the most important, and the safest on which to rely, whenever we find it. But we know that dynamic action may have more or less completely effaced this structure, and in a great number of cases has done so.

We know on what lines this effacement proceeds, and with what sort of new structures it replaces those it has modified or destroyed. It is, however, not uncommon to find that, even in greatly affected "dynamic" areas of this description, the action has not embraced the whole of the rock, and from among rolled-out, sheared, and puckered schists, may come specimens showing, more or less perfectly, the contact-structures which we seem to have good grounds for always recognizing as such.

NOTICES OF MEMOIRS.

COMPASS VARIATION AFFECTED BY GEOLOGICAL STRUCTURE IN BUCKS AND MONTGOMERY COUNTIES, PA.[1] By BENJAMIN SMITH LYMAN.

THE Journal of the Franklin Institute, October, 1897, contains an interesting paper by Mr. B. Smith Lyman, formerly State Geologist to Japan, describing a remarkable coincidence between the axis of a set of curves of magnetic variation in Bucks and Montgomery Counties, Pennsylvania, and a great deep-seated fault in the New Red strata below ending westwards in the axis of an anticlinal fold. Both the curves and the fault are shown on an accompanying map. From this paper we extract the following passages:—

The magnetic curves were mapped some years before the beginning of the recent Geological Survey, that for the first time fully proved the peculiar structure; but the curves had no influence whatever in the interpretation of the geology, and the correspondence was not perceived until long after the geological map was printed.

The magnetic map was made about the year 1883, by the Water Department of the city of Philadelphia, for use in its excellent topographical survey of the Perkiomen and neighbouring valleys under Mr. Rudolph Hering. The map records the results of a number of determinations of the magnetic declination made by the Water Department itself and by the Coast Survey and by other observers, and curves of equal declination were drawn for every tenth of a degree. The curves are so extremely at variance with the simple, nearly straight lines of earlier, less detailed maps, as either to show extreme confidence in the accuracy of the observations, or perhaps even to excuse a suspicion of the possible incorrectness of the curves in some way, especially in view of the acknowledged want of precision of some of the observations, and the absence of any obvious topographical or other occasion for such

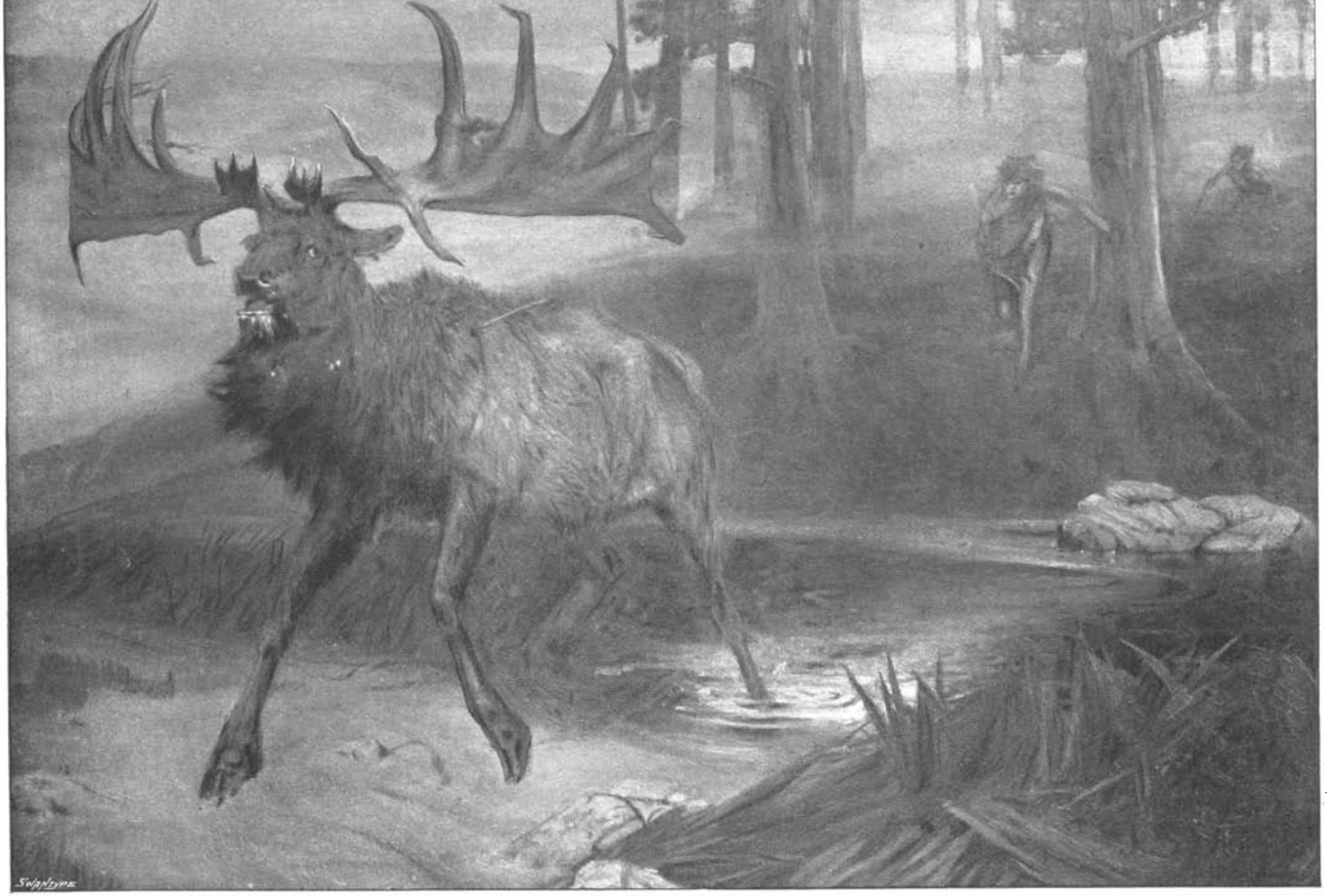
[1] Reprinted from the Journal of the Franklin Institute, October, 1897. Mining and Metallurgical Section: Inaugural Meeting, held April 28th, 1897.

great irregularity. But the curves are in the main beautifully confirmed and thoroughly vindicated by the underground geology.

The striking feature and dominant peculiarity of the curves is a very strong bend convexly north-eastward near New Hope and Lambertville, on the Delaware; but gradually changing towards the west, so that the curves near Shwenksville and Boyertown point still more sharply south-eastward. The axis of the bend in the curves is, then, itself greatly bent, nearly to a right angle. The Geological Survey of the two counties, begun at the end of 1887, has proved beyond a question the existence of an enormous fault, of about 14,000 feet, in the rock beds, almost precisely on the line of the Delaware River end of that magnetic axis, and following the same course past Doylestown, gradually dying out, and west of that town turning north-westward, passing north of Shwenksville, disappearing there as a fault, but continuing as a sharp anticlinal to the border of the New Red and of Montgomery County, 5 miles north-east of Boyertown.

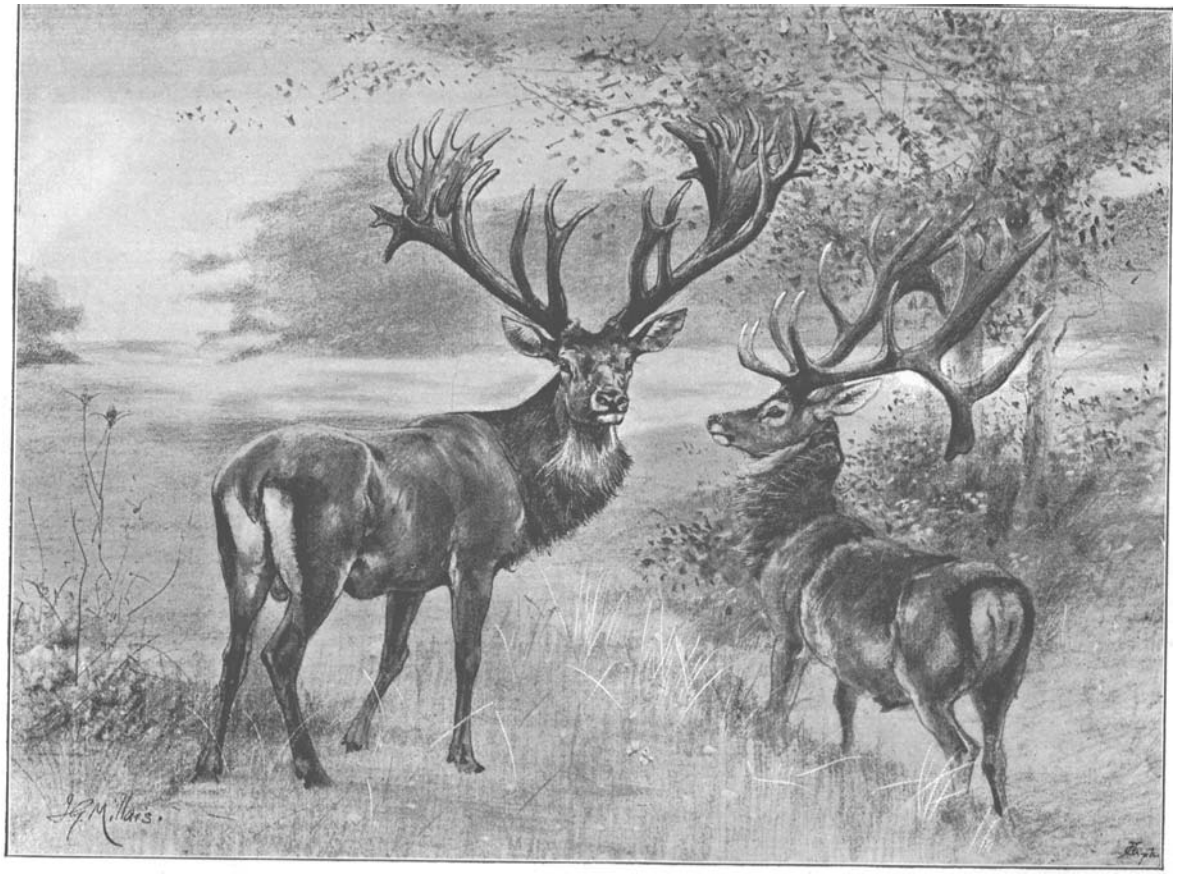
The geological structure of the map of 1893, published by the State Geological Survey, was drawn without the least reference to the magnetic curves, and, indeed, without any knowledge at that time of the slightest correspondence between them and the geology. The geological map gives the direction and amount of the dip at a couple of thousand points, amounting to a complete demonstration of the structure, and to a full proof of the situation and extent of the fault and of the sharp anticlinal into which the fault runs. The topography also given on the same map shows that there is no one strongly-marked ridge following the course of the axis of the magnetic curves. Indeed, there are more decided topographical indications in the way of long, rather high ridges in other directions. Furthermore, the form of the outcropping rock beds, sedimentary or igneous, does not correspond in any degree with the magnetic curves.

Moreover, some light is perhaps thrown upon the obscure subject of terrestrial magnetism. It is true, the nature of the relation between the magnetic and geological phenomena is not so easily determined; but it seems to become certain that the internal structure of the earth's crust has an important influence upon terrestrial magnetism, even if it be not in any degree its first cause. Terrestrial magnetism and its changes have sometimes been considered explainable by solar influences alone, no longer by direct action of the sun as a magnet, but by the sun's heating the atmosphere or the earth's crust. The present phenomena seem, however, to point to more strictly terrestrial processes as the true cause, and to suggest that the solar influence may partly at least be exerted through the attraction of gravitation as well as through heat. The enormous and locally unequal strains produced by the contraction of the earth's crust in cooling would be particularly liable to be affected by the presence of a deep fault or by a sharp anticlinal. Such lines would be places where the crust has yielded and is readier to yield, and consequently where the strain has



"Ancient Britons Hunting the Megaceros."

From a drawing by Sidney Steel. Reproduced by permission of Messrs. Sotheran & Co. from "British Deer and their Horns," by J. G. Millais.



The two great Stags of Warnham Court.

Drawn by J. G. Millais. Reproduced by permission of Messrs. Sotheran & Co. from "British Deer and their Horns," by J. G. Millais.

been to some extent relieved and is less. The recent occurrence of earthquakes along the New Jersey end of this very fault-line shows that the resistance there is less, and that the remaining strain must likewise be less. On such a comparatively weak yielding line the rock beds in readjusting themselves, even where there is no violent earthquake, must occasion a certain amount, not only of strain, but of friction and heat that might give rise to electrical currents. A decided magnetic effect, too, has sometimes been observed to accompany earthquakes, and in some cases to precede them. In like manner, the strains and yielding or readjustment that may be occasioned by the attraction of the sun and moon might apparently cause electrical currents; and, in fact, magnetic disturbances have been found to correspond, like tides, with the place of those heavenly bodies. Again, the broken or arched form of the rock beds may permit at least a temporary local variation in the temperature of the crust, as affected by the earth's hot interior, that could occasion electrical earth currents. Terrestrial magnetism seems, then, to arise not only from the manifold action of the sun's heat upon the air and the earth's crust, but from the internal movements of the crust and from the tidal effect of the sun and moon upon the air, ocean, and solid earth.

The author does not admit that the magnetic curves could have been produced by any known deposits of iron-ore or trap, near or distant; comparing such an idea to the ancient Oriental tales of the loadstone that drew men's boot-nails, or the seaside mountain that pulled the bolts out of ships' sides. He adds:—"Deposits of magnetic iron-ore, though differing much in magnetic force, seldom directly affect the most delicate magnetic needle at a distance of more than a few hundred feet."

REVIEWS.

BRITISH DEER AND THEIR HORNS. By JOHN GUILLE MILLAIS, F.Z.S., etc. With 185 text and full-page illustrations, mostly by the Author, assisted by Sidney Steel, two by E. Roe, and photographs; and a series of unpublished sketches by Sir Edwin Landseer. Imp. 4to; pp. xviii and 224. (London: Henry Sotheran & Co., 37, Piccadilly, and 140, Strand, W.C. 1897.)

(PLATES III AND IV.)

MR. MILLAIS is already favourably known to the public as the author of "Game-Birds and Shooting Sketches" and "A Breath from the Veldt," both rich in illustrations. Although a thorough sportsman, and, like his father, the late Sir John Everett Millais, Bart., R.A., a born artist, Mr. John Guille Millais combines with these qualities sufficient of the true naturalist and palæozoologist, to lead him in his "History of British Deer and their Horns" to enter upon a brief account of the ancient types of deer which inhabited these Islands in prehistoric times,