students, and in nearly every case there are a small number of questions or problems For Further Thought that go beyond basic review of text material. There are also Suggestions for Further Reading that include several kinds of material: up-to-date (but often relatively sophisticated) references in the subject area of the chapter; materials that may be more readable for the nonspecialist (including some older but fundamentally accurate works); and, occasionally, “classic” works by prominent geologists.

Most chapters contain one or more boxed inserts. These are of several types. Some describe tools of the geologic trade (e.g., thin sections, mass spectrometry). Some present case studies related to chapter material (flood recurrence-interval projection for a particular stream, groundwater depletion in the Ogallala aquifer system, shoreline stabilization efforts along the Texas shore). A few present tangential material of current or historical interest (subduction zones as candidates for waste-disposal sites, the nature of El Niño events), or somewhat more advanced concepts that might be appreciated most by better prepared students (paired metamorphic belts and plate tectonics, an introduction to simple binary phase diagrams). In all cases, the desire is to include the material for enrichment or information without disrupting the flow of the main body of text and presentation of fundamental concepts. Individual boxes may be included or omitted at the discretion of the instructor. Occasional smaller boxes also appear within the text. These could be viewed somewhat as long parenthetical remarks, minor digressions not lengthy enough to justify a major boxed insert, and usually lacking associated figures.

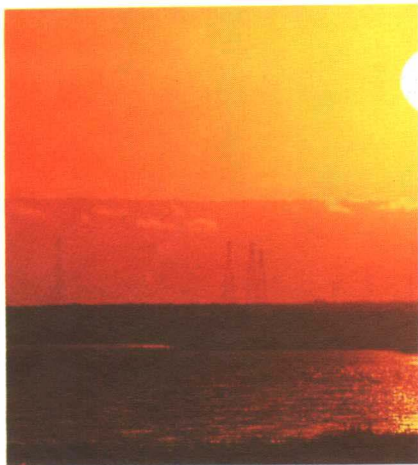
Appendices A and B will probably be of most use to those students whose physical geology course does not include a required laboratory. They may also be helpful in cases in which lecture and laboratory sections proceed independently, so that the lecture may get ahead of the corresponding subject in the lab.

Acknowledgments

A great many individuals have contributed to this project. The text owes its very existence in large part to the persistence and persuasiveness of Ed Jaffe, and in part to the more than 1000 beginning geology students I have taught. Those students continually remind me of the fascination of discovering geology for the first time, as well as of the need not to leap ahead too fast in teaching it to someone else.

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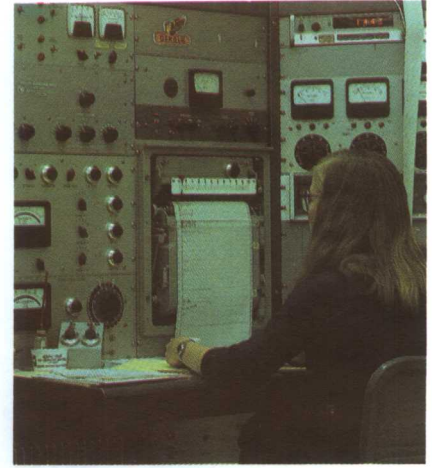
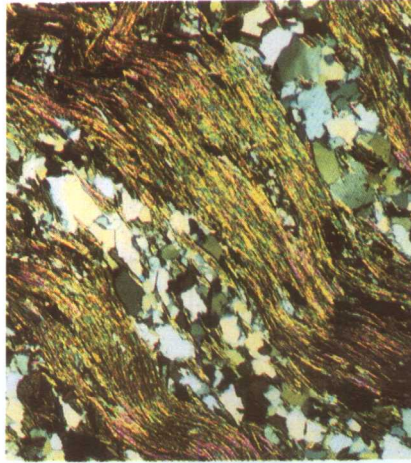
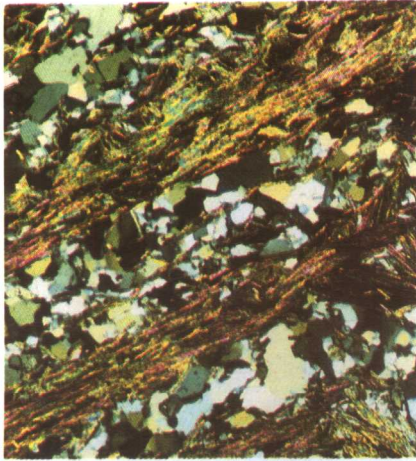
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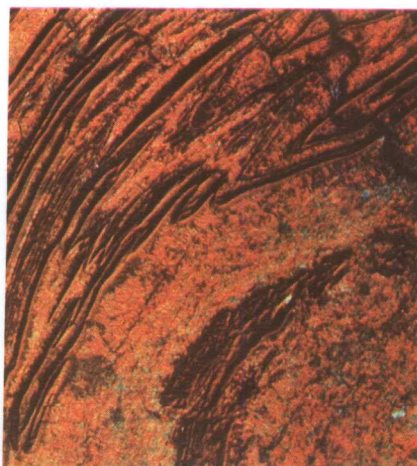
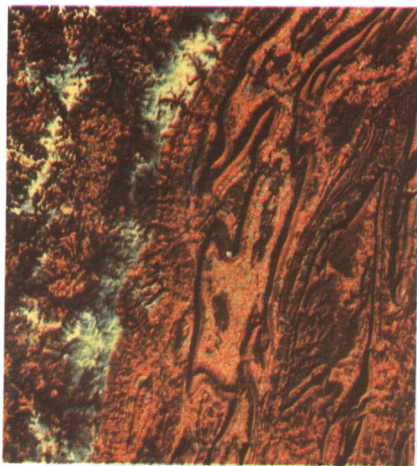
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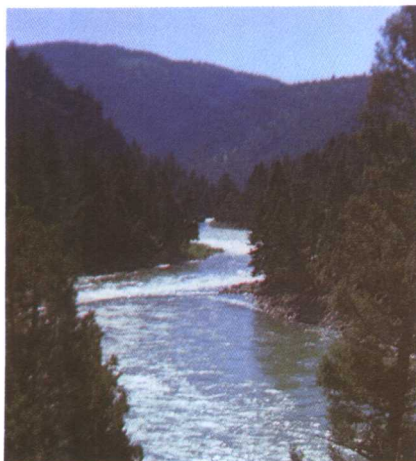
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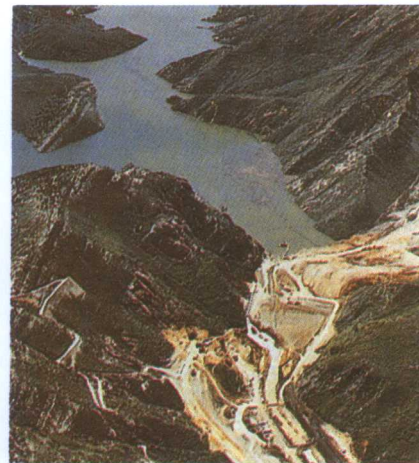
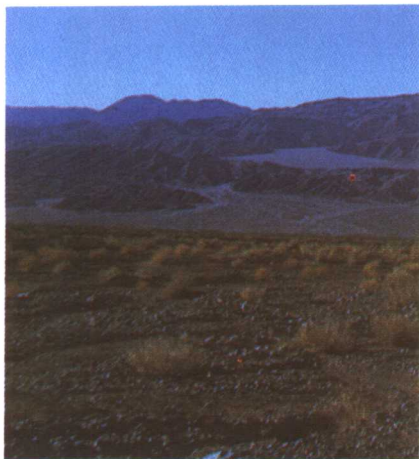
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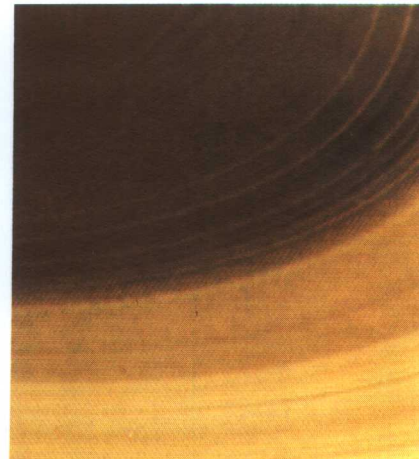
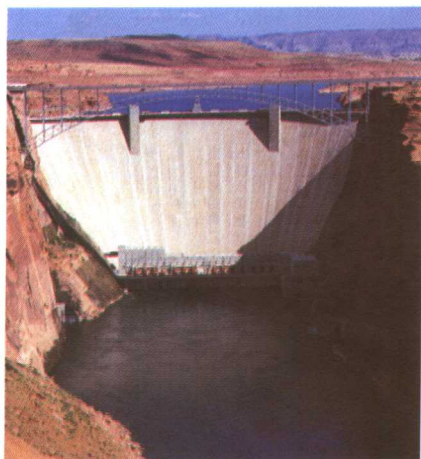
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