OROGRAPHIC GEOLOGY: OR, THE ORIGIN AND STRUCTURE OF MOUNTAINS: A REVIEW, PP. 11-134

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Orographic Geology;

OR,

THE ORIGIN AND STRUCTURE OF MOUNTAINS.

A REVIEW.

By GEORGE L. VOSE,

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"C'EST SUR-TOUT L'ÉTUDE DES MONTAGNES, QUI FERA ACCÉLÉRER LES PROGRÈS DE LA THÉORIE DE CE GLOBE."

Saussure, Voyages dans les Alps: Disc. Prelim.

BOSTON:

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149, WASHINGTON STREET.

1866.

OROGRAPHIC GEOLOGY.

OROGRAPHIC GEOLOGY.

THE study of mountains has always been a favorite one with geologists, and very properly so; for in these vast masses of rock we are presented with an array of facts which we should in vain seek for elsewhere. It is by means of these upturned strata, ruptured and worn by rivers into deep ravines and valleys, that we are made acquainted with the underlying formations. As Saussure observed, it is not in deep mines that we are to study the foundations of the earth's crust, but on the tops of high mountains.

Many geological theories seem to have been formed, not so much for the purpose of explaining facts, as to avoid the trouble of investigating them. Sweeping generalizations have been made, to support which, all the favorable evidence has been adduced, while the refractory phenomena have been left alone; and what makes it worse, many of the boldest speculations have been put forth under names which carry so much weight that no one thinks of questioning the conclusions, or even of asking for the evidence. Thus, the ideas held by Humboldt, Von Buch, Carl Ritter, Beaumont, and Agassiz regarding the origin of mountains, it will appear in the sequel, are altogether without foundation: nevertheless, the facts furnished by these distinguished men are of immense value.

It is perhaps a necessary evil attendant upon the use of text-books, that in order to tell a plain story and to make their subject comprehended, they assume a completeness in

the solution of problems which cannot possibly exist with our present acquirements. The result is, that readers of such get definite ideas, but incorrect ones; and afterwards, when they push their investigations beyond the region of text-books, they meet with new and troublesome facts, which make their ideas more correct, but less plainly defined. For example, nothing can be simpler than the standard explanation of mountain structure, which supposes a great wedge of granite to form the axis, upon the flanks of which the stratified rocks repose in an inclined position. This is quite definite, but, as will shortly appear, depends more upon the imagination of certain geologists than upon any thing in nature. Such explanation is a summary mode of disposing of certain supposed facts; but it ignores other facts, which, when closely examined, prove the whole to be no more than the "baseless fabric of a dream." Whoever goes for downright truth, will most often have to content himself with incomplete and unsatisfactory conclusions. But this should in no way discourage us; for correct theory and truth are one, and the truth can only be discovered by bringing our minds into accordance with it. The eminent Norwegian geologist, Keilhau, observes, "A complete and perfectly candid study of facts must often leave us with nothing but what is inexplicable;" but, as Professor Dana remarks, "the more reason for doubts we know, the better, if they actually exist."

There have been many geological theories put forth by persons possessing a strong fancy, but little knowledge of facts, to refer to which would be simply a waste of time. Omitting such, let us examine as briefly as possible those systems which, though unsatisfactory, deserve respect, both from the names under which they have appeared, and from the labor which has been expended in their illustration.

BEAUMONT'S HYPOTHESIS.

A distinguished French geologist, M. Elie Beaumont, proposed an explanation for orographic phenomena, which made

its first appearance in 1829, and which has been presented to the public since that time under a variety of modifications, both by its author and by other geologists.[1] M. Beaumont supposes, that, in the history of the earth, there have been long periods of comparative repose, during which the deposition of sedimentary matter went on regularly and continuously; that between these periods there have been short ones of paroxysmal violence, during which a great number of mountain-chains have been suddenly thrown up, all of the ranges originating at one time being very nearly parallel, no matter how far distant from one another; that these paroxysms have occurred from the remotest geological epochs, and may even now astonish us by new catastrophes producing new ranges. The origin of these mountain eruptions is found in the secular cooling of the globe, the whole mass of which, with the exception of an envelope much thinner in proportion than the shell to an egg, is kept in a melted condition by heat, but is constantly cooling, and thus contracting. The external crust does not gradually collapse upon the shrinking nucleus, but becomes separated from the central portion during the long periods, and, when it gives way, falls in suddenly along determinate lines of fracture. At such times the rocks are subject to great lateral pressure, which crushes the rigid masses, and bends the pliant ones into elevations and depressions, thus producing the folds or waves called mountains. All these lines of fracture, and thus of elevation, made at one time, are supposed to be parallel, — by which is meant that they lie on different small circles parallel to the same great circle; and

[1] Beaumont's views were communicated to the Academy of Sciences in Paris in June, 1829, and published in the Ann. des Sci. Nat., 1829; also in the Bull. Soc. Géol., for 1847, p. 864; still later in the twelfth volume of the Dictionnaire Universel d'Hist. Nat., 1852, — "Systèmes des Montagnes," — and the same published by itself in 3 vols. pp. 1543. It is examined by Mr. Hopkins, in his address to the Lond. Geol. Soc., and published in the Quart. Jour., vol. ix., 1853. It is given at length by Professor Nichol, in Johnston's Physical Atlas, pp. 5-8; and discussed in Lyell's Principles, chap. xi.

the various systems of parallel ranges are so grouped as to form a pentagonal network, upon which geometrical plan a vast amount of good mathematics has been wasted. The means by which the time of elevation of any given range is known, is the age of the sedimentary beds which are tilted up on the flanks of the central axis. Thus, if a mountain-range in any place has inclined beds of Silurian rocks upon its flanks, while the later Devonian rocks are undisturbed, then the elevation occurred between the Silurian and the Devonian ages; and, if a range in any other part of the world presents the same relations, it is inferred that the elevation took place at the same time.

LYELL'S OBJECTIONS.

To the above, Mr. Lyell objects, that there is no scale by which to measure the time which elapsed between the deposition of any one formation and the succeeding one, and hence that there can be no such thing proved as contemporaneous elevation.[1] Again, M. Beaumont refers to the Longmynds, a small range in Shropshire, England, as having been elevated after the Cambrian and *before* the Silurian; and he refers the elevation of nine other ranges in France, Germany, and Sweden to the same time, because they are parallel to what he terms the typical Shropshire range: but both Mr. Murchison and the Government Geological Survey of Great Britain have plainly shown, that this small chain, the Longmynds, was not elevated until *after* the Silurian. Thus, if the other ranges *are* parallel to the typical one, their parallelism and contemporaneity have not the relation assumed by Beaumont. To avoid these difficulties, M. Beaumont has, since first putting forth his theory, so modified it as to destroy the only claim it ever had to attention, — its simplicity; inasmuch as he has multiplied the number of successive upheavals, and asserts that new lines of elevation sometimes take the direction of old ones,

[1] Principles, chap. xi.

thus destroying entirely the use of parallelism as a time boundary. Again, Mr. Lyell justly observes, that the theory of a sudden elevation of mountains deprives us of that slow denudation which in all cases must have occurred to produce the present surface of the continents. In judging thus of M. Beaumont's plan, we must be careful not to do him the injustice of allowing him no part in the formation of a theory of mountain structure. He has furnished us an immense mass of facts regarding the disposition of mountain-ranges, and has thus made us acquainted with some of the conditions to be accounted for.[1]

AGASSIZ'S IDEAS REGARDING MOUNTAINS.

Professor Agassiz's ideas regarding mountains may be gathered from papers recently published in the Atlantic Monthly.[2]

[1] Mr. Hitchcock, in his Manual, p. 193 (1859), thinks that M. Beaumont may have pushed his principle too far, but that "there is too much evidence of uniformity and even identity in the manner in which the different chains have been elevated, too much proof of occasional paroxysmal and vertical movements and of intervening long periods of repose, not to admit that law has presided over the phenomena." We can hardly understand why law is any less important for results produced gradually, than when produced suddenly. Mr. Hitchcock farther says, p. 194, that Mr. Lyell has "shown only that it is difficult to fix upon that point in the interval between two consecutive rocks when the convulsion took place, and that the fundamental principle of Beaumont's theory remains unaffected;" and, "in respect to the exact geological time when the elevation occurred, it is, to say the least, very probable that it took place just at the termination of the period during which the elevated rock was in course of formation; for such a convulsion furnishes, in many cases at least, the only known reason why its deposition was brought to a close." We think Mr. Lyell has shown the impossibility of fixing, within immense limits, the point at which the change took place; and it seems to us, that the frequent and total changes in the nature of the Appalachian strata, which for a vast depth are conformable, show that convulsion is by no means necessary for producing a well-marked separation between beds. We think, also, that Mr. Lyell has entirely overthrown Beaumont's doctrine of the relation between the age and direction of mountain-chains. The doctrine of the sudden elevation will be seen in advance to be opposed by many important facts.

[2] Vols. xi. and xii., 1863.