Structural Geology Lab 3: Geologic Maps and Cross-sections

I. Geologic Maps

A. Topography (surface elevation) + aerial distribution of rock units

1. geologic contacts: boundaries between rock units as depicted on maps
   a. strike and dip of beds
   b. Defining mappable units
      (1) rock characteristics that differ from one another
         (a) lithology / facies
         (b) texture
         (c) composition
         (d) stratigraphic age
            i) fossils
            ii) superposition
            iii) radiometric dating
2. Faults, fold axes, fractures, lineations, foliations

II. Structural Attitudes from Outcrop Patterns

A. strike = lines on surface of bed of equal elevation

1. Technique: find two points on map where a given geologic contact lies at the same elevation

   a. strike line = line connecting two points of equal elelvation on geologic contact

   b. Dip angle and direction

      (1) draw line perpendicular to strike line of given elevation to point of contact of known elevation 2
      (2) determine vertical distance between two points
      (3) determine horizontal distance between two points

      (4) Tan (dip) = V/H , use inv tan function to determine angle

III. Stratigraphic Thickness from Outcrop Patterns

A. Trigonometric Solutions

1. Basic Data:
   a. h = width of bed outcrop measured perpendicular to strike
   b. dip of bed
   c. t = thickness of bed measured perpendicular to bedding plane = unknown variable in this case

2. Determining Stratigraphic Thickness on Flat Terrain

   a. t = h sin(dip)

3. Determining Stratigraphic Thickness on Sloping Terrain (refer to figures in lab manual on page 35)

   a. Bedding and topography slope in same direction; bedding dips more steeply than slope of topography

      (1) t = h sin(dip)- v cos(dip)

   b. Bedding and Topography slope in same direction; bedding dips more gently than slope topography

      (1) t = v cos(dip)-h sin(dip)

   c. Bedding and topography slope in opposite directions

      (1) t =h sin(dip) + v cos(dip)

B. Graphical Solutions for determining bed thickness

   1. Technique (refer to diagram on page 36)

      a. Find two contour lines (elevation 1 and 2) that cross both the upper and lower contact of a given bed

         (1) For elevation 1, draw two strike lines, one for the upper and one for the lower contact
         (2) For elevation 2, draw two strike lines, one the the upper and one for the lower contact.

         (3) Use fold line technique shown in e.g. 3.6 to determine thickness according to map scale

IV. Geologic Cross-sections

A. Cross-section

   1. vertical sections show "side view" of rocks in view at 90 degrees to map surface

   2. cross-sections very useful in constructing and interpreting geologic structures
      a. age / stratigraphic relationships
      b. structural relationships

B. Topgraphic Profiles

   1. It is assumed that we have, and can all draw a topographic profile
      a. horizontal scale of profile = map scale
      b. vertical scale of profile = variable according to exaggeration needed to illustrate topographic/geologic features

(1) vertical exaggeration: expanding the vertical scale of cross section to exaggerate topographic relief

(2) Numerical determination of vertical exaggeration

(a) e.g. map scale = 1:24000; 1 in = 2000 Ft

(b) Vertical profile scale of 1:1 map:profile
i) 1 in = 2000 Ft of relief
ii) Vertical exaggeration = 1 (none)

(c) Exaggerated Vertical scale
i) Profile scale: 1 in = 500 Ft
ii) Map scale: 1 in = 2000 Ft

Vertical exaggeration = map scale/profile scale =
(1 in/500 Ft)/(1 in/2000 Ft) = 4 "vertical exaggeration" = x4

C. Geologic Cross-Sections

1. Show stratigraphic and structural relationships of rock units

a. data sets
(1) geologic maps
(2) drill/subsurface data

b. commonly superposed on topographic profiles

2. Tips and tricks

a. goal: trying to show true stratigraphic and structural relations in cross-section

(1) Formation thickness
(2) succession of beds
(3) dip of beds

b. Line of cross-section perpendicular to strike

(1) line will be parallel to "dip line", hence true dip angles will be displayed in cross-section
(2) use strike and dip data to show angles of dip
(3) preserve outcrop widths as determined from maps
(4) preserved stratigraphic thickness as determined from outcrop widths and dip angles
(5) must interpret structure and draw in fold relations
(a) solid contacts where showing folds in subsurface
(b) dashed lines to project fold patterns above topographic grade (i.e. to depict that which has been removed by erosion)

c. Line of cross-section not perp. to strike
   (1) must show dipping beds as apparent dip angles
      (a) easiest to use nomogram to determine apparent dips

d. Vertical exaggeration and geologic cross-sections
   (1) any vertical exaggeration in cross-section will distort dip angle relationships
   (2) For true relations: draw cross-section perp. to strike and with vertical exaggeration of "1".

Lab Exercise Instructions

1. Assemble Bree Creek map on p. 259-269 of lab manual
   A. cut and paste map sheets together
   B. tape sheets together from behind (not on map side, since you will be drawing on these)
   C. Color in map with colored pencils
      i. LIGHTLY color in map units, be neat and make it look presentable
      ii. Use the following color code for the map

Rock Units	Color
Thd	Yellow
Tr	light green
Tg	Dark Red
Tdd	Peach
Tmm	Light blue
Tm	brown
Tts	Dark green
Tb	purple
Te	dark blue
Kdt	Light Red
Mr	green stripes
Dlm	Orange
Sm	blue stripes
Omt	red stripes
Omd	yellow stripes

      iii. Neatly fold your map into an 8.5 x 11 packet so that you can transport and work on it through out the remainder of the semester

2. Using the three-point technique complete problem 3.1

3. using trig. technique, work on problem 3.2 for units Tmm and Tts ONLY.

4. Using graphic technique, work on problem 3.3 for Thd at Gandalf's Knob and Tg at Galadriel's Ridge ONLY.

5. Complete problem 4.1, drawing a geologic cross-section (p. 49 using figure on p. 51)