Mr. W. Boyd Dawkins objected to calling in hypothetical causes to account for effects when existing causes are sufficient, and cited the sudden melting of snow as a sufficient cause, as had already been suggested by Mr. Prestwich.

Sir Charles Lyell supported the same view, and mentioned a case which had occurred at Salisbury some few years ago as an instance of the effects of such floods. He also cited the existence of flint implements in the gravels on either side of Southampton Water as evidence of the existence of man during a long period of excavation of valleys. He also mentioned the discovery by Dr. Harris of flint gravel *identical with that of the present valleys* beneath the Basalt of Miocene date in Antrim.

Mr. Searles V. Wood, Jun., insisted on the impossibility of even an enormously increasing rainfall filling the valleys as suggested by Mr. Tylor, and pointed out the influence which such an accession of fresh water must have had on the animal life in the estuaries. He also mentioned tidal action as an excavating agent in valleys.

Prof. Ansted showed, by calculation, that even a vast increase in the rainfall would not suffice to fill the valleys so as to deposit the gravels as at present found.

Mr. Whitaker quoted the existence of distinct terraces of gravel one above the other in the Thames Valley as proving the gradual excavation of the valley.

Prof. Morris doubted as to the precise character and age of the deposits in the valleys in South Wales having been accurately ascertained.

Prof. Ramsay made some concluding remarks (as President), expressing his disagreement with the views of the author as to the enormous magnitude of the ancient rivers.

CORRESPONDENCE.

ON THE CAUSE OF CONTORTIONS, FAULTS, AND DISLOCATIONS IN THE CRUST OF THE EARTH.

SIR,—I observe from several recent articles in the GEOLOGICAL MAGAZINE, as, for example, the paper of Mr. Wilson in your May number (p. 205), and the letter of Mr. Maw in that for this month (p. 294), that the attention of geologists is being directed to the mechanical effects of upheaval or depression acting on extensive portions of the rocky crust of the earth. May I be allowed to ask the consideration of those who may be engaged in such inquiries to certain passages relating to this subject to be found in my volume on Volcanos, which may not have fallen under their observation? I refer especially to pages 46–52 (edit. Longman, 1862), in which it is suggested that whether the disturbing force be elevation or depression (arising from whatever cause), there must exist a centre, or central axis, of dislocation, where the disturbing force will be at its maximum, and also some lateral limits beyond which it does not operate; and that the effect produced on the mass of rock included within these limits must be similar to "that which is known to be produced in a beam fixed at

either end, and broken by upward pressure at its centre, namely, a compression which takes effect in the central part *beneath*, and in the lateral parts adjoining the fixed extremities *above* a neutral line or 'pivot axis;' while, on the other hand, the upper portion of the central parts and the lower strata of the lateral parts will be subjected to a tearing strain." The resulting effect of such dislocating forces on rocks of so rigid and coherent a character as to break rather than bend, or yield like a liquid or pasty mass under pressure, would be to cause rents at right angles to the direction of the dislocating force and "gaping," *i.e.* widening upwards, in the case of an elevatory action about the centre and downwards about the lateral portions, and *vice versâ*, of course, in the case of a depressing action. If any of these rents opened so far downwards as to reach a mass of matter liquefied by heat, or at such a temperature as to be more or less liquefied by the reduction of pressure to which under such circumstances it would be exposed, the result would be the suction or pumping up of such liquefied or pasty matter into the fissures, and should any of these reach the outer atmosphere, its explosive eruption on those points. While, on the other hand, in the portions subjected to compression the result would be the contortion and outward bulging of such masses of rock as were pliable, and the dislocation and outward shoving of wedge-shaped portions of such rocks as were too rigid to yield otherwise, much "as we see wedge-shaped chips split off and forced outwards from the edges of a crack formed in the same relative position through a rigid mass of stone or metal broken across by pressure" (p. 54, *op. cit*).

I will not occupy more space in your pages by an extension of these quotations. But your readers will, I think, admit that these considerations may serve to throw some light on the questions relating to the probable origin of the fissures, faults, veins, dykes, contortions, and other obvious displacements of superficial rocks, to which Mr. Maw's and Mr. Wilson's observations refer. In the work above cited I have ventured to carry still further the speculations they suggest, by hazarding the supposition that, when repeated, elevatory movements have operated through a long time over very wide areas, the result may be seen along the central axes of dislocation in some of the chief mountain ranges of our continents, while distant parallel lines of volcanic development mark the horizontal limits of disturbance on one or both sides, where the production of rents gaping downwards may have allowed the heated subterranean matter to force its way up towards, or actually to the subaërial surface. These last speculations must go for what they are worth. But the mechanical theory on which they rest can hardly, I think, be disputed. It differs in some respects (as I have shown in Volcanos, p. 51) from those of Mr. Hopkins and Mr. Darwin, but rather in the terms of the question, that is, the supposed circumstances, than in its solution. With regard to outward bulging or contortion, accompanied as it must be by movement and friction, *inter se* of the particles, should they be capable of movement, being the cause of slaty cleavage, I have always agreed with

the late Mr. D. Sharpe, and have myself more than once suggested to geologists, but as yet, I fear, without much success, that the laminar structure of the metamorphic schists is owing to the same cause—gneiss being only a *squeezed granite*.

G. Poulett Scrope.

Fairlawn, Cobham, Surrey, *June 5*, 1868.

ON FAULTS AND CONTORTIONS IN STRATA.

Sir,—I read with considerable interest a short paper in your May number, by Mr. J. M. Wilson, attempting to explain the causes by which contortions and faults are produced. Mr. Wilson's theory, that "contortions are the inevitable result of the depression," and "faults of the elevation of a curved surface," from its soundness and simplicity is likely to be generally accepted; at the same time I do not think that all faults or contortions can be ascribed to the operation of one universal cause. In the first place, if such were the case, should we, according to Mr. Wilson's view, *ever* find that the direction of the fault hades (underlies) in the direction of the *up*throw? Such cases do occur, though they are exceptional. Secondly, according to Mr. Wilson's theory of faulting, the elevation of a very extensive area of the earth's surface is necessary for the production of a complete series of upthrows and downthrows, as shown in Fig. 4, p. 207, Geological Magazine. Now I have lately met with such a series in a horizontal line, 136½ feet long, in the Upper Red Marls of the Keuper Series, Nottingham. It occurs on the brow of the hill near the Mapperley Reservoir, and is well shown in a road cutting. I enclose a rough sketch of the section. I think there can be no doubt that the cause which produced that faulting acted locally, and if that cause were the elevation of a curved surface (which perhaps may have been the case), that curved surface was not due to the curvature of the earth's surface, for over an horizontal area of 45½ yards there would be no appreciable curvature from such a source. If the faults had all been vertical, or inclined in parallel directions, I should have been inclined to adopt Sir C. Lyell's theory of cavities, but on a smaller scale, such, for instance, as might be caused by the carrying away, by percolating water, of salt, gypsum or other mineral in chemical solution, or, under certain circumstances, in mechanical suspension. The sinking of a stratum into a cavity could produce such faulting as shown in Fig. 1. For the present case I would suggest the following explanation in want of a better :—

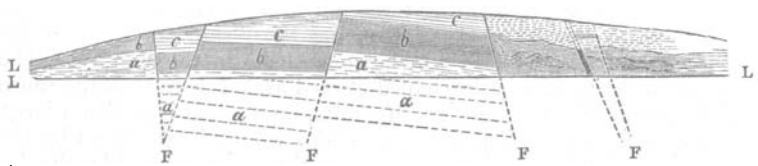

Fig. 1. Section of New Red Marls, Mapperley Road, Nottingham. Average height of section, 5 feet 4 inches. Total length, 136 feet 6 inches. Greatest amount of faulting ascertainable, 2 feet 6 inches. L. L., Level of the Road. The strata on the right of section are obscured by distortion and exposure to the atmosphere. F F F lines of faulting. The letters *a a*, *b b*, *c c*, indicate the portions of the dislocated beds which were once continuous.