

dip of the cleavage, or they may have yielded in a plane perpendicular to that dip, or they may have undergone both these movements. By microscopic examination of minute crystals, and by other observations too minute to be detailed here, Mr. Sorby comes to the conclusion that the absolute condensation of the slate rocks amounts upon an average to about one half their original volume. This must have resulted chiefly from the forcing of the particles more closely together, so as to fill up the spaces left between them, when they only touched each other. The rest of the change has been due to elongation, which has produced slaty cleavage.

Most of the scales of mica occurring in certain slates examined by Mr. Sorby, lie in the plane of cleavage; whereas in a similar rock not exhibiting cleavage, they lie with their longer axes in all directions. May not their position in the slates have been determined by the movement of elongation before alluded to? To illustrate this theory, some scales of oxide of iron were mixed with soft pipe-clay, in such a manner that they inclined in all directions. The dimensions of the mass were then changed artificially to a similar extent to what has occurred in slate rocks, and the pipe-clay was then dried and baked. When it was afterwards rubbed to a flat surface perpendicular to the pressure and in the line of elongation, or in a plane corresponding to that of the dip of cleavage, the particles were found to have become arranged in the same manner as in natural slates, and the mass admitted of easy fracture into thin flat pieces in the plane alluded to, whereas it would not yield in that perpendicular to the cleavage.*

This experiment may lend countenance to the opinion that the lamination of basalt and trachyte, and even of some kinds of gneiss, and the grain of certain granites, may all have been determined by a mechanical cause, a movement having taken place after the development of crystals in the pasty mass.

Mr. Scrope, in his description of the Ponza Islands, ascribed "the zoned structure of the Hungarian perlite (a semi-vitreous trachyte) to its having subsided, in obedience to the impulse of its own gravity, down a slightly inclined plane, while possessed of an imperfect fluidity. In the islands of Ponza and Palmarola, the direction of the zones is more frequently vertical than horizontal, because the mass was impelled from below upwards.† In like manner, Mr. Darwin attributes the lamination and fissile structure of volcanic rocks of the trachytic series, including some obsidians in Ascension, Mexico, and elsewhere, to their having moved, when liquid, in the direction of the laminae. The zones consist sometimes of layers of air-cells drawn out and lengthened in the supposed direction of the moving mass. He compares this division into parallel zones, thus caused by the stretching of a pasty mass as it flowed slowly onwards, to the zoned or ribboned structure of ice, which Professor

* Sorby, as cited above, p. 610, note. † Geol. Trans. 2d ser. vol. ii. p. 227.