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LANDSCAPE

AN INTRODUCTION TO PHYSICAL GEOGRAPHY

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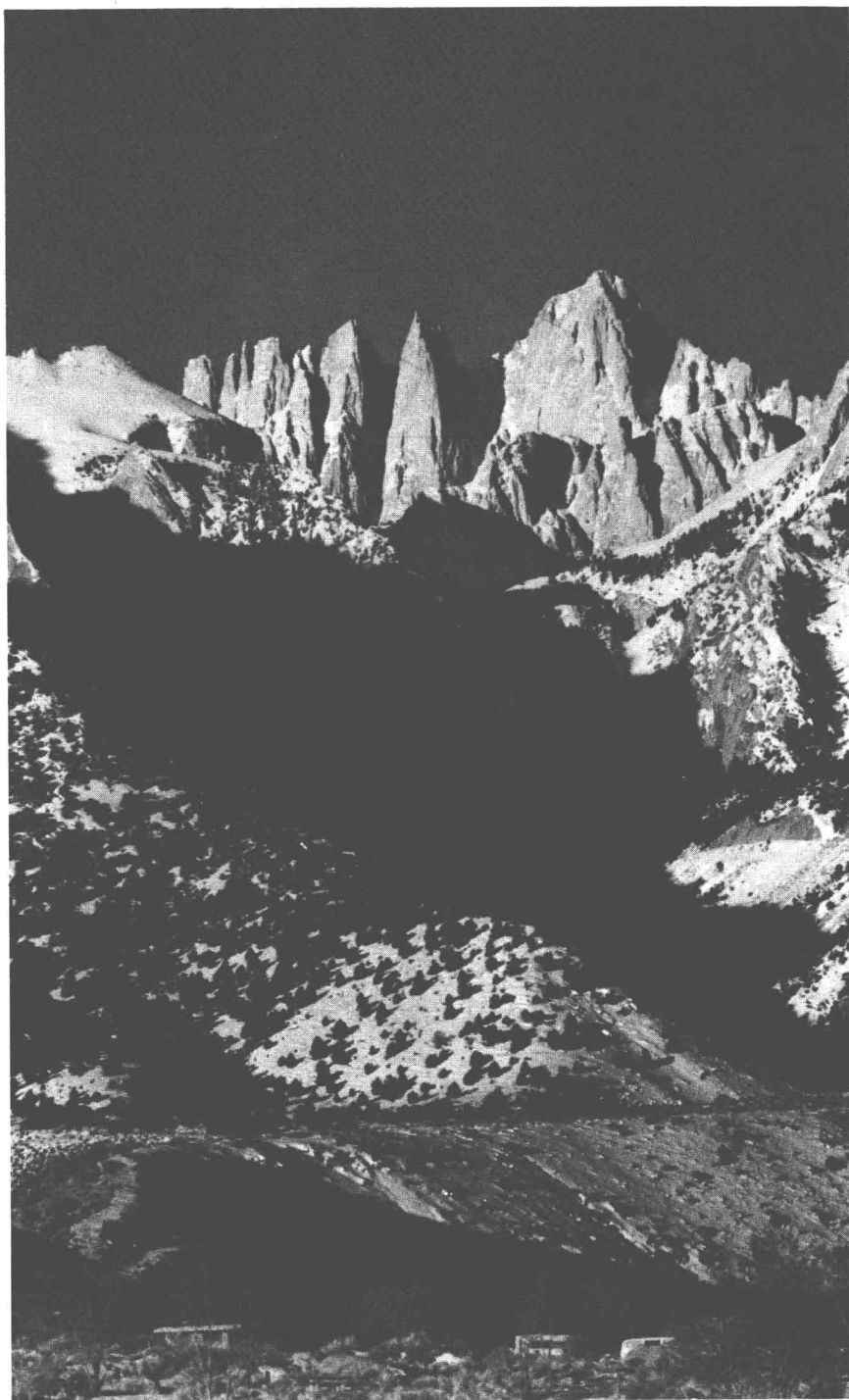
LANDSCAPE

AN INTRODUCTION TO
PHYSICAL GEOGRAPHY



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PREFACE

Physical geography has held a special place in colleges and universities for many decades. One of the reasons for this is that physical geography courses have been very attractive to undergraduates in the liberal arts and general education programs. The social sciences and teacher training programs, in particular, have found the scope and subject matter of physical geography well suited to their curricula, and many geography departments have grown with the enrollments contributed by these programs.

But physical geography has also grown as a scientific field in the past several decades. Professional geographers, with their diverse interests in matters of environment, land use, and human activities, have added new knowledge and perspectives to the field. Geophysics, hydrology, planning, and other fields have become friendly allies, and physical geography has shared much with each of them. Government programs dealing with environment and resources have brought renewed attention and new research funding to the problems traditionally studied in physical geography. As a whole, a great deal has been learned. New ideas have emerged, some old ones have been discarded, and other old ones have been dusted off and granted new credence. Our purpose in writing this book was to draw together some important lines of thought of the past three or four decades, weld them together with the traditional framework of physical geography, and offer a physical geographer's portrayal of physical geography as it enters the 1980s.

From the wide range of topics and themes embraced by physical geography, we have chosen to focus this book on driving forces and processes in the landscape. Much of the text is, perforce, explanatory in style, with a distinct bent toward fundamentals and the systematic underpinnings of the field. Accordingly, we have written a good deal on concepts about the way the landscape works and changes, emphasizing many that we think are essential to understanding the spatial patterns and trends that are so central to geography.

A conscious effort was made to avoid setting the intellectual scope of this book only on topics that are physical geography by name or tradition; rather, the scope is open to questions and topics that by their very nature belong to physical geography. Therefore, when it was appropriate to do so, we followed topics well beyond the conventional bounds of

physical geography and into the realms of whatever disciplines could help reflect on them. Whether they know it or not, many other fields pursue physical geographic research and make valuable contributions to the field. These fields deserve recognition, and we would be remiss, from an intellectual standpoint, if their findings were not woven into the larger body of geographical knowledge so that the student may gain a sense of how the various fields of the academic community are interrelated.

Many people have contributed to the building of this book, and we owe our sincere thanks to each of them. At the top of the list are those colleagues who provided reviews and advice on all or large parts of the manuscript: Walter A. Schroeder (University of Missouri), Hugh M. Raup (Harvard University), Melvin G. Marcus (Arizona State University), Jerry E. Mueller (New Mexico State University), A. John Arnfield (Ohio State University), Bruce D. Marsh (Johns Hopkins University), Denise Flynn (University of Michigan, Flint), Mark L. Hassett (University of Michigan, Flint), Charles D. Belt, Jr. (Saint Louis University), Eldridge M. Moores (University of California, Davis), Stanley W. Trimble (University of California, Los Angeles), Jay R. Harman (Michigan State University), Orman Granger (University of California, Berkeley), David M. Helgren (University of California, Davis), Donald F. Eschman (University of Michigan), Robert A. Muller (Louisiana State University), Danny Marks (University of California, Santa Barbara), and Charles B. Hunt.

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And to our fathers and grandfathers we owe more than we are able to know for our abiding curiosity in the land.

Flint, Michigan
Washington, D.C.
June 1980

W.M.M.
 J.D.

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INTRODUCTION

"Physical geography invites you to consider the terrestrial machinery which makes day and night, seed-time and harvest; which lifts the vapor from the sea, forms clouds, and waters the earth; which clothes it with verdure and cheers it with warmth, or covers it with snow."

M. F. Maury, *Physical Geography*, New York: University Publishing Company, 1897.

PHYSICAL GEOGRAPHY: THE FIELD OF STUDY

Physical geography is a small but challenging field which, in the family of natural sciences, is nestled among larger sciences such as geology, botany, and agronomy. It is held together by a set of perspectives at the center of which is the study of the landscape. Although individual geographers would debate this point, most would probably agree that physical geography is concerned with the origin, composition, and spatial expression of the landscape, especially the natural landscape. In other words, we could say that physical geography is concerned with three fundamental questions: How is the landscape formed? Of what is it composed? And what are its dimensional characteristics?

Since the nineteenth century, when physical geography emerged as a field of study in American, Canadian, and European colleges and universities, its chief accomplishment has been to describe and to map landscape features over broad regions. Drawing on the studies and surveys of geologists, botanists, anthropologists, human geographers, explorers, and surveyors, physical geographers produced maps and reports on the distribution of soils, land forms, drainage features, vegetation, climate, rocks, and mineral resources.

For certain regions, this information was combined to form large composite maps. By virtue of the correlations that appeared in the distributions of features such as soils, vegetation, and climate, natural regions were identified. Known as physiographic regions, these have become a major focus of study in physical geography throughout most of the twentieth century. Coupled with land-use information, physiographic regions became an important basis for regional geography, the kind of geography most of us were introduced to in grade school, which told about the land and life of the Lapps, the Chinese, and so on.



I. C. Russell, one of the explorer-scientists of the U.S. Geological Survey, leading a field party across the Malaspina Glacier, Alaska, in the late 1800s.

ABOUT THIS BOOK

This book attempts to tell about the landscape by beginning at a more fundamental level than do most other physical geography textbooks. Our main concern is more with the processes that shape the distribution of landscape features than with the distributions themselves. But in order to understand these processes, we must also appreciate the nature of the forces which drive them. Thus we are led to the question of energy, not the popular question about energy the human resource, but the question of energy the driving force of nature and how it relates to streamflow, glaciers, climate, soils, and vegetation.

How do we go about telling the story of the forces in the land and the processes they drive? In geography the storyteller is usually faced with the dilemma of whether to begin at a grandiose scale, encompassing areas the size of continents, or at a more manageable scale, say, the size of a small community or a farm. Although we have tried to use spatial scales that are traditional to geography, we found it necessary in some chapters to focus on very small parcels of space, small at least from the geographer's perspective. The reasons for this are that: (1) most of us who are not earth scientists find it easier to visualize concepts and to relate information to settings about the size of those in which we carry on our daily routines than to those that are much larger; and (2) discussions of many aspects of landscape dynamics are easier to relate, especially from a teacher's standpoint, in a small spatial setting rather than in a broad geographic setting. So in many discussions we will start in small spaces, develop an idea, and then try to apply it to much larger pieces of earth space.

The Main Themes

An introductory textbook must introduce the reader to a great many facts about the field of study. This book is no exception as physical geography texts go, for it utilizes conventional terms and presents many facts about the earth. However, this book goes several steps farther, in that facts and terms are woven into a conceptual fabric that rests on several major themes.

Three themes receive particular emphasis. One, of course, is based on the idea that an appreciation of the driving forces of nature is fundamental to an understanding of process and change in the landscape. One way of addressing energy in this context is with the aid of a simple model called the *energy balance*. This model is based on energy flow to and from a system and the energy taken up in the system for work and storage. A *system* is a group of features linked together by a flow of material or energy. The oceans, rivers, and atmosphere, for in-

stance, are linked by a flow of moisture and thus together constitute a system. Unit I, devoted to a general discussion of the energy balance of the earth's surface, traces the flow of energy through the atmosphere to the land and oceans, then back into the atmosphere, and finally into space beyond. The energy-balance concept is also applied to water (Unit III), soil moisture (Unit IV), vegetation (Unit V), and glaciers and shorelines (Unit VIII).

Two other themes are also set forth. One, called the *stress-threshold concept*, has to do with the relationship between the stress produced by a force such as wind or running water and the resistance earth materials have to it. For each material such as a soil type or a plant species, there is a maximum level of resistance, called a threshold, that can be tolerated without change taking place. If the level of stress surpasses the threshold of resistance, the material gives way. In a soil under the stress of running water, this produces erosion; in vegetation under the stress of wind, this produces damage or death to plants. What makes the landscape interesting in this respect is that not only do the levels of stress vary widely over space and time, but also the thresholds of resistance vary widely among different materials in the landscape. Therefore, the number of combinations of stress and resistance thresholds that produce change in the land is enormous. The stress-threshold concept is particularly helpful in understanding the interplay between plants and environment (Unit V), but it is also useful in understanding rock deformation (Unit VI), mass movement (Unit VII), and soil erosion (Units VII and VIII).

The third main theme of this book concerns the magnitude and frequency of change in the landscape. This has to do with the behavior of landscape processes and which episodes of a process, little or big, frequent or infrequent, do the greatest amount of work in the long run. The *magnitude-and-frequency concept* helps us understand that change in the land is often sporadic and that different combinations of processes can have widely differing influences in the landscape. The magnitude-and-frequency concept is pertinent to many topics, including streamflow, mass movement, and vegetation change. Unit VI is devoted exclusively to this theme.

ENERGY AND PROCESSES ON THE EARTH'S SURFACE

Compared to our neighbor the moon, the earth's surface is very lively. Geologically, the moon's interior is much less active than the earth's interior, because it appears that the moon has lost most of its internal heat supply. As a result, earthquakes, volcanoes, and related geologic processes, which are so active at the earth's surface, have apparently