FORMULAS FOR CALCULATING STRATIGRAPHIC THICKNESS EXPOSED BETWEEN TWO DIPS

Recently in the examination of one of our thick California formations it was found necessary to determine accurately the thickness exposed between various outcrop samples collected for microfaunal determination. Planetable traverses were run connecting the different exposures, and these traverses were of a zig-zag shape inclined generally to the strike of the formation. In order to calculate the thickness between the different exposures, special formulas had to be worked out. I am giving here the simplest of these formulas, believing they may be useful to others encountering the same field conditions.

Given two exposures on, say, a hillside, showing dips and strikes that may correspond, or may be quite different: it is required to find the stratigraphic thickness measured normal to the bedding exposed between the two dips. The strata between are concealed, and the assumption is made that the dip as well as the strike varies in a uniform manner from the first to the second outcrop. The straight line, rarely level, connecting the two dips is denoted by \( s \). The relations are shown in Figure A.

The coordinates of the two exposures are \((x_1, y_1, z_1)\) and \((x_2, y_2, z_2)\). The positive \( x \) axis is directed north, the positive \( y \) axis east, and the positive \( z \) axis vertically upward. These coordinates provide for the horizontal positions of the dips, as well as their elevations.

The direction cosines \((L, M, N)\) of the line \( s \) are given on Figure A. Here \( s^2 = (x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2 \).

The direction cosines \((l, m, n)\) of the normal to the bedding plane at any point on the line \( s \) are given on Figure B expressed in terms of the dip and strike, and also in terms of the intercepts. If we make the assumption that the direction cosines vary in a linear manner between the two dips, then these quantities are determinable in the concealed strata at any point along the line \( s \).

The direction cosines of the normal to the bedding plane at the first exposure are \((l_1, m_1, n_1)\) and at the second exposure \((l_2, m_2, n_2)\).

Let \( dT \) be the normal to the bedding plane at any point on the line \( s \). Also \( dT \) represents the elementary stratigraphic thickness at this point. The angle \( \epsilon \) between the normal \( dT \) and the line \( s \) is found from the equation: \( \cos \epsilon = Ll + Mm + Nn \). It is further evident that \( dT \) is the projection of \( ds \), hence \( dT = ds \cos \epsilon \).

Therefore \( dT = (Ll + Mm + Nn)ds \).