COMPUTING STRATIGRAPHIC THICKNESS.

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ABSTRACT. A general formula for the computation of stratigraphic thickness is derived which may be used under any conditions of traversing regardless of the bearing of the traverse, the slope of the traverse, the bearing of the strike, or the dip of the strata. Practical examples are given.

THE general trigonometric formula derived in this paper may be used under any conditions where it is desired to find the thickness of strata existing between any two given points whose positions with respect to traverse bearings are known.

It is required to have the following data which are all routine observations in the recording of any traverse:

(1) Positions or bearings of the stations.
(2) Vertical distance between the stations.
(3) Horizontal distance between the stations.
(4) Strike and dip of the strata.

A paper by Mertie[1] makes use of the slope angle and the slope distance between stations. However, in practice, it is found that slopes change, sometimes very rapidly and complexly over short distances. Accordingly, the procedure described below will prove to be very rapid and practical regardless of frequency of change in the angle of slope since neither the slope angle nor the slope distance is used.

The bearings are made by compass; the vertical distance between stations is determined by the Locke hand level; and the horizontal distance between stations is measured by tape.

The usual condition is that of ascending a slope or hillside with the strata dipping in a direction opposite to the topographic slope. Fig. 1 is a geometric construction representing such conditions.

Let A be the origin of the traverse and B the next station. C is the vertical projection of B on a horizontal plane. Then BC (with right triangle ACB revolved downward 90° to the left in the figure) is the vertical distance from A to B and AC

[1] Mertie, J. B., Jr.: Graphic and mechanical computation of thickness of strata and distance to a stratum, U. S. G. S. Prof. Paper 129-C, 1922.

is the horizontal distance. Let AC be denoted by d and BC by h.

Let AX be the plotted direction of the strike of the formation. Draw LY parallel to AX through point C. Denote the angle between the direction of the traverse (AC) and the bearing of the strike (AX) by β.

Through C erect a perpendicular to the strike direction meeting AX at E. From E draw line EZ making angle CEZ (de-

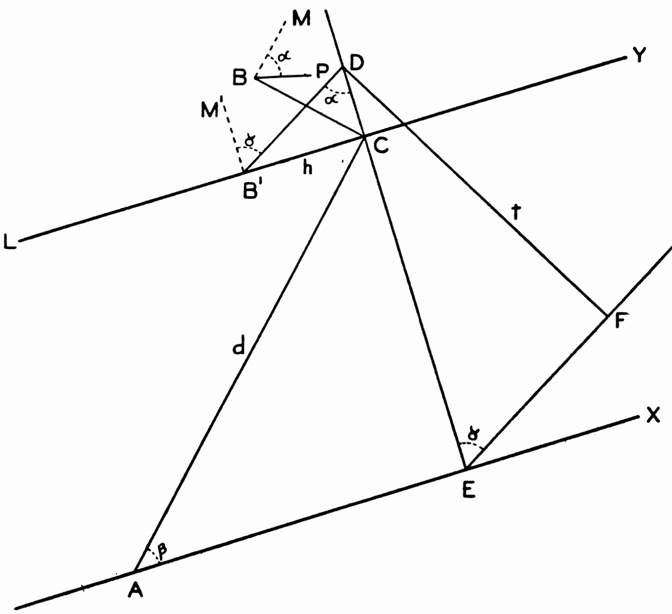

Fig. 1.

noted by α) equal to the angle of dip of the strata. (This angle is revolved upward 90° to the right in the figure.) Lay off CB' on LY equal to CB (or h). In effect this rotates point B of the traverse into the stratum passing through point C. The dip angle, α, is indicated by angle MBP which, when rotated, becomes $M'B'D$. Line $B'D$, accordingly, is parallel to line EZ. Hence D is the point where the stratum through B intersects the perpendicular EC. From D draw DF perpendicular to $B'D$ and EZ and designate DF by t. Thus t represents the perpendicular distance between the strata, or, the stratigraphic thickness, which is to be determined.

DERIVATION OF THE FORMULA.

$$t = (EC + CD) \sin \alpha$$

$$EC = d \sin \beta \text{ and } CD = h \cot \alpha$$

$$t = (d \sin \beta + h \cot \alpha) \sin \alpha$$

$$(1) \quad t = d \sin \alpha \sin \beta + h \cos \alpha$$

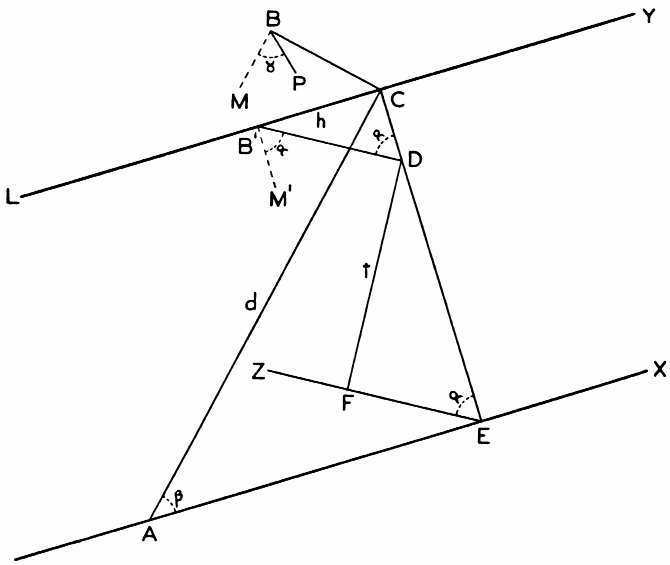

FIG. 2.

Fig. 2 shows the geometric construction when the slope of the traverse and the dip of the strata are in the same direction, in which case

$$t = DE \sin \alpha$$

$$DE = (CE - CD)$$

$$CE = d \sin \beta \text{ and } CD = h \cot \alpha$$

$$t = (d \sin \beta - h \cot \alpha) \sin \alpha$$

$$(2) \quad t = d \sin \alpha \sin \beta - h \cos \alpha$$

Hence the general formula, as derived above, is

$$(3) \quad t = d \sin \alpha \sin \beta \pm h \cos \alpha$$

Plus (+) is used when the traverse slope and the dip angle are in opposite directions; minus (−) is used when they are in the same direction.

When working uphill it is obvious that when the slope of the traverse and the dip of the strata are in the same direction the traverse is passing stratigraphically downward, except where the slope angle is greater than the dip angle—which condition is rarely met. Hence, in practice, in order to obtain the proper sign for ascending or descending in the formation, the formula should be used as follows:

$$(4) \quad t = h \cos a \pm d \sin a \sin \beta$$

and the rule for plus and minus signs as given above is observed.

Occasionally a traverse may be run along a very winding road—on a mountain side, for example—with reversed curves as given by the following data taken from an actual field traverse. This will illustrate the advisability of using the general formula as given immediately above in (4).

Sta.	Dist.	Traverse	Strike & Dip	h	t
7	79–0″	S34E	N67E57SE	65″	+67.96
8	84–4	S34E	"	"	+72.35
9	71–3	S45E	"	"	+58.58
10	66–6	N70E	"	36″	+ 4.41
11	119–6	N5W	N67E51SE	65″	−92.43
12	92–7	N	"	"	−63.02
13	79–6	N12E	"	"	−47.43
14	84–6	N25E	"	"	−40.18
15	52-8	N51E	"	30″	− 9.51
16	45–0	S70E	N60E60SE	48″	+31.79
17	73–6	S30E	"	65″	+65.92
18	82–6	S3E	N70E55SE	"	+67.35
19	102–8	S3E	"	"	+83.06

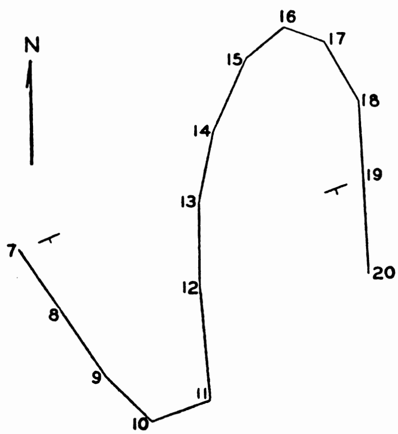

Fig. 3.

To further emphasize the importance of carrying the proper sign in the general formula, the above traverse is shown plotted in Fig. 3.

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