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GEOLOGY

EARTH HISTORY

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PREFACE TO VOLUMES II AND III.

THE salient features of the purpose and plan of this work were set forth in the preface to Volume I, published two years ago. The subject of that volume, Geological Processes and their Results, is sufficiently distinct from the theme of these volumes, The History of the Earth, to give occasion for additional prefatory remarks. Though the subjects are thus measurably distinct, they have been given a common bond by the treatment of the geological processes in a historical way, on the one side, and by the development of the earth history on dynamical lines, on the other. Not only has the history been treated from a causal point of view in these volumes, but processes and principles have been discussed wherever the phase of the history has seemed to make such discussion particularly pertinent. Such special discussions have usually been introduced at the first stage in the history at which the phenomena they are intended to elucidate were declared features, or at which their expression is well suited to treatment. Sometimes, however, they have been delayed, to avoid emphasizing too many dynamic subjects at a given stage. Sometimes, too, the dynamic treatment has been divided between successive historical expressions, as when the subject is very complex, or when different phases are best expressed at different historical stages. This is the case, for example, with the dynamics of deformation, which were treated at some length in Volume I, are further discussed in the chapters on the origin and the early stages of the earth, are again touched upon in connection with several periods when deformation was pronounced, and are reverted to finally in the last chapter, in their application to the peculiar phenomena of the continental borders. A similar method is used in the treatment of climatic problems, particularly that of glaciation, which is considered at some length in connection with the remarkable Permian phenomena, because of its advantageous historical setting between antecedent and subsequent mild

periods, and is resumed in connection with the recent glacial period, where localization and periodicity, together with many details, are best expressed. This recurrent treatment is intended to relieve, in some measure, the stress of treatment of these intricate themes at any one point, but more especially to combine dynamical discussion with the phenomena which it is to explain, as these phenomena unfold themselves stage by stage. This has been done in the belief that such discussions often have their most obvious force only in such relations, and in the further belief that the definite development of a historical problem in its natural associations is an advantageous antecedent to the discussion of the dynamic agencies that constitute its elucidation. It has been thought that this association of phenomena with their causes is important enough to justify even some reiteration of causes or relations, when these are essential to firm basal conceptions.

In harmony with this recurrent recognition of the dynamical element in the physical evolution of the earth, special effort has been made to give to the evolution of the successive phases of the earth's inhabitants their appropriate dynamic and physiographic relationships. In addition to the more familiar relations of life to its environment, the special function of the epicontinental seas and their oscillations has received emphasis, because these have been the chief media through which the more legible part of the geologic record has been made. As a corollary of this, the expansions and contractions of the land, on the one hand, and of the epicontinental seas, on the other, and their contrasted influences on the life of the land and of the shallow seas, respectively, have been given unusual prominence.

Special emphasis is also laid on the features of the ancient lands wherever the data permit. The sources of the sediments, and the modes and conditions of their derivation, at all stages, are regarded as equally important with the sediments themselves, and often more significant of vital conditions. Base-level states, on the one hand, and states of much relief, on the other, are recognized as influential factors in determining not only the character of the deposits, but the evolution of life on both land and sea. Terrestrial deposits, as distinguished from marine deposits, are recognized in many periods, particularly in the Devonian, Carboniferous, Permian, Triassic, Comanchean, and Tertiary, and in the last, notably in the Lafayette. The terrestrial deposits so recognized are not merely lacustrine, or even

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fluvial, in the narrower sense, but embrace also the products of general aggradation on surfaces of low gradient, by pluvial and other subaërial agencies.

On the physical side, the chief effort has been to give a connected and interpretative sketch of the earth's history, especially as exemplified by the North American continent. Imperfection of knowledge makes this sketch incomplete at some points, and limitations of space have made it brief, even when knowledge is more adequate. Both imperfection of knowledge and limitations of space have made it impracticable to deal with other continents as fully as with our own. It is believed, however, that the principles set forth in connection with the history of our own continent are applicable to all continents, and that the course of events in all has been, in principle and in leading facts, similar to that in our own.

While recognizing the alternative views, the doctrine of the permanence of the continents plays an unusually large part in the interpretations of continental evolution, of the migrations of life, and of the successive developments of provincial and cosmopolitan faunas. So also the doctrine of the periodicity of the great deformative movements forms a notable feature in the interpretations of life evolution, and in the reciprocal developments of land and sea life, as well as of provincial and cosmopolitan faunas.

Exceptional attention is given to the evolutions of faunas and floras and to their radiations and migrations, while less attention is given to the unrelated features of the life, however bizarre these may be in themselves. The familiar calling of the biological roll under each period is abandoned, and will perhaps be missed; but it has been thought that the mutations of the assemblages of composite life of the great provinces that arose in succession from changes in geographic configuration, are more important as elements in the history of the earth's inhabitants than the classification of life forms as such, particularly as such classification is still in a state of transition. The order of treatment of the various forms of life in the several periods is varied according to what is conceived to be their historical importance or natural relations.

Without giving special adhesion to any particular doctrine of life development, beyond a cordial recognition of the new mutation theory of DeVries, as well as the older and more familiar ones, the progressive

evolution of life is made a subject of constant remark, with suggestions as to biological, as well as physiographic, relationship and dependence.

In the biological, as in the physical parts, the unsolved problems are frankly recognized, and the student is made a party to a common desire, if not a common effort, to secure more light on dark subjects. These volumes therefore attempt not merely to record the salient facts of historical geology, and to suggest dynamic relations and interpretations, but to indicate to rising geologists the need of further investigations, of more light, and of revised interpretations on not a few phases of the earth's history.

Perhaps the most radical departure of this work from the precedents of its class lies in the larger emphasis laid on the hypotheses of the origin of the earth, and especially in the introduction of a new hypothesis of earth genesis, whose dynamic sequences depart widely from familiar lines. This recognition of divergent hypotheses at the very outset necessarily involves an effort to carry through the interpretations of the whole history parallel systems of doctrine built on the diverse hypotheses recognized. Especially is it incumbent to try to carry out the logical sequences of the new hypothesis in its application to the main problems that remain unsolved, particularly those of deformation, vulcanism, and atmospheric states. Introduced concurrently with the more familiar views, these newer modes of interpretation form an alternative system running through the whole work. It is believed that this will be at least stimulating, whether or not it shall prove to be a step toward the final system of interpretation, which future research alone will determine.

A few new elements of geologic classification which have not usually received more than partial recognition in standard works are herein given full recognition. In the class of time-divisions technically designated *Eras*, the *Proterozoic*, long since proposed by Irving, has been adopted, and made to cover about the ground included under the Algonkian of the U. S. Geological Survey. In other words, it is made to include the group of chiefly sedimentary or meta-sedimentary systems below the Cambrian and above the great terranes of chiefly igneous or meta-igneous origin, referred to the Archeozoic. The Lower Carboniferous, or Sub-carboniferous, is recognized as a distinct system under the name *Mississippian*, which has already received some