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ORIGINAL ARTICLES.

I. NOTES ON THE SHAPE AND STRUCTURE OF SOME PARTS OF THE
ALPS, WITH REFERENCE TO DENUDATION.

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IT is often said that controversies advance science. I believe, on the contrary, that they retard it—that they are wholly mischievous, and that all good scientific work is done in silence, till done completely. For party in politics, there are some conceivable, though no tenable, reasons; but scientific controversy in its origin must be always either an effort to obscure a discovery of which the fame is envied, or to claim credit for a discovery not yet distinctly established: and it seems to me there are but two courses for a man of sense respecting disputed statements;—if the matter of them be indeed doubtful, to work at it, and put questions about it, but not argue about it; so the thing will come out in its own time, or, if it stays in, will be no stumbling-block; but if the matter of them be not doubtful, to describe the facts which prove it, and leave them for what they are worth.

The subject of the existing glacial controversy between older and younger geologists seems to unite both characters. In some part, the facts are certain and need no discussion; in other points, uncertain, and incapable of being discussed. There are not yet data of measurement enough to enable us to calculate accurately the rate of diluvial or disintegrating action on mountains; there are not data of experiment enough to enable us to reason respecting the chemical and mechanical development of mountains; but all geologists know that every one of these forces must have been concerned in the formation

of every rock in existence: so that a hostile separation into two parties, severally maintaining a theory of Erosion, and a theory of Fracture, seems like dividing on the question whether a cracked walnut owes its present state to nature or the nutcrackers. In some respects, the dispute is even more curious; the Erosion party taking, in Geology, nearly the position which they would occupy zoologically, if they asserted that bears owed the sharpness of their claws to their mothers' licking, and chickens the shortness of their feathers to the friction of the falling bit of shell they had run away with on their heads. For indeed the Alps, and all other great mountains, have been tenderly softened into shape; and Nature still, though perhaps with somewhat molluscous tongue, flinty with incalculable teeth, watches over her craggy little Bruins,

‘ — forms, with plastic care,
Each growing lump, and brings it to a bear.’

Very assuredly, also, the Alps first saw the world with a great deal of shell on their heads, of which little now remains; and that little by no means so cunningly held together as the fragments of the Portland Vase. No one will dispute that this shell has been deeply scratched, and clumsily patched; but the quite momentous part of the business is, that the creatures have been carefully Hatched! It is not the denudation of them, but the incubation, which is the main matter of interest concerning them. So that Professor Ramsay may surely be permitted to enjoy his glacial theory without molestation—as long as it will last. Sir Roderick Murchison's temperate and exhaustive statement* seems to me enough for its extinction; but where would be the harm of granting it, for peace' sake, even in its complete expansion? There were, we will suppose, rotatory glaciers—whirlpools of ecstatic ice—like whirling Dervishes, which excavated hollows in the Alps, as at the Baths of Leuk, or the plain of Sallenche, and passed afterwards out—‘queue à queue’—through such narrow gates and ravines as those of Cluse. Gigantic glaciers in oscillation, like handsaws, severed the main ridge of the Alps, and hacked it away, for the most part, leaving only such heaps of sawdust as the chain of the Turin Superga; and here and there a fragment like the Viso and Cervin, to testify to the ancient height of the serrated ridge. Two vast longitudinal glaciers also split the spine of the Alps, east and west, like butcher's cleavers, each for sixty miles; then turned in accordance to the north (‘Come sì volge, con le piante strette, a terra, e intra se, donna che balli’),

* Address at Anniversary Meeting of R. Geographical Society, 1864.

cut down through the lateral limestones, and plunged, with the whole weight of their precipitate ice, into what are now the pools of Geneva and Constance. The lakes of Maggiore, of Como, and Garda, are similar excavations by minor fury of ice-foam;—the Adriatic was excavated by the great glacier of Lombardy;—the Black Sea, by the ice of Caucasus before Prometheus stole fire;—the Baltic, by that of the Dovrefeldt, in the youth of Thor;—and Fleet Ditch in the days of the Dunciad by the snows of Snow Hill. Be it all so: but when all *is* so, there still was a Snow-hill for the snows to come down. —there still was a fixed arrangement of native eminence, which determined the direction and concentrated the energies of the rotatory, precipitate, or oscillatory ice. If this original arrangement be once investigated and thoroughly described, we may have some chance of ascertaining what has since happened to disturb it. But it is impossible to measure the disturbance before we understand the structure.

It is indeed true that the more we examine the Alps from sufficiently dominant elevations, the more the impression gains upon us of their being rather one continuously raised tract, divided into ridges by torrent and decay, than a chain of independent peaks: but this raised tract differs wholly in aspect from groups of hills which owe their essential form to diluvial action. The outlying clusters of Apennine between Siena and Rome are as symmetrically trenched by their torrents as if they were mere heaps of sand; and monotonously veined to their summits with ramifications of ravine; so that a large rhubarb-leaf, or thistle-leaf, cast in plaster, would give nearly a reduced model of any mass of them. But the circuit of the Alps, however sculptured by its rivers, is inherently fixed in a kind of organic form; its broad bar or islanded field of gneissitic rock, and the three vast wrinkled ridges of limestone which recoil northwards from it, like surges round a risen Kraken's back, are clearly defined in all their actions and resistances: the chasms worn in them by existing streams are in due proportion to the masses they divide; the denudations which in English hill-country so often efface the external evidence of faults or fissures, among the Alps either follow their tracks, or expose them in sections; and the Tertiary beds, which bear testimony to the greater energy of ancient diluvial action, form now a part of the elevated masses, and are affected by their metamorphism: so that at the turn of every glen new structural problems present themselves, and new conditions of chemical change. And over these I have now been meditating—or wondering—for some twenty years, expecting always that

the advance of geology would interpret them for me: but time passes, and, while the aspect and anatomy of hills within five miles of Geneva remain yet unexplained, I find my brother-geologists disputing at the bottom of the lake. Will they pardon me if I at last take courage to ask them a few plain questions (respecting near and visible hills), for want of some answer to which I am sorely hindered in my endeavours to define the laws of mountain-form for purposes of art?

Fig. 1 is the front view, abstracted into the simplest terms, and laterally much shortened, of the northern portion of the ridge of the Mont Salève, five miles from Geneva.

Fig. 1.—Northern portion of the Ridge of Mont Salève.

It is distinguished from the rest of the ridge by the boldness of its precipices, which terminate violently at the angle c, just above the little village called, probably from this very angle, 'Coin.' The rest of the ridge falls back behind this advanced

Fig. 2.—Section of Mont Salève at a, fig. 1. (Ruskin.)

corner, and is softer in contour, though ultimately, in its southern mass, greater in elevation. Fig. 2 is the section, under a, as I suppose it to be; and fig. 3, as it is given by Studer.

Fig. 3.—Section of Mont Salève at a, fig. 1. (Studer.)

To my immediate purpose, it is of no consequence which is the true section; but the determination of the question, ultimately,

is of importance in relation to many of the foliated precipices of the Alps, in which it is difficult to distinguish whether their vertical cleavage across the beds is owing merely to disintegration and expansion, or to faults. In all cases of strata arched by elevation, the flank of the arch (if not all of it) must be elongated, or divided by fissures. The condition, in abstract geometrical terms, is shown in fig. 4. If $A D$ was once a continuous bed, and the portion $C D$ is raised to $E F$, any connecting portion, $B C$, will become of the form $B E$; and in doing this, either every particle of the rock must change its place, or fissures of some kind establish themselves. In the Alpine limestones, I think the operation is usually as at $G H$; but in the Salève the rock-structure is materially altered; so much so that I believe all appearance of fossils has been in portions obliterated. The Neocomian and the Coralline Jura of the body of the hill are highly fossiliferous; but I have scrambled among these vertical cleavages day after day in vain; and even Professor Favre renders no better account of them.*

Fig. 4.—Diagram of Upheaved Beds.

The whole ridge of the mountain continues the curve of the eastern shore of the Lake of Geneva, and turns its rounded back to the chain of the Alps. The great Geneva glacier flowed by it, if ever, in the direction of the arrows from x to y in fig. 1; and, if it cut it into its present shape, turned very sharply round the corner at c ! The great Chamonix glacier flowed over it, if ever, in the direction of the arrows from x to y in fig. 2. It probably never did, as there are no erratic blocks on the summits, though many are still left a little way down. But whatever these glaciers made of the mountain, or cut away from it, the existence of the ridge at all is originally owing to the elevation of its beds in a gentle arch longitudinally, and a steep semi-

* 'Considérations sur le Mont Salève,' Geneva, 1843, p. 12.

arch transversely; and the valleys or hollows by which this ridge is now traversed, or trenched (M, the valley of Monnetier; A, the hollow called Petite Gorge; B, that called Grande Gorge; and C, the descent towards the Valley of Croisette), owe their origin to denudation, guided by curvilinear fissures, which affect and partly shape the summits of all the inner lateral limestone-ranges, as far as the Aiguille de Varens.

It is this guidance of the torrent-action by the fissures; the relation of the longitudinal fault to the great precipice; and the altered condition, not only of the beds on the cliff-side, but of the Molasse conglomerates on the eastern slope, to which I wish presently to direct attention: but I must give more drawings to explain the direction of these fissures than I have room for in this number of the Magazine; and also, before entering on the subject of the angular excavation of the valley at M, and curvilinear excavations at A and B, I want some answer to this question—one which has long embarrassed me:—The streams of the Alps are broadly divisible into three classes: 1st, those which fall over precipices in which they have cut no ravine whatever (as the Staubbach); 2nd, those which fall over precipices in which they have cut ravines a certain distance back (as the torrent descending from the Tournette to the Lake of Annecy); and, 3rd, those which have completed for themselves a sloping course through the entire mass of the beds they traverse (as the Eau Noire, and the stream of the Aletsch Glacier). The latter class—those which have completed their work—have often conquered the hardest rocks; the Eau Noire at Trient traverses as tough a gneiss as any in the Alps; while the Staubbach has not so much as cut back through the overhanging brow of its own cliff, though only of limestone! Are these three stages of work in anywise indicative of relative periods of time?—or do they mark different modes of the torrents' action on the rocks? I shall be very grateful for some definiteness of answer on this matter.

II. ON THE FOSSIL NECK-BONES OF A WHALE (*PALÆOCETUS SEDGWICKI*), FROM THE NEIGHBOURHOOD OF ELY.*

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[Plate II.]

THOUGH the oldest English Whales yet named are found in the Crag, Prof. Sedgwick, a quarter of a century since, obtained from Ely some anchylosed cervical vertebræ evidently

* This paper was read before the Phil. Soc. Cambridge, May 2, 1864.