indubitably intrusive, exhibit a structure closely allied to that of peridotites and identical with that of other serpentines, where the evidence is inconclusive. Do we as yet know of any case where a well-marked and definite general structure is common both to a rock of sedimentary and to one of igneous origin? Is it not a legitimate conclusion, that serpentine is of a common origin with peridotite, and that the latter is one of the igneous rocks?

Hence I think I am justified in saying that, notwithstanding the ingenuity of Dr. Hunt's reasoning and his skilful special pleading, no theory regarding the origin of peridotites and serpentines can be held to be complete which does not take account of the fact that some of them are as fully proved to be intrusive rocks as any dolerite or basalt, felstone or trachyte.

V.—Note on a Graphic Table of Dips.

By R. D. Oldham, A.R.S.M.

That there is a wide-felt want, among field-geologists, of some rapid and sufficiently accurate method of solving such problems as arise in the ordinary course of their work is proved, if proof were necessary, by the summary of the literature bearing on this subject, given in the April Number of this Journal by Mr. Harker, who has certainly carried it to its highest point, for methods more simple than those given by him it is impossible to imagine. There is, however, a method, by which most of these problems can be solved by inspection without recourse to construction or calculation, which I would submit to the notice of geologists in general.

The problems arising in the ordinary course of field geology are mainly of four kinds: (1) where the true dip is known and the dip in the direction of a line of section is required; (2) where two apparent dips are known and the true dip is required; (3) problems connected with the outcrop of beds on sloping ground; and (4) those connected with the tilting of beds already inclined. I omit the obtaining of the thickness of a series of beds whose dip and breadth of outcrop are known, as the solution is self-evident to all who can understand what is meant by 'scale'; of these, class (1) is of by far the most frequent occurrence, while cases falling under heading (4) are somewhat rare. I propose describing my method of constructing what may be called a graphic table of dips by which all cases falling under heading (1) can be solved by inspection, and then passing on to an extension of the principle by which cases falling under headings (2) and (3) may be similarly solved.

Draw a square as *OABC* (Fig. 1), of convenient size, and with centre *O* and radius *OA* strike a quadrant inside the square; divide this quadrant into equiangular distances of convenient magnitude, and draw radii at those intervals from *O*, prolonging them till they cut the opposite sides of the square; from the points where the radii cut the side *AB*, perpendiculars are to be drawn to the base *OC*, and with centre *O* and radii equal to the distances so cut off a concentric series of quadrants are to be drawn. The intervals cut off by this series of perpendiculars along the base *OC* form a scale of cotangents of the angles made by their respective radii with the base *OC*, or of tangents of the angles made with the side *OA*; for convenience then we may graduate the base *OC* as a scale of cotangents, and the side *OA* as a scale of tangents, and graduating the radii according to the angles, they make with *OC* the graticule is complete.

In describing the use of this device, I shall refer to the point *O* as the point of *origin*, to the line *OC* as the *axis*, to the lines diverging from *O* as *radii*, and to the perpendiculars to *OC* as *normals* to the axis. Its use is as follows:—

(1) Given the direction and amount of the true dip, to find the apparent dip in any other given direction.

(*a*) When the dip does not exceed 45°. Take the point on the radius corresponding to the angular divergence of direction between the given and required dips, which represents the angle of dip according to the scale of tangents (as graduated along *OA*), and follow the normal till it cuts the axis; the point of intersection gives the required angle of dip, using the scale of tangents as before.

Example.—A bed dips 30° to N. 50° E.; required its apparent dip to E. 10° S. The angular divergence being 50°, take the point where the 30° quadrant cuts the 50° radius, and follow the normal to the axis which it cuts at the intersection of the 20° quadrant; the dip required is therefore 20°.

(*b*) When the dip exceeds 45°. Take the point on the axis representing the given dip (using the scale of cotangents along *OC*), and follow the normal till it intersects the radius corresponding to the angular divergence between the direction of the given and required dips; and the point of intersection will give the required angle of dip.

Example.—A bed dips 70° to N. 10° W.; required its dip to N. 40° E. The angle of divergence being 50°, take the point representing 70° on the axis and follow the normal till it cuts the radius of 50° at the intersection with the 60° circle; 60° is consequently the required dip.

Should the intersection of the normal and radius not fall within the square, a different procedure must be adopted. In this case the normal from the point where the radius corresponding to the divergence cuts the outer quadrant (that of 45°) must be followed to the axis, and the distance between the intersections with the axis and the radius corresponding to the true dip if laid off from *C* along *CB* will give the required angle of dip; or a line may be drawn parallel to the axis through the point of intersection with the radius representing the dip, and the point where it cuts the scale on *CB* will give the required dip. For the ready application of this method it would be advisable to have a series of lines parallel to *OC*, which, to prevent confusion, I have not inserted in the diagram.

Example.—A bed dips 50° to N.E.; required its dip to N. 10° W. The angle of divergence being 55°, take the point where the 55° radius cuts the 45° quadrant, and follow the normal till it cuts the 50° radius, and from that point follow a line parallel to the axis (dotted in Fig. 1) till it cuts the side *BC* at 34° from *C*; 34° is the required dip.

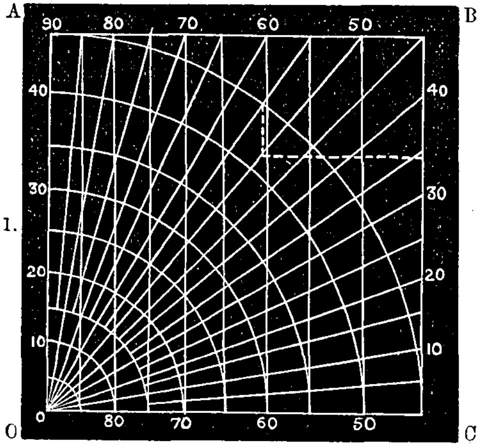

Fig. 1.

This method is in principle rigidly accurate, but the degree of accuracy attainable in practice depends on the scale of the graticule and the degree of care with which it is applied.

For the solution of the other classes of problems, the scale of tangents and co-tangents require to be extended so as to embrace at least 60° of the quadrant and we require the circle round *O* to be completed; in Fig. 2 I have given one-half only, as this will be sufficient for explanatory purposes.

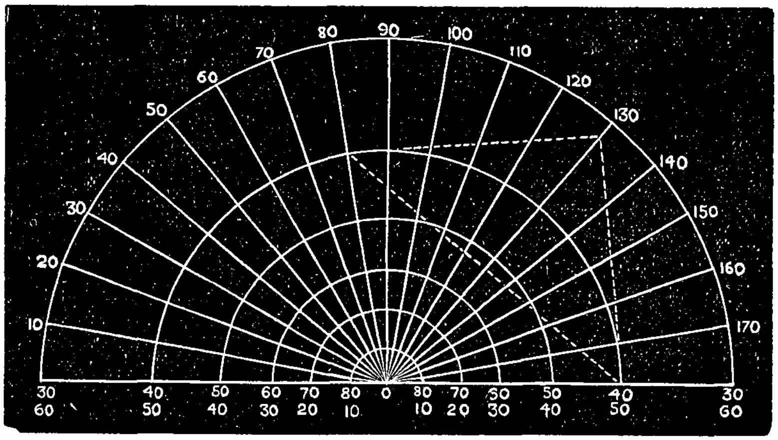

Fig. 2.

(2) Given the apparent dip in two directions; required the direction and amount of the true dip.

(*a*) When both the dips are greater than the minimum angle on the scale of cotangents; the said scale to be used throughout. On a piece of tracing paper draw two straight lines crossing each other at right angles; place this on the graticule in a position such that one of the lines shall cut the two radii representing the given directions of dip at points corresponding to their respective angles, and the other lie over the origin, then the point of intersection will give the direction and amount of the true dip. This method is represented by the dotted line in Fig. 2.

(*b*) When both the given dips are less than the maximum angle on the scale of tangents; the said scale to be used throughout. Take two pieces of paper whose edges are truly square, and lay one with its edge along the radius representing the direction of one of the given dips, and its corner at the point corresponding to the dip in that direction, and lay the other in a corresponding position on the radius representing the second direction of given dip, then the intersection of the free edges will give the direction and amount of the true dip. This method is represented by broken lines in Fig. 2.

It will be seen that neither of these methods are applicable in every case, but only when both the dips fall on to a single scale; but as the scale can be extended so as to embrace 70° of the quadrant without becoming cumbrous, one or other method will be applicable in every case likely to occur in practice.

(3) Given the dip of a bed and the slope of the ground, to determine the direction of its outcrop. The methods given under (2) are to be employed, but in the reverse manner, viz. that described under (2 *b*), where the scale of cotangents has to be used, and that under (2 *a*), where the scale of tangents must be used.

If the direction of outcrop and of the slope of the ground be given, the true dip can be obtained by first determining the respective angles of slope in the given directions of outcrop as described under heading (1), and then combining these by methods (2 *a*) or (2 *b*) as may be most suitable. Any other modification of these, which are all that ordinarily occur in practice, are too obvious to necessitate a detailed description.

As regards problems falling under heading (4), viz. those connected with the tilting of already inclined beds, Mr. Harker's method can be followed, on the graticule I have described, by means of a piece of tracing paper, but this method is cumbrous, presents no advantage whatever over a direct and purely graphical solution, a matter of the less consequence, as the interest of these problems is rather fanciful than practical, the data required for their solution being seldom or never obtainable.

VI.—The Rhætic Section at Wigston, Leicestershire.

By E. Wilson, F.G.S., and H. E. Quilter.

ALTHOUGH Rhætic rocks have already been noticed at one or two points in Leicestershire, viz. at Leicester by Mr. W. J. Harrison and between Barrow and Sileby by Mr. Etheridge,[1] the complete sequence of this series has not hitherto been observed in that county. Very recently our attention has been directed to a

[1] Quart. Journ. Geol. Soc. vol. xxxii. p. 212; Geol. Mag. 1874, p. 480.