

With reference to inequalities arising from the friction of a resisting medium at the earth's surface, the author observes that they could not exist, if, as in the manner here shown, the axis of rotation coincided from the origin with the axis of figure.

In conclusion, he remarks, that if we could assume for the planets a similarity of physical constitution to that of the earth, the theorem as to the difference of the greatest and least moments of inertia of the earth would be applicable to all the planets; and thus we should be as well assured of the stability of our system, with respect to the motion of rotation of its several members, as we are already respecting their motion of translation.

In a postscript, referring to a third cause of disturbance in the place of the earth's axis of rotation, suggested in a letter from Sir John Lubbock, namely, the effects of local elevation and depressions at the earth's surface, the author states; if, with Humboldt, we regard the numbers expressing the mean heights of the several continents as indicators of the plutonic forces by which they have been upheaved, we shall readily see that these forces are of an inferior order to those affecting the general forms and structure of the earth. If the second class of forces acted so as not to influence in any way the stability of the earth's axis of rotation, the former class might, under certain conditions, produce a sensible change in the position of the axis. But when the tendency of the second class of forces is to increase the stability of the earth's axis, it would not be easy to show the possibility of such conditions as to render the operation of the other forces, not only effective in counteracting that tendency, but also capable of producing a sensible change in the place of the axis of rotation.

3. A paper was in part read, entitled, "On the Arrangement of the Foliation and Cleavage of the Rocks of the North of Scotland." By Daniel Sharpe, Esq., F.R.S., V.P.G.S. Received November 20, 1851.

February 19, 1852.

WILLIAM SPENCE, Esq., V.P., in the Chair.

The reading of Mr. Sharpe's paper, "On the Arrangement of the Foliation and Cleavage of the Rocks of the North of Scotland," was resumed and concluded.

The author applies the term, *cleavage* or *lamination*, to the divisional planes by which *stratified* rocks are split into parallel sheets, independently of the stratification; *foliation*, to the division of *crystal-line* rocks into layers of different mineral substances; *slate*, to stratified rocks intersected by cleavage; and *schist*, to foliated rocks only which exhibit no bedding independent of the foliation.

He considers that no distinct line can be drawn between gneiss and mica schist, chlorite schist, &c., which pass from one into the

other by insensible gradations; have the same geological relations, and foliation subject to the same laws. He states that their boundaries have been laid down arbitrarily on the published maps of Scotland. The quartz rock of Macculloch includes two formations; the one, a quartzose variety of gneiss, included in this paper under that head; the other, a stratified sandstone altered by plutonic action.

The author treats the foliation of gneiss and schist as a series of simple curves, obtained by observing the general direction, and disregarding the minor and more complicated folds. The convolutions are usually greatest where the dip is slightest, but where the foliation is vertical or nearly so, it usually follows true planes without contortion; thus the most correct observations are those taken where the foliation is vertical.

When the foliation of gneiss and schist is traced over extensive areas, and the minor convolutions disregarded, it is usually found to form arches of great length and many miles in diameter, bounded by vertical planes, between which the inclination increases with the distance from the axis. Each arch is succeeded by a narrow space in which the dip is irregular, and beyond which another arch commences of a form similar to the first. Portions of two adjoining arches seen without the rest form the fan-like structure observed by several geologists. The arrangement of the foliation in arches corresponds with that of the cleavage of the true slates previously described by the author, except in the greater convolution of the gneiss and schist.

Along the southern border of the Highlands a band of stratified clay slate rests on mica schist: at the junction, the foliation of the schist conforms to the cleavage of the slate, and the two together form an arch, but there is no connection between the stratification of the slate and the foliation; moreover, the divisional planes cross from one rock to the other, without change of direction, being planes of foliation in the mica schist, and of cleavage in the slate: these facts confirm Mr. Darwin's opinion, that cleavage and foliation are due to the same cause.

The author describes the parallel arches of foliation which cross the Highlands, illustrating his description by sections and a map on which they are laid down, and tracing in detail the vertical planes which bound the arches. Commencing on the south, the first vertical plane runs about four miles within the Highland border, with a mean direction of about N. 55° E.: it crosses more than once the junction of the clay slate and mica schist. South of this plane the cleavage of the slate forms the beginning of an arch, which ends abruptly at the junction of the slate with the Old Red Sandstone.

To the north of this vertical plane four arches run across the Highlands: the most southern of these, with a diameter of ten or twelve miles, is formed partly of the cleavage of the slate, and partly of the foliation of the mica schist. The hills on the south side of Loch Tay coincide with its central axis. The vertical plane which forms its northern boundary crosses Ben Lawers, and has a mean direction

of N. 50° E. The next arch northward, consisting principally of gneiss, has a diameter varying from twenty-five to thirty miles; its axis runs for some distance along the central ridge of the Grampians. The granite of Cruachan and Ben Muich Dhui interfere with the regularity of the foliation of this district, and the lines are thrown to the north by the granite of Aberdeenshire: the line which bounds this arch on the north crosses the Spey near Laggan, and runs N. 40° E. through Corbine into the Monagh Leagh mountains. To the north of that line, the foliation of the gneiss forms an arch only ten miles wide, bounded on the north by a vertical plane running N. 35° E. which crosses Coryaraick. This plane forms the southern boundary of an arch, varying from fifteen to twenty-five miles wide, entirely of gneiss, bounded on the north by a band of vertical foliation which runs about N. 30° E. from Glen Finnan through the middle of Rosshire and across Ben Nevis. To the north-west of this band there is half an arch in the foliation, varying from twenty to thirty miles wide, which ends abruptly at a line to be drawn from Loch Éribol and Loch Maree, on the west of which the gneiss is unconformable to that hitherto described, but agrees with that of the Island of the Lewis, forming a series of arches which run about N.W.

From the want of parallelism in the lines of foliation of the Highlands, they would all nearly converge between Lough Foyle and Lough Swilly among the mica schists of the North of Ireland.

The most rugged and elevated hills are usually on or near the lines of vertical foliation; the axes of the arches are generally found in high land, and the principal valleys occur between the central axes of the arches and their vertical boundaries. Thus the main physical features of the Highlands are connected with the foliation of the gneiss and schists; but the granites and porphyries which have broken through those rocks, and disturbed the regularity of the foliation, have also greatly modified the surface of the country.

The contortions of gneiss and schists being unaccompanied by fracture, must, the author considers, have been produced when the matter of those rocks was semi-fluid: in this state the mineral ingredients appear to have separated and re-arranged themselves in layers according to their affinities, while the whole was subjected to pressure acting along certain axes of elevation, which raised those layers into arches.

February 26, 1852.

COLONEL SABINE, Treasurer and V.P., in the Chair.

The following paper was read:—

“On the Motions of the Iris.” By B. E. Brodhurst, Esq., M.R.C.S. Communicated by Thomas Bell, Esq., Sec. R.S. Received November 20, 1851.

The observations made in this paper are distributed under three