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# Essentials of Physical Geography Today

SECOND EDITION

Theodore M. Oberlander  
Robert A. Muller



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SECOND EDITION

Theodore M. Oberlander

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RANDOM HOUSE *New York*

Second Edition

987654321

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Library of Congress Cataloging-in-Publication Data

Oberlander, Theodore.

Essentials of physical geography today.

Includes index.

1. Physical geography. I. Muller, Robert A.

II. Title.

GB55.023 1987 910'.02 86-29711

ISBN 0-394-36280-2

Cover Illustration: *Landscape, Hudson Valley* by Frederick E. Church. Courtesy of the Cooper-Hewitt Museum, Smithsonian Institution/Art Resource.

Graphic Supervision and Cover Design: Lorraine Hohman

Production Manager: Laura Lamorte

Manufactured in the United States of America

# Preface

This introduction to physical geography is concerned with the natural world as it is seen from the human perspective. Physical geography is the geography of the human environment, and is more than a mere composite of other physical sciences such as meteorology, climatology, biology, pedology, and geology. Physical geography not only describes the natural phenomena at the earth's surface but also, and more importantly, seeks explanations of how and why physical processes act as they do, how their effects cascade through the earth's physical and biotic systems, and how they are significant to life on our planet. The subject matter of physical geography centers upon the surface region where land, sea, and air meet and interact, and where life flourishes. Human impacts on the natural systems operating at this interface are an essential consideration, tending to disturb the equilibria established among natural physical systems over long periods of time and triggering rapid change in nearly all of the earth's environments.

The processes that influence surface phenomena involve both energy and materials. Energy continuously cascades through physical systems ranging in scale from the global biosphere to single microbes. Materials such as carbon, water, and oxygen flow through these systems in never-ending cycles that involve inputs, storages, outputs, stability thresholds, and quasiequilibrium states. The study of physical geography emphasizes the ways in which the various physical systems interact, constantly exchanging energy and materials.

While our goal is to organize the complexity of our planet by using the concepts of energy systems, we have no desire that these concepts diminish the fascination derived from consideration of the individual wonders of the real world. Despite our use of generalizing theory, our focus is on the world itself, in all its awesome but comprehensible complexity.

This second edition of *Essentials of Physical Geography Today* combines the general organization, perspective, and style of its predecessor with many new elements: some from the third edition of *Physical Geography Today* and others presented here for the first time. Those familiar with the first edition of *Essentials* will detect many important changes in the text. Biogeography receives greater recognition in the form of a chapter concerned with the biosphere and ecological energetics, modified from a similar chapter in *Physical Geography Today*. Discussion of geological structures is advanced to the chapter on the earth's lithosphere; and climatic influences on landforms, omitted from the preceding edition, are surveyed in the introductory chapter on landforms.

New "Environmental Issues" boxes have been added to highlight a wide variety of current topics featured in the news and of concern to both geographers and the general public. Our new "Case Studies in Physical Geography" supplement includes 27 case studies, 11 more than in the last edition. Sixteen of these case studies are totally new. The case studies have been moved from the text to a supplement to



provide instructors with more flexibility and choice in the selection of topics for special emphasis.

For the first time, third-order headings have been utilized. They clarify the text for both the instructor and the student. The lengthy figure captions of former editions of *Essentials* and *Physical Geography Today* have been abbreviated, with portions of the former captions incorporated into the text. This more effectively integrates the text and figures. The chapter summaries of the former edition have been replaced by lists of key words. Review questions and class applications of the text material, suitable for discussion or laboratory work, are appended to each chapter. We have also included a glossary of terms, which most students find helpful for quick reference and review.

Our aim has not been to introduce and define every term used by physical geographers in their professional work, nor to touch on every phenomenon that enters into the realm of physical geography. Rather than lightly skimming a very large surface, we have sought to develop an understanding of the most essential facts and relationships by extended treatment of the topics that seem to be of paramount importance. Some of these have not previously been explored in beginning textbooks in physical geography.

The text serves as the basis for a semester or a two-semester sequence. Much attention has been devoted to continued improvement of the book's graphics, which have been a popular feature of past editions of *Physical Geography Today* and *Essentials*. Many new illustrations have been introduced in this new edition in the hope of enhancing student understanding of processes and interactions, and of the overall perception of physical landscapes.

## Acknowledgments

We are grateful for the assistance of the reviewers whose comments and suggestions

helped us shape the third edition of *Physical Geography Today* and thereby the second edition of *Essentials*, which builds upon the foundation of the former book. A preliminary draft of the manuscript of *Physical Geography Today* was reviewed by Robert B. Batchelder, Boston University; Vernon Meentemeyer, University of Georgia; Laurence S. Kalkstein, University of Delaware; Wayne N. Engstrom, California State University, Fullerton; Patricia F. McDowell, University of Oregon; Patrick J. Bartlein, University of Oregon; the late Jack R. Villmow, Northern Illinois University; Marlyn L. Shelton, University of California, Davis; Kenneth L. White, Texas A. & M. University; and Jay R. Harman, Michigan State University. Detailed comments on each chapter of *Physical Geography Today* were provided by Robert B. Batchelder, Boston University; John J. Alford, Western Illinois University; David McArthur, San Diego State University; Carl L. Johannessen, University of Oregon; John Lier, State University of California at Hayward; and John Street, University of Hawaii. We are also grateful for the work of Harry Spector, who collated reviewers' comments and edited the text.

In preparing the second edition of *Essentials of Physical Geography Today* we are indebted to Donald W. Ash, Indiana State University; Anthony J. Brazel, Arizona State University; Ronald H. Isaac, Ohio University; Patricia F. McDowell, University of Oregon; and Kathleen C. Parker, University of Georgia, who contributed detailed reviews of the first edition of *Essentials*. Their comments and suggestions have been extremely helpful to us. We gratefully acknowledge the assistance of many people at Random House in the preparation of this edition: notably Barry Fetterolf, Suzanne Thibodeau, Sylvia Shepard, Holly Gordon, Carolyn Viola-John, Laura Lamorte, Lorraine Hohman, and Kathy Bendo. We appreciate their encouragement as well as all of their direct contributions. Mary Moulton and Lucille Oberlander deserve thanks for their time-

consuming work on this book's Index. As always, our wives, Lucille and Jeanne, did many of the things that were most crucial in bringing this undertaking to fruition. And, of course, we must acknowledge the contributions of our students, our teaching assistants, and the countless persons whose paths we have crossed to

our benefit in the preparation of this book—as well as those whose needs have had to wait while project-related deadlines and emergencies were being met.

THEODORE M. OBERLANDER  
ROBERT A. MULLER

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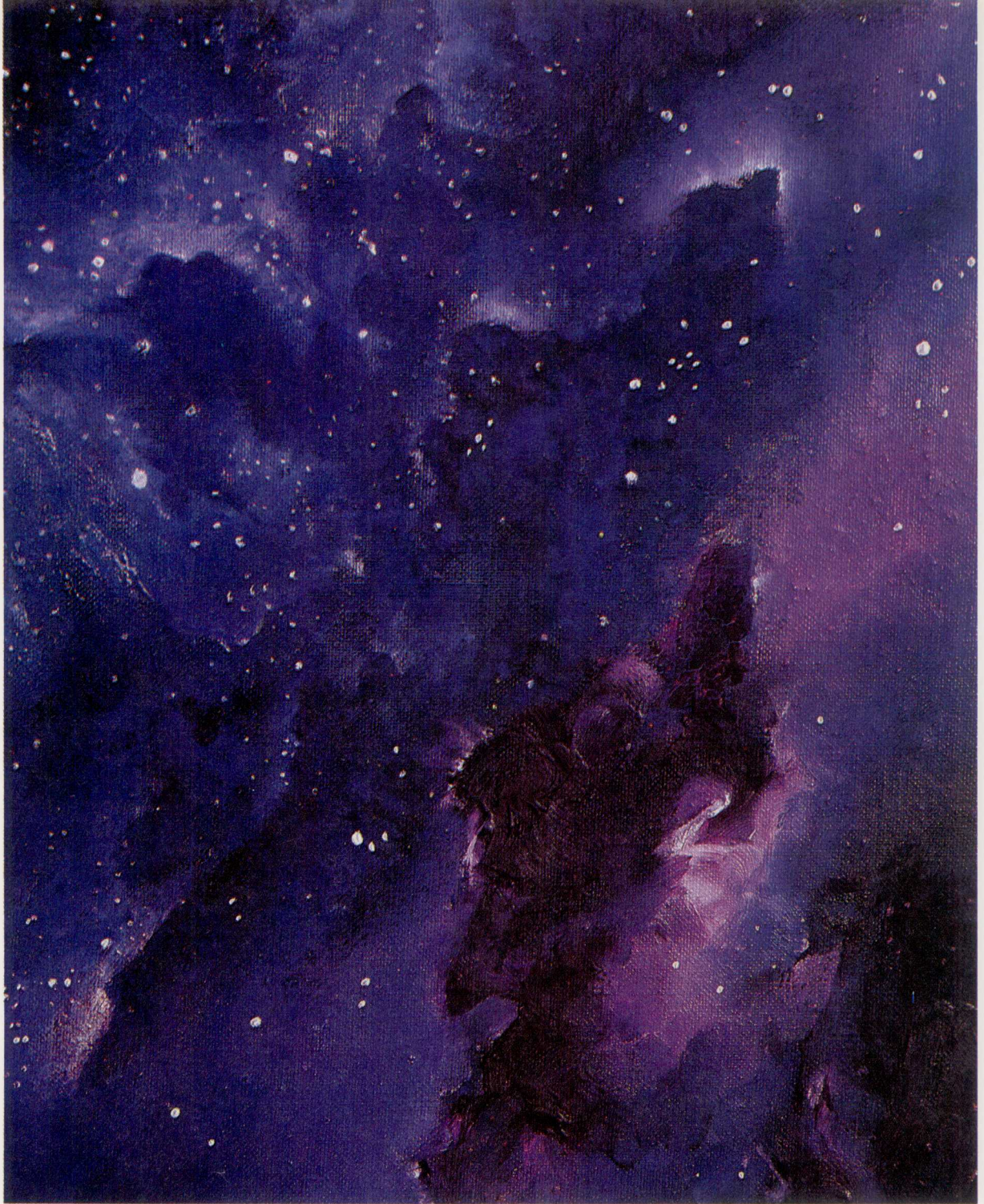
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## INDEX I.1



# Essentials of Physical Geography Today



*The Mystery*, by T. M. Oberlander, 1966



The origin of the universe and our solar system with its nine planets remains a matter of scientific speculation. What is clear is that the planet earth has changed astonishingly since its formation about 5 billion years ago. Physical geography is the study of the processes that continue to modify our planetary environment.

## **Physical and Human Geography**

### **Formation of the Earth**

Birth of the Universe

Formation of the Planets

Structure of the Earth

The Early Atmosphere

The Early Landscape

### **Life on the Earth**

The Fossil Record

Organic Evolution

Interaction of Life with the Environment

### **Dating the Earth**

Radiometric Dating

Other Dating Methods

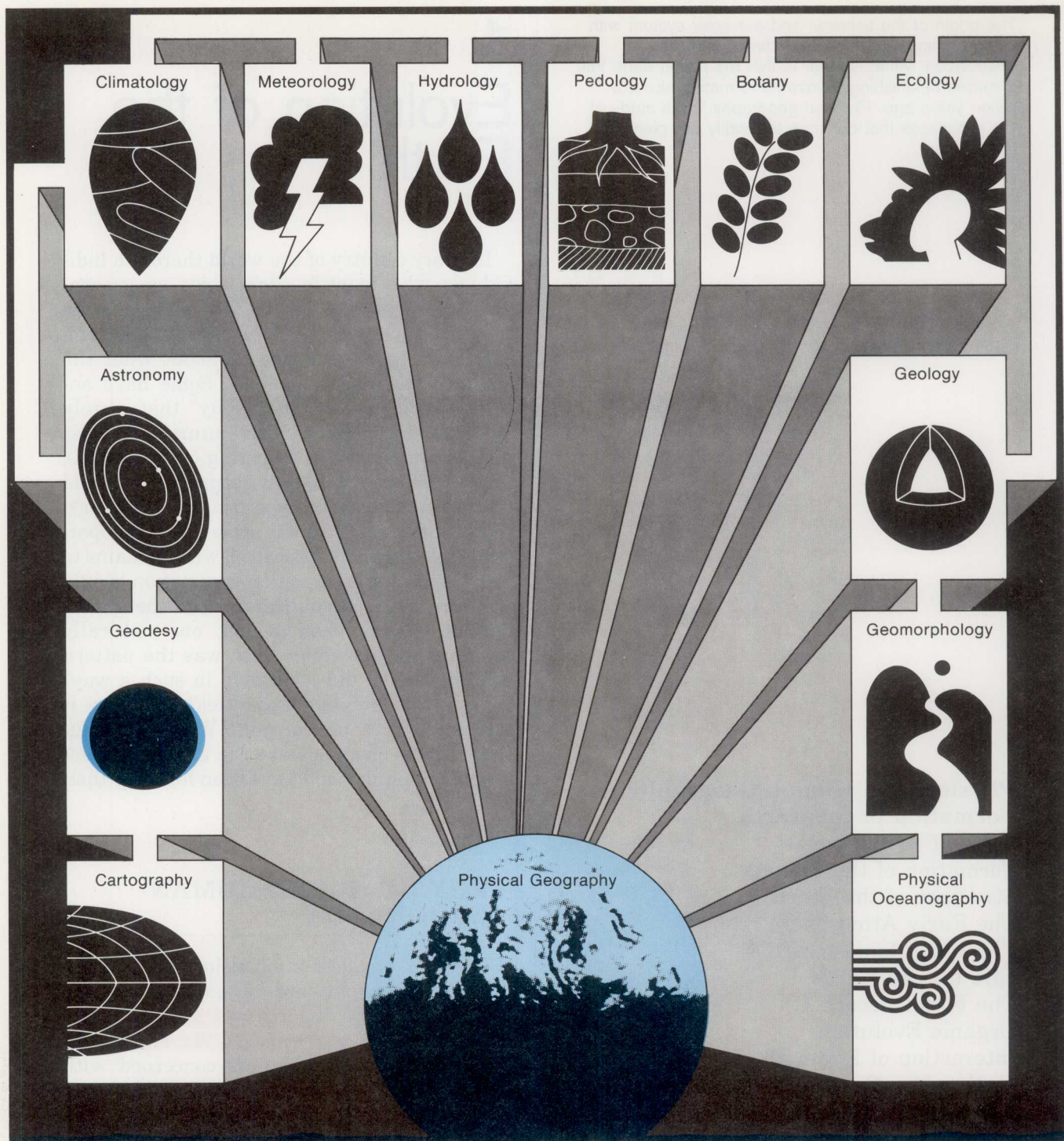
# 1 Evolution of the Earth

In every country of the world there are individuals who identify themselves as geographers. Everyone is aware that geography is concerned with *where things are*, but beyond this most people are unsure about what the study of geography involves. Some have encountered a type of "geography" that merely describes the earth and the natural processes and human activities occurring on its surface, and others are aware that geography is a field that seems to have no clear boundaries. Everything in the universe has some spatial properties. Once these are described, what remains to be done? The answer is that description is only the beginning. Having determined the spatial pattern of any phenomenon, one naturally asks further questions: How was the pattern achieved? Why did it develop in such a way? What are its current tendencies? How does it influence other phenomena? What is its future? These questions are the essence of geographical inquiry and have been for more than 2,000 years.

## **PHYSICAL AND HUMAN GEOGRAPHY**

The two broadest subdivisions within the field of geography are *physical geography*, which focuses on the **natural processes that create physical diversity on the earth**, and *human geography*, which is concerned with **human activity on our planet**. However, human activities clearly alter natural processes and the physical environment, and natu-







**Figure 1.1 (opposite)**

Physical geography draws upon the specialized knowledge of many disciplines. The unique contribution of physical geography is its focus on the interactions of the varying phenomena that combine to give each place its particular character. (Tom Lewis)

ral processes and features exert many influences on human activities. Thus physical and human geography are intimately interwoven. While they cannot be entirely separated, it is possible to focus upon either the human phenomena played out on the physical stage or the physical stage on which humans must perform. This book does the latter.

The earth's surface is a constantly changing arena in which energy from the sun and from the earth's interior act upon air, rock, soil, water, and a host of living organisms. All are intricate systems linked by and to the physical processes that shape our natural surroundings. Because physical geography analyzes the complex natural processes that determine the human environment, its subject matter must be extremely diverse (Figure 1.1). Its focus is on interactions, such as the effect of solar energy on atmospheric motion, the role of water in the development of soil, or the influence of vegetation on erosion processes. Similarly, human geography studies the interplay of physical, cultural, historical, and economic influences and their effect on human activities throughout the world. Geography's emphasis on the interactions among various physical and human systems provides a unique point of view, one that no other single field of science offers.

Physical geography is the original environmental science—traditionally concerned with the interaction between human beings and the physical environment. The relentless intensification of our extraction of water, food, fuel, and raw materials from the earth is increasingly affecting our environment and the natural processes that maintain it. In many cases human activities have unintentionally triggered changes in natural systems, affecting

EVOLUTION OF THE EARTH

even the earth's capacity to support life. Knowledge of the subtle linkages within and between environmental systems can help us reduce the danger of negative side effects resulting from our activities on the surface of the earth.

As this chapter stresses, the present is part of a continuum of change that goes back some 5 billion years. The changes have left a variety of traces. These include the deposits made by geological processes, which speak to us of changing climates, upheavals of the land, and rises and falls in the level of the seas; fossilized plants and animals, which record the history of life on our planet; datable materials of various types, which enable us to develop a reliable chronology of events; and even a record of the earth's changing magnetic field, which has contributed critical information about long-term movements of the earth's crust. Such clues have led to a generally accepted reconstruction of the principal events in the history of the earth. This chapter outlines those events, which have created the major physical systems that are the subjects of later chapters.

## FORMATION OF THE EARTH

### Birth of the Universe

Before the earth could be formed, the universe had to come into being. Scientific evidence suggests that the universe did not always exist, but originated at a definite point in time. Most scientists believe that before this event all the matter and energy in the universe had been squeezed into a single nucleus, or "cosmic egg."

#### The Big Bang

Between 10 and 20 billion years ago, its internal energy caused this nucleus to explode in what is called the *Big Bang*, which threw matter outward in all directions. During this expansion, the elements were formed by the fu-