Economic Geology, v. 17, pp. 572-574

ANALYSIS OF STRUCTURE BELOW AN UNCONFORMITY.[1]

J. B. MERTIE, JR.

Structural unconformities are stratigraphic criteria of the first order, and deserve to be scrutinized carefully. The purpose of this paper is to point out a simple method of interpreting the structural data available from an unconformable relationship of geologic strata.

If the beds above and below an unconformity are both tilted, it is evident that the direction and amount of inclination of the underlying beds is the combined result of two distinct periods of deformation. This composite tilt may be resolved into two components, corresponding to the two deformations, and in this way the attitude of the lower beds previous to the second period of folding may be deciphered. If sufficient data of this kind are available, the regional pre-unconformity structure may be worked out. Likewise in certain fault problems, where tilted blocks owe their position to two or more movements, the principle may also be used to advantage.

The principle involved is not new. Harker,[2] in 1884, considered the problem as follows: "Strata having a dip given in direction and amount receive a secondary tilt given in direction and amount; to find the direction and amount of the resulting dip." He gave, without proof or discussion, a formula suitable for derivation of the pre-unconformity dip, but not for the strike. Incidentally, he and others writing in the *Geological Magazine* at that time considered graphic solutions of other stratigraphic problems, which appear to have been generally overlooked.

The simplicity of the problem is apparent when considered as an application of spherical trigonometry. In Fig. 51, two per-

[1] Published by permission of the Director of the U. S. Geological Survey.

[2] Harker, Alfred, "Graphical Methods in Field Geology," *The Geological Magazine*, New Series, Decade III., Vol. 1, 1884, pp. 154–162.

spective drawings of spherical triangles are given, illustrating two possible cases, *i.e.*, (*A*) where the beds above and below an unconformity dip in the same direction with regard to the vertical, and (*B*) where they dip in opposite directions.

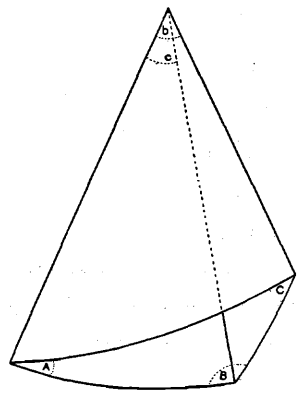

FIG. 51 *A*.

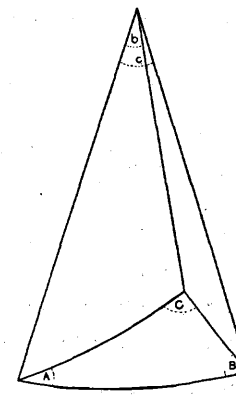

FIG. 51 *B*.

In the spherical triangle represented by Fig. 51, *A*, let the stratigraphic data be represented as follows:

Let A = Present angle of dip of the beds above an unconformity.

B = The supplement of the present angle of dip of the beds below an unconformity.

c = The angle between the strike of the upper and lower beds.

By rotating the figure until the plane of the spherical angle b becomes horizontal, it will be seen that the angle C represents the dip of the lower beds prior to their second deformation, and that the angle b represents the angular difference between the present strike of the upper beds and the strike of the lower beds prior to their second deformation. Fig. 51, *B* shows the same relationship, except that B represents the present dip of the lower beds instead of its supplement, and C represents either the pre-unconformity dip of the lower beds, when C is acute, or its supplement, when C is obtuse. The solution of this problem is therefore the solution of an oblique spherical triangle.

The value of C may be obtained from the following spherical triangle formula:

$$\cos C = \sin A \sin B \cos c - \cos A \cos B. \qquad (1)$$

After C is obtained, the angle b may be obtained from either of the two following formulas:

$$\cos b = \frac{\cos A \cos C + \cos B}{\sin A \sin C}, \qquad (2)$$

$$\cot b = \frac{\sin A \cot B + \cos A \cos c}{\sin c}. \qquad (3)$$

Equations (1), (2), and (3) could, if desired, be plotted as four-variable alignment charts, but in view of the relative infrequency with which they will be used, it seems to the writer that solutions by logarithms or slide rule will be more practical.

U. S. GEOLOGICAL SURVEY,
WASHINGTON, D. C.