SYMPHONY OF THE EARTH

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To
REGINALD ALDWORTH DALY
*a constructive expression
of the author's high respect
for his masterly and inspiring leadership
in the development of
earth science*

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PREFACE

On several occasions I have been asked whether topics of earth science could be explained in more or less conventional prose. Of course this can be done. I hope chapter I meets with the most extreme wishes in this respect. I even venture to believe that chapters II, IV, VI and VII can also be digested without special strain. Though chapter V, and parts of chapter III may require a special effort of concentration on the part of the reader, there should be nothing in this book that cannot be understood by an intelligent person who is willing to try. Sometimes, however, the use of technical terms cannot well be avoided without affecting the meaning and accuracy of the ideas. However, I have attempted to restrict the use of these terms to a minimum. Moreover most scientific expressions and terms will be explained when used for the first time and when occurring again one will find a reference to these places in the index. Finally a list of the names of geological formations in their proper sequence is made available for consultation in table I, at the end of the Preface (p. XII).

Each chapter constitutes a subject in itself. However, as in the author's "The Pulse of the Earth" the reader will find that the different topics demonstrate the deeper correlation that links together a variety of terrestrial processes, which — at first sight — appear to be unconnected.

Each chapter is adapted from one or more addresses and lectures delivered on various occasions and in different countries. (Full reference to these, as well as to the reading literature, is made at the end of each chapter). Accordingly the text closely follows the spoken word.

Chapter I. *Symphonia terrestris*. Time and again the different themes of earth science will appear to be intimately interwoven parts of the great and fascinating symphony of the earth. This is what the first chapter tries to make clear in a general review, a sketch of the broad outlines, a score of the terrestrial symphony.

Some special topics come up for a fuller discussion in the ensuing chapters.

Chapter II. *A country below sea-level* is a sort of fascinating detective

story. Hardly anything could be more dull than the starting point, viz. a few layers of clay and peat in the western provinces of the Netherlands. However, tracing their origin means unravelling the intricate interplay of movements of land- and sea-level. It will be demonstrated that the only means to disentangle this problem is furnished by data from oceanic and continental coasts bordering the seven seas.

Chapter III. *Across the Alps* might bear as undertitle: experimenting with a tablecloth. The rumpled tablecloth is represented by the Jura Mountains, the table by their rigid basement and the two are separated by a lubricating layer. By what processes was the tablecloth pushed into folds? To obtain a more or less satisfactory answer the whole Alpine belt has to be crossed from north to south, and a few excursions have to be made sideways. Some of these trips are far from easy going, which in a book like this means difficult reading. At the end, however, we return to the starting point and try to answer the first question.

Chapter IV. *Deep furrows on the continents and in the deep-sea*. The foregoing chapter touches on processes acting deep under the Alpine scenery. In order to study what processes probably take place in the deep realms beneath a folded mountain belt no region is more illuminating than the island-arcs of the East and West Indies. It is not the aim of this very short chapter to trace their geological history in its various aspects. The principal point which will be considered briefly is the origin of the deep-sea troughs accompanying the rather recent strip of mountain building in the East Indies. Moreover, structural zones of the western part of the East Indies have their counterpart in similar structures on the Asiatic continent. On the other hand tracing the continental structures back towards the East Indies furnishes a means of elucidating certain aspects of the submarine furrows.

Chapter V. *The root of a mountain chain*. After an excursion towards the deep-sea furrows of the East Indies and their counterparts in Burma, it will be less difficult to follow the author when he tries to plumb the depths beneath the Alps. Apart from results obtained in the two previous chapters, geophysical data will form the main guiding lines in exploring these deep-seated realms. This chapter forms as it were the completion of the picture developed in chapter III which was concerned with the more superficial features of the same area.

Chapter VI. *A trip on a volcano*. Apart from the mountain chains, which were considered in the three previous chapters, volcanoes and their associated phenomena offer another means of plumbing the depth of the earth. Starting from a trip on Mount Vesuvius several questions of general

interest will be discussed. This means travelling mentally also in several other volcanic districts — Scotland, Mount Etna, New Hampshire, Sumatra, the Pacific, etc. — and, at the end, returning to the starting point.

Chapter VII. *Life and its evolution*. The last chapter is concerned with one of the problems mentioned cursorily on the last page of chapter I. It presents some meditations on the characteristics and evolution of life during the long eras of earth history and on the influence of the physical environment in the broad sense of the word. Some of the modern views on the problems of life and matter can only be expressed in non-pictorial concepts. But what then is the standard of valuation in these theories? In a short final section it is attempted to give a concise answer to these absorbing questions; in the meantime something is left to the reader to think over for himself.

Professor Ph. H. Kuenen has given generous assistance by reading the manuscript and Professor Arthur Holmes went through the page proofs. I owe much to their constructive criticism and valuable suggestions.

Seven of the figures have appeared already in "The Pulse of the Earth" (viz. figs. 3, 7, 9, 11, 12, 41, 67) and twenty five other text-illustrations have been taken from "Leven en Materie" (viz. figs 17, 94–99, 101–112 and 115–120). They were executed by Mr. C. van Werkhoven and Dr. R. de Wit respectively.

To Mr. J. Vuyk I owe the final drafting of the other 91 text illustrations as well as of Plates III, IV, V, VI and VII.

Plates III A, IV B, V A, V C, and IX A are reproduced from photographs which were on sale as picture-postcards. The other reproductions of landscapes are after photographs by the present author.

It is a pleasure to record my cordial thanks to the Secretary of the Royal Netherlands Academy of Sciences at Amsterdam for supplying the blocks of figures 20, 23, 28, 30, 32, 33, 42, 46–50, 57, 58, 61–65 and Plate III.

I also desire to express my thanks to the Council of the Dutch Society of Sciences (*Hollandsche Maatschappij van Wetenschappen*) at Haarlem for their permission to publish chapter I which, in a non-illustrated Dutch version, appeared previously in the series *Haarlemse Voordrachten* (No. VII, De Erven F. Bohn, N.V. Haarlem, 1948).

To Mr. W. Nijhoff and his staff I am very grateful for the care and courtesy which they have given to all the details involved in the production of this book.

TABLE I
Geological formations with their approximate
duration in millions of years ¹⁾).

Eras	Periods and systems		Approximate ages in millions of years														
Cenozoic	{	Pleistocene	1														
		Tertiary	Pliocene 1-12														
			Miocene 12-26														
			Oligocene 26-38														
			Eocene 38-58														
Mesozoic	{	Cretaceous	58-127														
		Jurassic	127-152														
		Triassic	152-182														
Paleozoic	{	Permian	182-203														
		Carboniferous	203-255														
		Devonian	255-313														
		Silurian	313-350														
		Ordovician	350-430														
		Cambrian	430-510														
Pre-Cambrian (known rocks)			510-2000														
Origin of the Earth			about 3300														
<table> <tr> <td rowspan="8">Names of Tertiary Stages and substages used in Chapter III</td><td rowspan="8">{</td><td>Pliocene</td><td>{ Pontian</td></tr> <tr> <td rowspan="4">Miocene</td><td>{ Tortonian</td></tr> <tr> <td>{ Helvetian</td></tr> <tr> <td>{ Burdigalian</td></tr> <tr> <td>{ Aquitanian</td></tr> <tr> <td rowspan="2">Oligocene</td><td>{ Upper (Stampian, Rupelian)</td></tr> <tr> <td>{ Lower</td></tr> <tr> <td>Eocene</td><td></td></tr> </table>				Names of Tertiary Stages and substages used in Chapter III	{	Pliocene	{ Pontian	Miocene	{ Tortonian	{ Helvetian	{ Burdigalian	{ Aquitanian	Oligocene	{ Upper (Stampian, Rupelian)	{ Lower	Eocene	
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			{ Burdigalian														
			{ Aquitanian														
		Oligocene	{ Upper (Stampian, Rupelian)														
			{ Lower														
		Eocene															

¹⁾ Time-scale according to recent data by A. Holmes. The scale of the figures in the text are based on an older time-scale.