M. Helper '96

# LAB 10: GEOLOGIC MAPS II. DETERMINING STRIKE AND DIP AND UNIT THICKNESSES FROM GEOLOGIC MAPS

In our first lab on geologic map interpretation, we looked at determining strike and dip *directions* by constructing strike lines, lines connecting two or more points on a contact that have the same elevation. Today we go one step further and determine dip angle. We will begin by first examining ways to calculate **true dip**, the angle of dip perpendicular to strike, and move on to look at **apparent dips**, which are not perpendicular to strike. Both are of obvious importance in constructing cross sections, and can be used to predict where a bed, fault, or other planar feature should occur based on limited mapping.

We will also look at a simple way to determine unit thicknesses from strike lines and dips.

A. <u>Determining dip from adjacent strike lines</u>

Recall from the first lab that strike lines on a inclined plane represent the intersection of a horizontal plane at the elevation of the strike line with the inclined plane. Also recall that if a surface is planar, every strike line on it must be parallel. The map distance between adjacent, parallel strike lines on a plane is related to the dip of plane (Θ) by a simple formula:

$$X = Y/(\tan \Theta) \quad \text{or} \quad \Theta = \tan^{-1}(Y/X)$$

where X is the *perpendicular* distance between adjacent strike lines, Y is the difference in the elevation of the two strike lines, and Θ is the **true dip** angle (Fig. 1). An **apparent dip** in any direction can be calculated by the same formula for any distance X' (Fig. 1) *not perpendicular* to the strike lines. Apparent dips will always be less than the true dip. Such apparent dips are needed when constructing cross sections that aren't perpendicular to strike, as in the exercises below.

B. <u>Determining bed thickness from strike lines</u>

A units **true thickness** is defined as its thickness measured perpendicular to its top and base. Thickness measured in all other directions are **apparent thickness**, which are greater than true thickness. For inclined units, this means true thickness can only be measured in the plane containing the dip direction; any other direction yields apparent thicknesses. The perpendicular map distance between strike lines on the *top and the base of a unit* is thus a function of true thickness (strike lines are by definition perpendicular to dip direction) and the dip. The steeper the dip, the thinner a unit will look on a map and vice-versa.

To measure unit thickness, t, (Fig. 2), we measure a perpendicular distance between strike lines *of the same elevation* on the top and base of the unit (d) and, using the dip (Θ)of contacts, use the right triangle relation:

$$t = d \sin \Theta$$

## Exercises

### Map 1

Map 1 shows the geology of an area being considered for a dam and reservoir. A melange is generally a poorly stratified mixture of rocks, in this case with a mud matrix.

1) Construct strike lines for the units on the East side of the fault.
   - a) What are the directions of strike and dip?
   - b) Based on superposition, which unit is oldest?
   - c) What is the basal conglomerate contact?

2 Calculate the dip of the units above the sandstone and below the conglomerate.
   - a) What is it?
   - b) What are the true thicknesses of each of these units?

3) Construct strike lines on the fault plane.
   - a) What is the strike and dip of the fault plane?
   - b) Which side is downthrown?
   - c) Is this a normal or reverse fault?
   - d) What is the age of the fault?

4) Examine the placement of the proposed dam.
   - a) If the dam were built here, what would be the maximum water depth of the reservoir if it were full?
   - b) What units would underlie the reservoir?
   - c) Give three reasons why this site might not be suitable for a dam and reservoir.

5) Examine the proposed line of the supply tunnel. Assume the tunnel is to be driven horizontally, and the NW portal at locality A is to be at 1500 feet.
   - a) Calculate the apparent dip of the beds in the direction of the tunnel.
   - b) Use this value to construct a cross section from A to B, along the path of the tunnel.
   - c) What rock types will the tunnel pass through?
   - d) If the water table lies at 1475' at the NW portal, rises to 1570' in the center of the tunnel, and is at 1475' at the SW portal, which units will be water saturated in the tunnel and which won't?
   - e) Why shouldn't a tunnel be built here?
   - f) Suggest a better depth and/or orientation for the tunnel.

6) Give the geologic sequence of events for the area.

Map 2

1) Determine the strike and dip of all units on the map.

2) Using the proper apparent dips, construct a cross section from A to B.

3) Describe the motion on the fault.

4) Determine the thickness of the sandy shale unit.

Map 3

1) Find the strike and dip of the units.

2) Label the faults with proper symbols, and indicate their dips.

3) List the sequence of geologic events.