A SIMPLE METHOD FOR DETERMINING TRUE BED-THICKNESS

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INTRODUCTION

Bed-thickness, measured along the perpendicular to the bedding plane, is the basic parameter required for characterization of a sedimentary unit. In sedimentary facies analysis, care has to be taken of precision in determination of bed-thickness. A number of attempts have been made to attain required precision in acquisition of this parameter. Different techniques have been adopted according to the convenience (Kummel, 1943; Krumbein and Sloss, 1963). Orientation of the sections, most often, is not suitable for direct measurement of the true bed-thickness, and only the apparent bed-thickness, measured along any direction different from the bed-normal, is obtained therefrom. Palmer (1919) developed trigonometric methods for determination of true bed-thickness from the apparent one. But these methods are applicable only when the apparent thickness is measured on a plane perpendicular to the strike of the bed. In nature, however, the sections are mostly oriented oblique to the strike of the bed, and direct application of Palmer's methods finds its limitation. The trace of the plane perpendicular to the strike of the bed can be determined and drawn on the exposure before determination of the apparent thickness along that line. But the method is not convenient, and becomes difficult for thick beds with uneven outcrop surface. Mertie (1922) came forward with numerical solutions to this problem, and developed nomograms for graphic solutions to general formulae used for estimation of true bed-thickness from the apparent one, measured along any arbitrary direction. The method proposed by Mertie (1922) involves precise acquisition of five basic parameters.

1. Apparent thickness of the bed.
2. Angle of slope along which the bed thickness has been measured.
3. Angle between strike of the bed and direction of measurement.
4. Elevation difference between the end points of measurement.
5. Dip of the bedding plane.

In general, the exposures are mostly uneven, and the angle of slope of the section often varies from bed to bed in the same succession. It also becomes difficult to estimate the outcrop slope for thick beds due to uneven character of the exposure. In some sections the direction of measurement has also to be changed for different beds for inaccessibility or paucity of suitable exposure. Correct estimation of elevation difference between the end points of measurement also becomes difficult accordingly. Finally, determination of thickness of each of the beds from

obtained data involves mathematical calculations and application of the methods proposed by Mertie (1922) in the field becomes time-consuming and inconvenient.

Compton (1962) made an elaborate discussion on measurement of stratigraphic section, and considered the situation of measurement of slope distance in a direction oblique to the dip direction of the beds. He suggested a trigonometric solution to get the measurement in a direction perpendicular to the strike of the beds (Compton, 1962, p. 240) before application of the methods for determination of true thickness proposed by Palmer (1919). Critical analysis of the trigonometric method for corrections of slope angles and oblique sections proposed by Compton (1962) reveals that a slight modification of this technique can lead to acquisition of true bed-thickness in a precise way without using any other formula. This convenient and precise method for acquisition of true bed-thickness is presented here. This can be used as a general method for determination of thickness of a bed from any type of section.

DETERMINATION OF TRUE BED-THICKNESS

Bed-thickness is the normal distance between the two confining surfaces of a sedimentary unit. The distance between traces of these two surfaces on section, measured along any other direction is the apparent thickness of the bed. The true bed-thickness can only be directly obtained from a section perpendicular to the bedding plane. Section of any other orientation provides the apparent thickness of the bed. The true thickness can be obtained through orthographic projection of the line segment representing the apparent thickness on a line perpendicular to the bedding plane. Figure 1 illustrates this geometric principle of estimation of true bed-thickness from the apparent one. *OP* represents the apparent thickness of a bed measured on a section oblique to the bedding plane. *OQ* is the orthographic projection of *OP* on a plane perpendicular to the bedding plane, and makes an angle θ with *OP*. Then,

$$OQ = OP \cos \theta \qquad (1)$$

Now, *OP* is the apparent thickness (*A*) and *OQ* represents the true thickness (*T*) of the bed. Hence, equation (1) can be rewritten as

$$T = A \cos \theta \qquad (2)$$

Three basic data are required for obtaining the true bed-thickness (*T*) from equation (2).

1. Attitude of the bedding plane.
2. Distance between the traces of two confining surfaces of the bed under consideration (apparent thickness) measured on a section of any orientation.
3. Attitude of the direction of measurement.

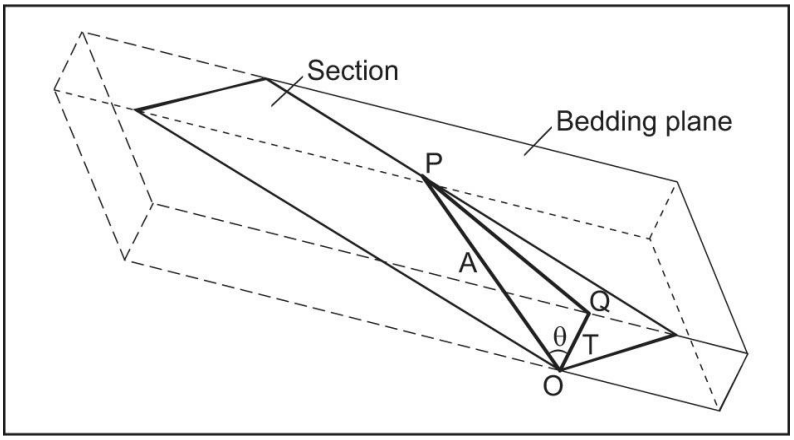

Fig. 1. - Sketch showing geometric relation between true bed-thickness (*T*) and the apparent one (*A*). OP represents the apparent bed-thickness (*A*) measured on a section oblique to the bedding plane. OQ is the orthographic projection of *OP* on a plane perpendicular to the bedding plane, and represents the true bed-thickness (*T).*

Attitude of the bedding plane can be directly measured. If suitable exposure is not available, it has to be determined from the traces of bedding plane on the section with the help of an inclinometer (Dasgupta, 1995). After obtaining the attitude of the bedding plane, the pole of the same is plotted on a stereonet. During measurement of the apparent thickness, the orientation of the measuring tape is correctly recorded as attitude of a line, and is plotted on the same stereonet. The angle between these two lines, i.e., pole of the bedding plane and attitude of the direction of apparent thickness, can be easily determined from the stereographic projections (Fig. 2). This angle represents θ of equation (2). Putting this value of θ in equation (2), the true thickness (*T*) of the bed can be obtained from the measured apparent thickness (*A*).

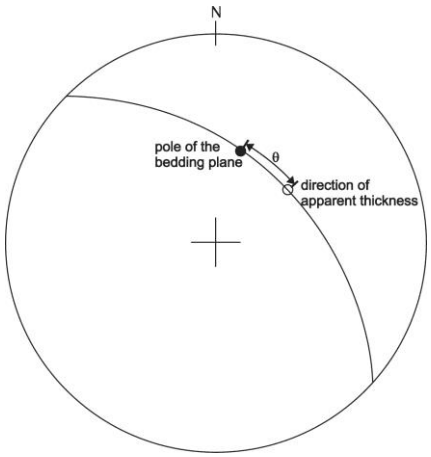

Fig. 2. - Definition sketch for determination of angle (θ) between the bedding plane normal (pole) and the direction of measurement of apparent bed-thickness from the stereo graphic projections.

ADVANTAGES AND LIMITATION

The present method for determining true bed-thickness has the following advantages over the existing methods to make the measurement procedure more accurate and convenient.

1. The basic data can be easily obtained.
2. The method is independent of orientation of the section.
3. The method does not involve any complicated calculation.
4. It is simpler, more accurate and much less time-consuming than any other method available for determination of true bed-thickness.
5. This method can be used as the general procedure for determination of bed-thickness. The apparent thickness of the bed can be measured along any direction. Unevenness of the outcrop surface does not affect the accuracy of obtained data.

Besides the above advantages, the method under discussion has a limitation. It is directly applicable for measurement of tabular bodies of uniform thickness with planar confining surfaces. In case of lenticular beds and beds with curved bounding surfaces, apparent thickness has to be measured on the section along trace of the plane perpendicular to the general strike of the associated planar beds of the same succession.

REFERENCES

Compton, R.R., 1962. Manual of field geology. New York, John Wiley and Sons, Inc., 378 pp.

Dasgupta, P., 1995. A new model of inclinometer and its application in determination of attitude of foreset planes. Journal of Sedimentary Research, A65, 562-563.

Krumbein, W.C., Sloss, L.L., 1963. Stratigraphy and sedimentation. Second Edition: San Francisco and London, W.H. Freeman and Co., 660 pp.

Kummel, B., Jr., 1943. New technique for measurement of stratigraphic units. American Association of Petroleum Geologists, Bulletin, 27, 220-223.

Mertie, J.B. Jr., 1922. Graphic and mechanical computation of thickness of strata and distance to a stratum: U.S. Geological Survey, Professional Paper 129, 39-52.

Palmer, H.S., 1919. New graphic method for determining the depth and thickness of strata and projection of dip. U.S. Geological Survey, Professional Paper 120, 123-128.