GEOLOGICAL MAPS & STRUCTURES

CONTENT

1. Dipping Strata

2. Determination of Dip

   - ➢ True dip
   - ➢ Apparent Dip

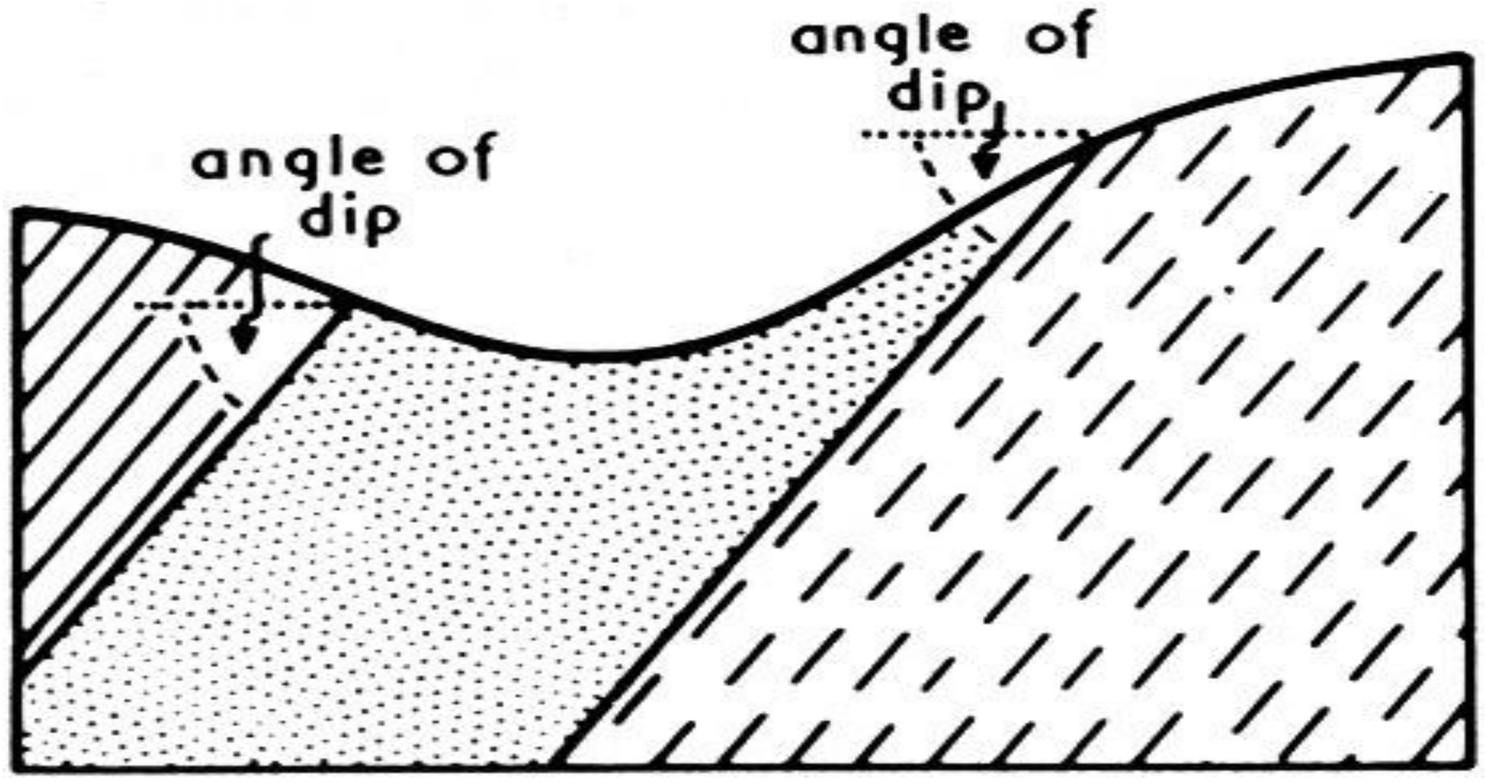
3. Calculation of Vertical & True Thickness

4. Three-Point Problems

DIPPING STRATA

Inclined strata **are said to be** dipping**.**

Angle of dip **=** maximum angle measured between strata and the horizontal (regardless of slope of the ground).



Section showing dipping strata. Angle of dip is measured from horizontal

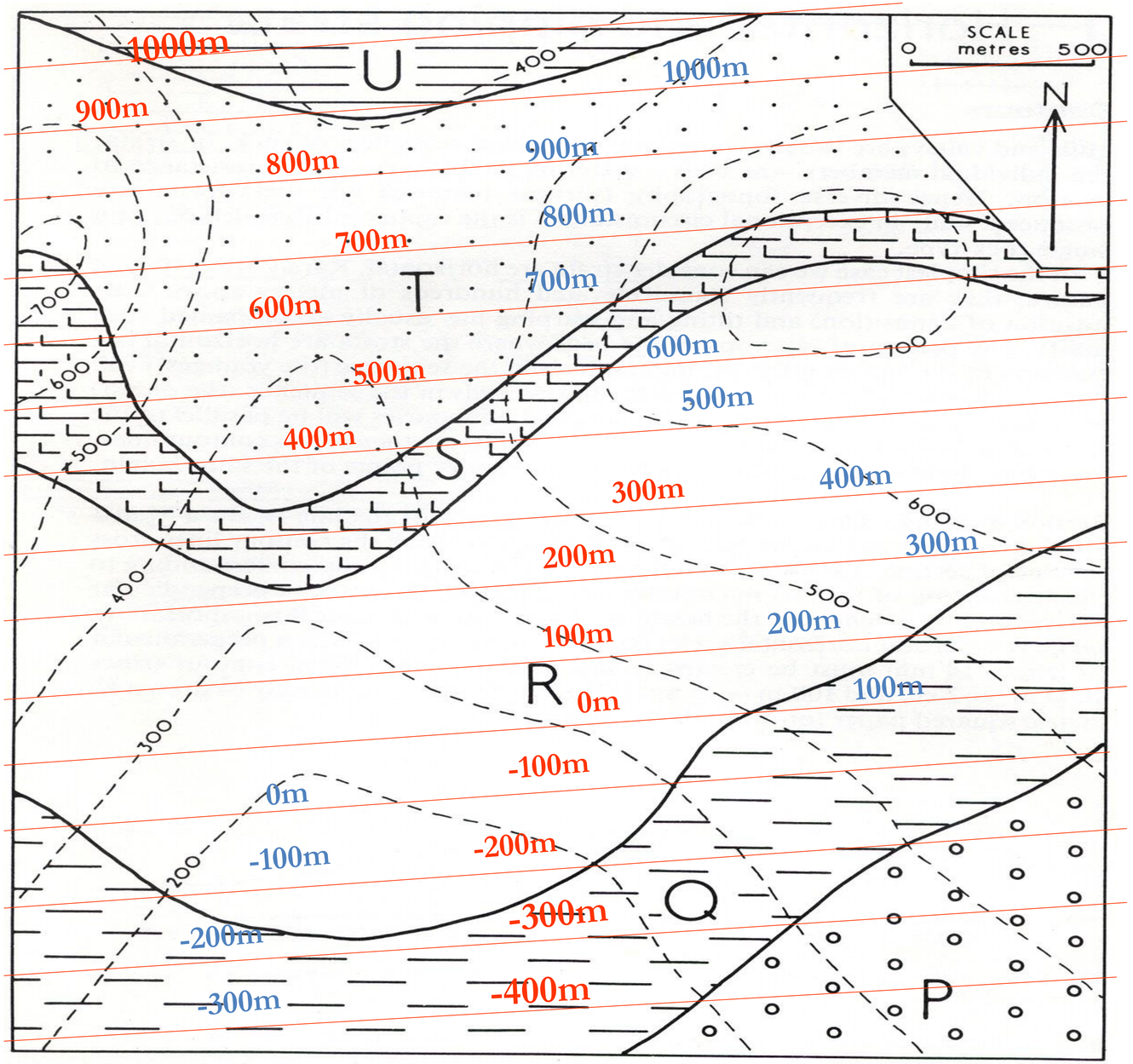
DIPPING STRATA…..contd.

Structure contours (= Strike Lines)

Just as it is possible to define the topography of ground by means of contour lines, so can we also draw contour lines on a bedding plane. These we call structure contours or strike lines:

- The former since they join points of equal height
- The latter since they are parallel to the direction of strike

Construction of Structure contours (Strike Lines)

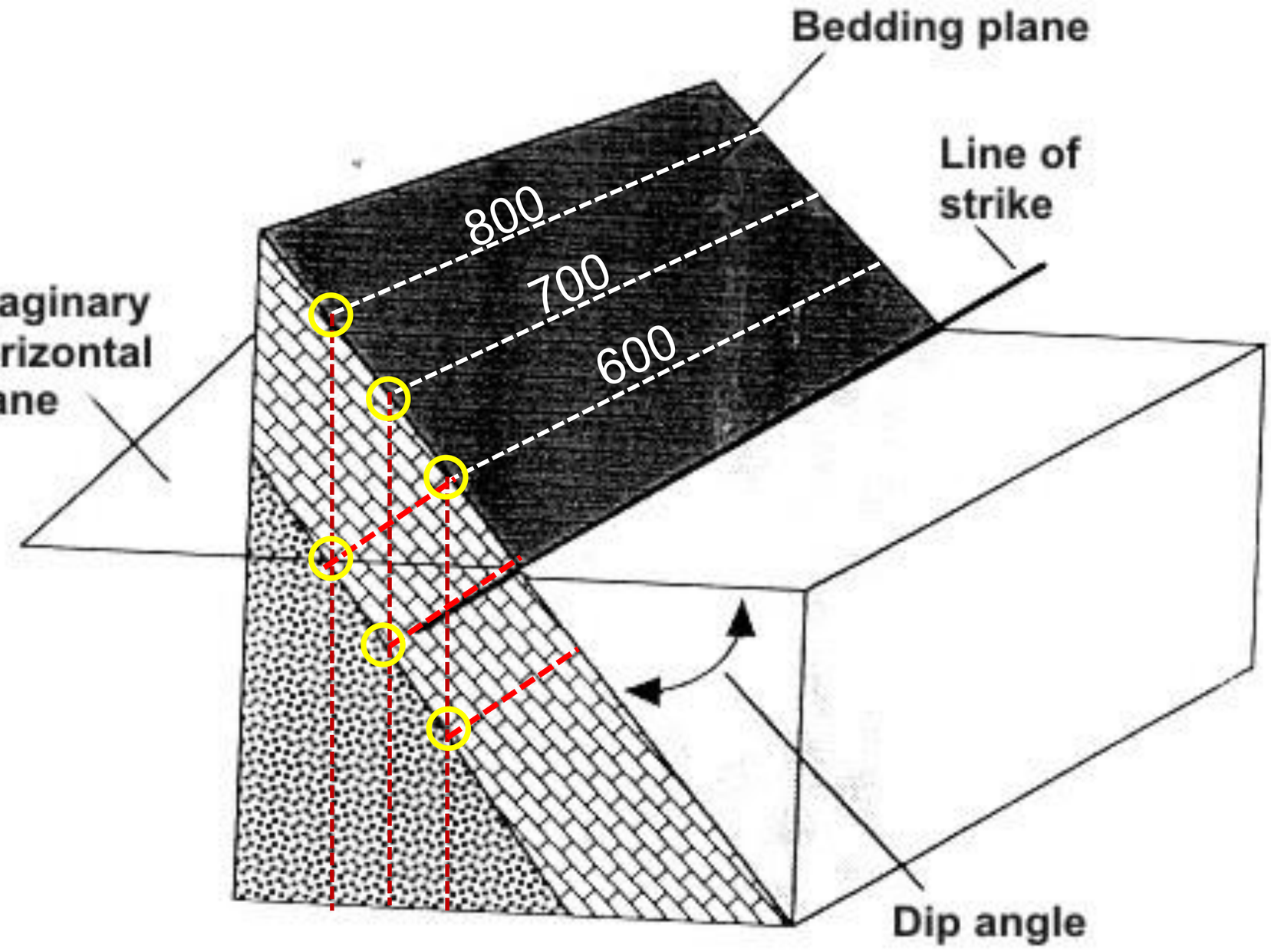


Height of geologic boundary is known where it crosses a topo contour line.

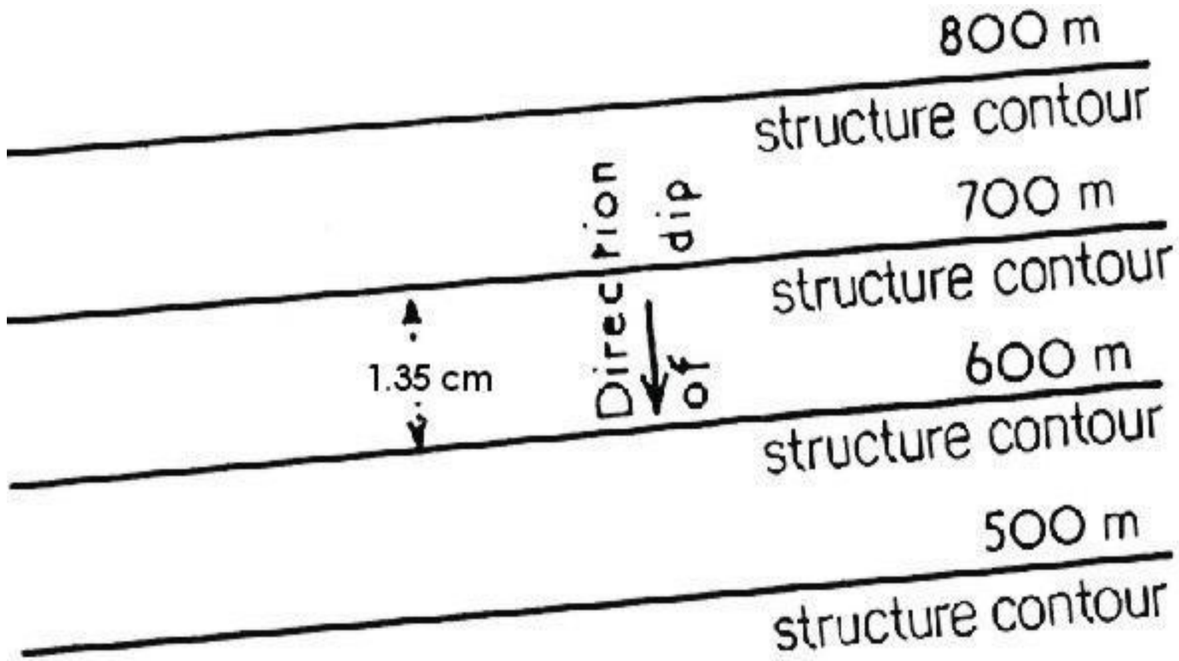
E.g., boundary between beds S and T in map cuts the 700 m **contour @ 3 points. These points lie on the 700 m structure contour.**

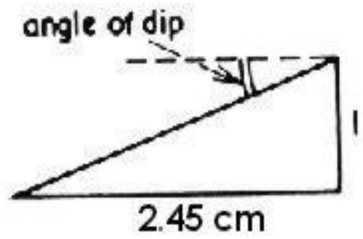
Since these maps portray simply inclined plane surfaces, *structure contours will be straight, parallel* **and - if dips are constant** - *equally spaced*.

Construction of Structure contours (Strike Lines).....contd.



Determination of Angle of Dip





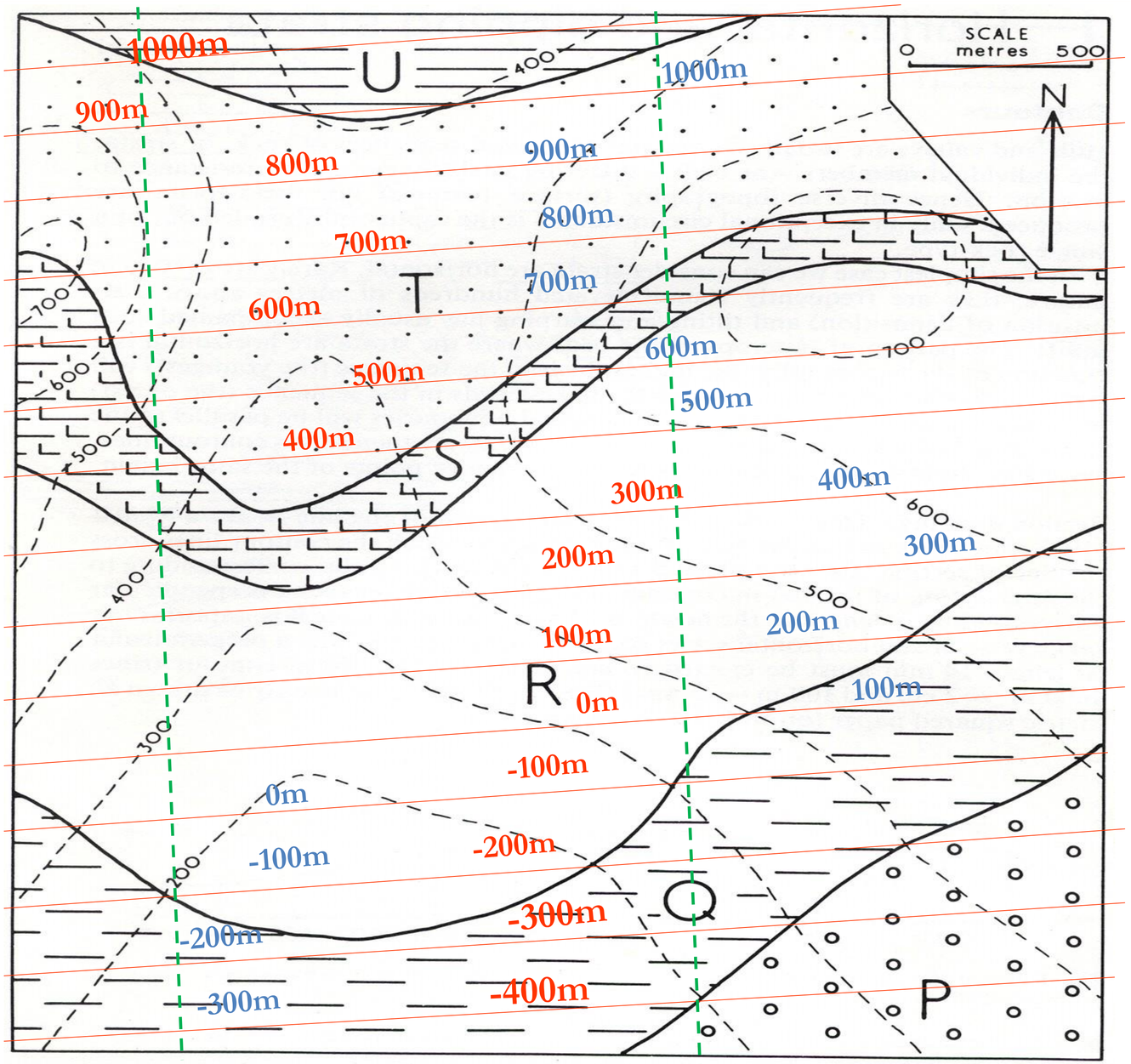
Gradient = 700 m - 600 m in ‘X’ cm

i.e. = 100 m in ‘X’ cm.

As the scale of the map is given as ‘Y’ cm = 500m, ‘X’ cm = ‘Z’ m

Hence, **the gradient** is 100 **in** ‘Z’.

Section Drawing

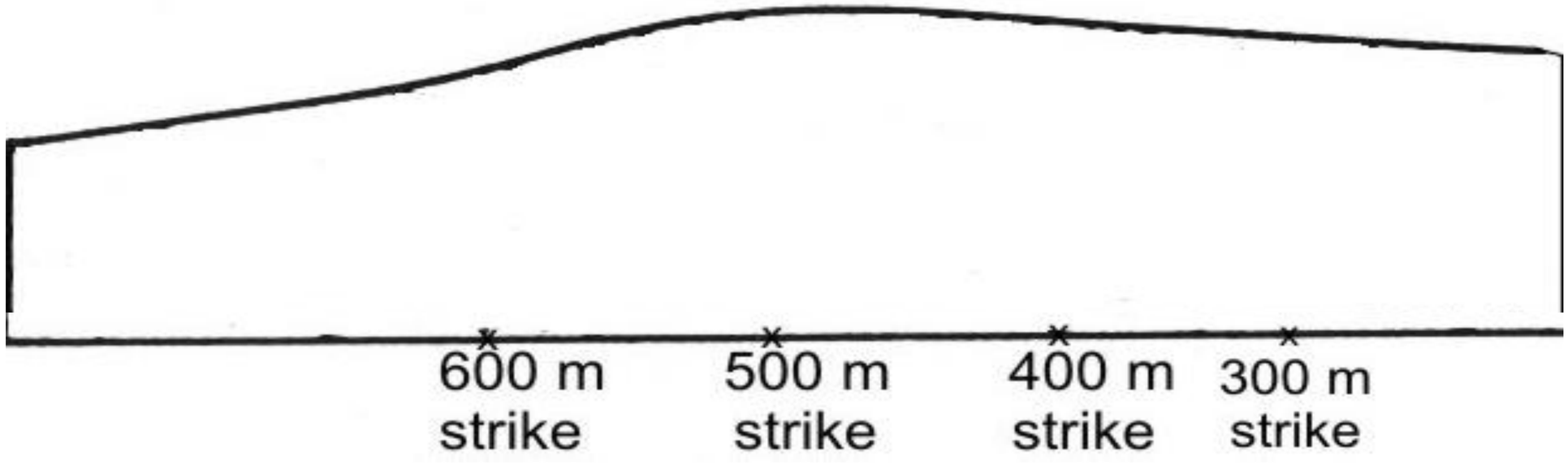


- Choose appropriate line of section.
- Draw topographic profile, as already described before

Section Drawing…..contd.

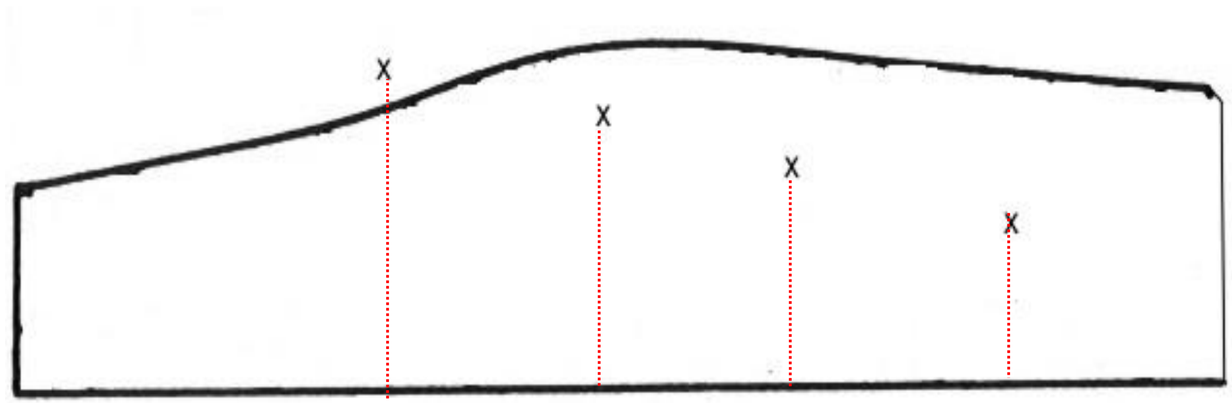
With topographic profile drawn……

- Mark geological boundaries (interfaces) at points where they are crossed by section line:

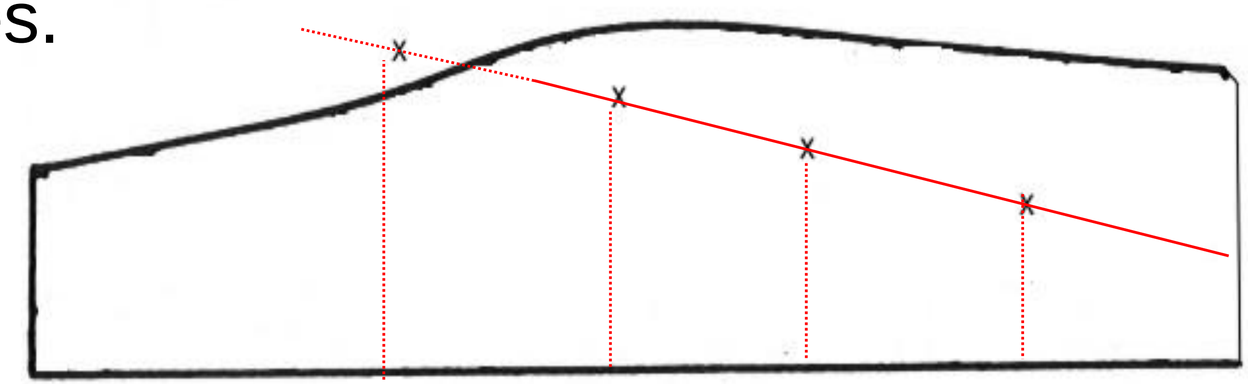


Section Drawing.....contd.

- Then draw perpendiculars from the base line, of length corresponding to the height of the structure contours.

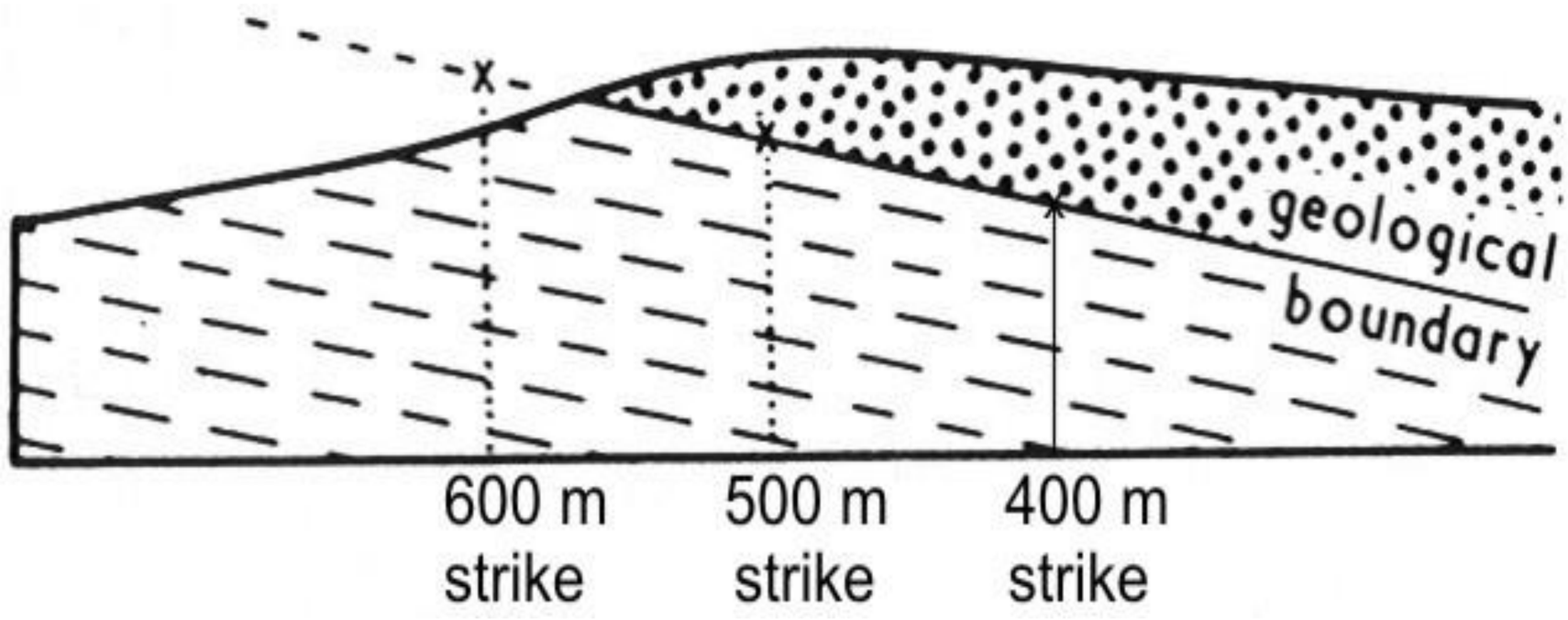


- Join the points above. This forms a geologic boundary at the angle of dip of the lithologies.



Section Drawing.....contd.

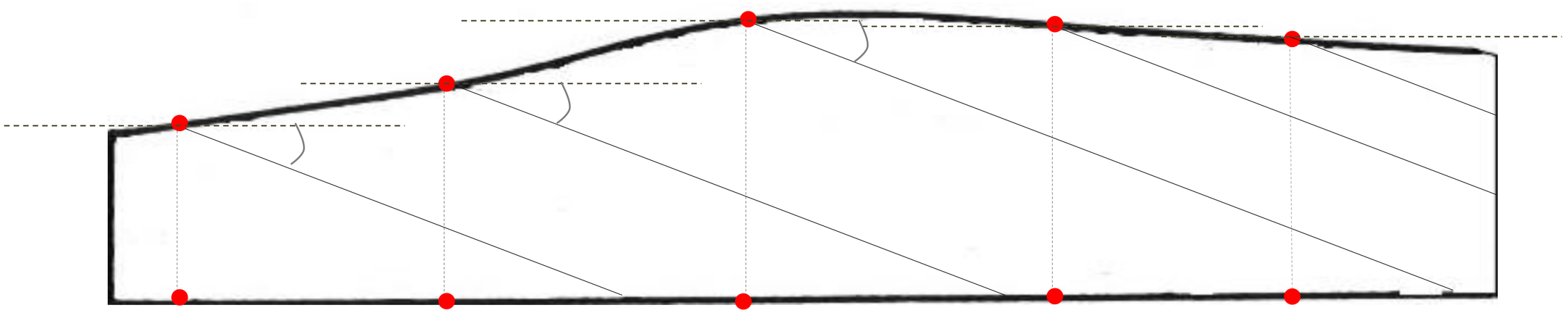
- Shading-in of the geology.....



Section Drawing…..contd.

Alternative method, and which might turn out to be simpler, is:

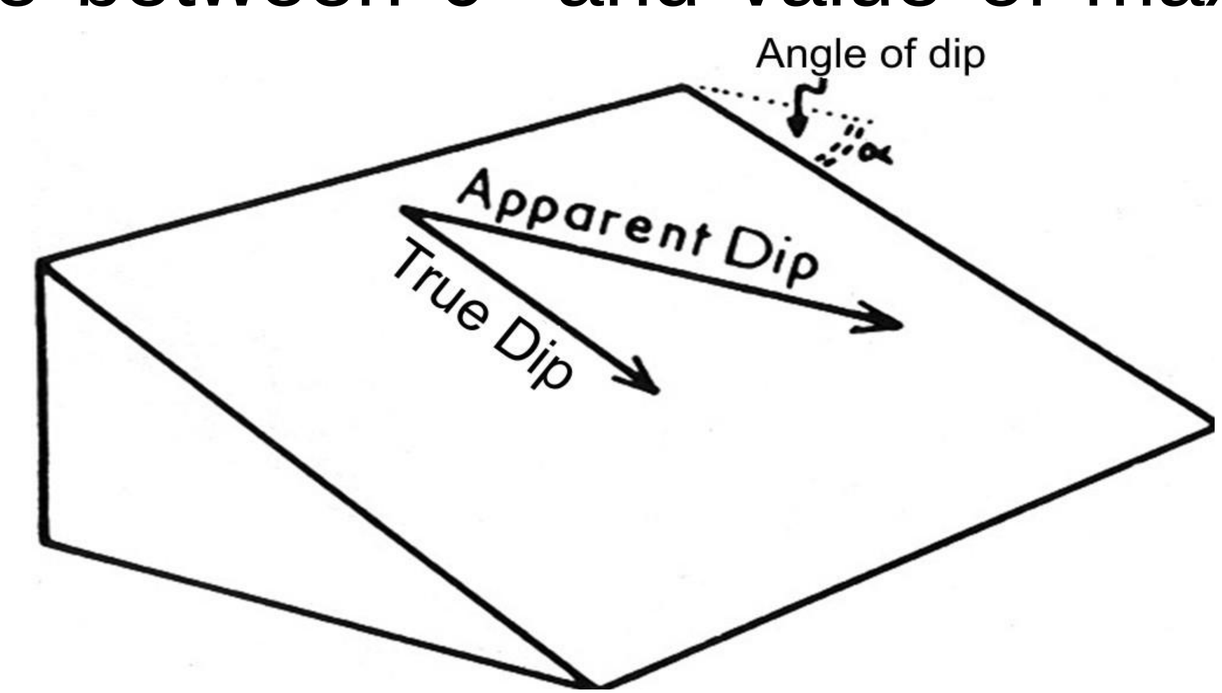
- Mark geological boundaries (interfaces) at points where they cross section line.
- Place these along section line and project them up to where they intersect topography.
- Using angle of dip calculated, slant geological boundaries accordingly.



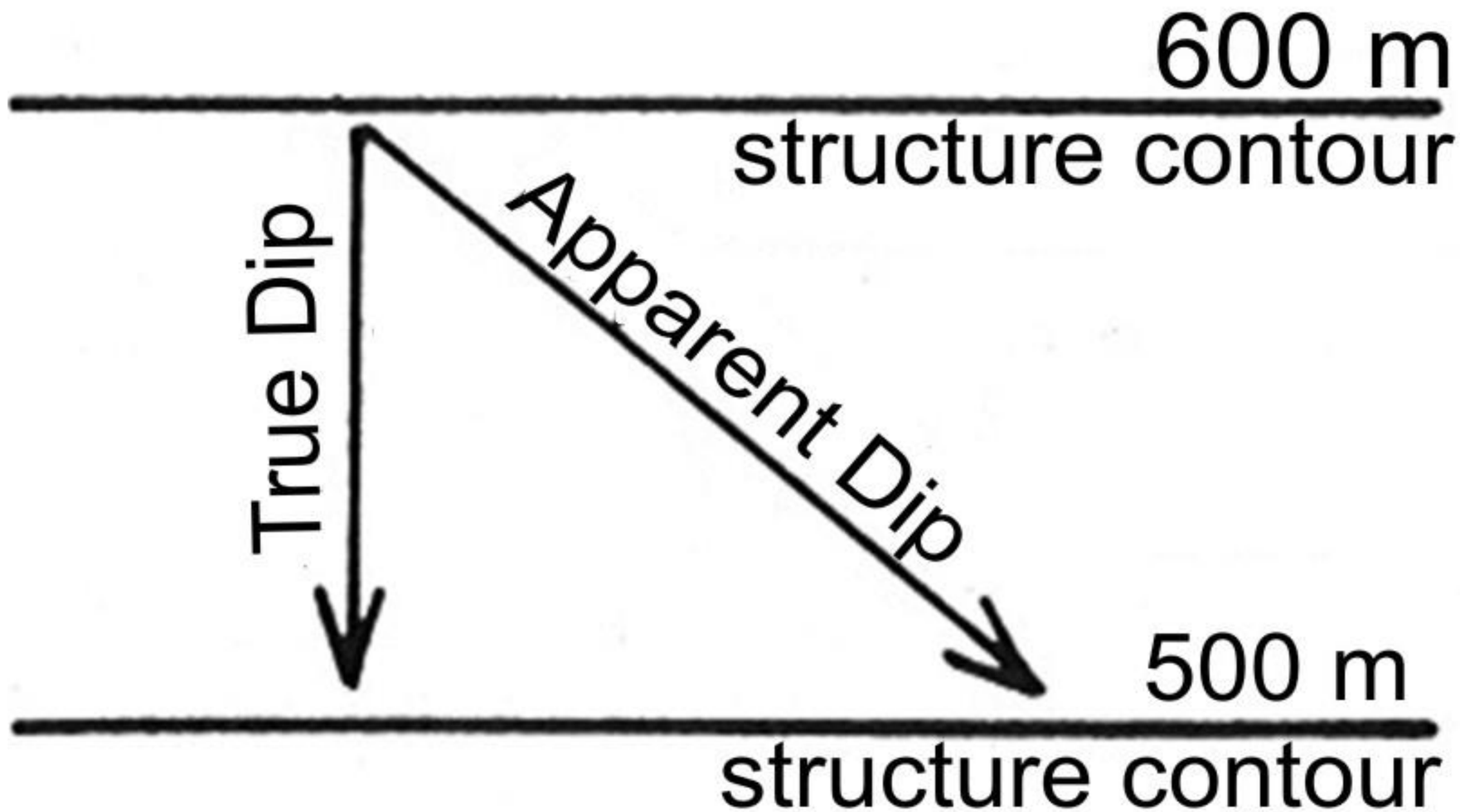
Determination of Apparent Dip

True and Apparent Dip

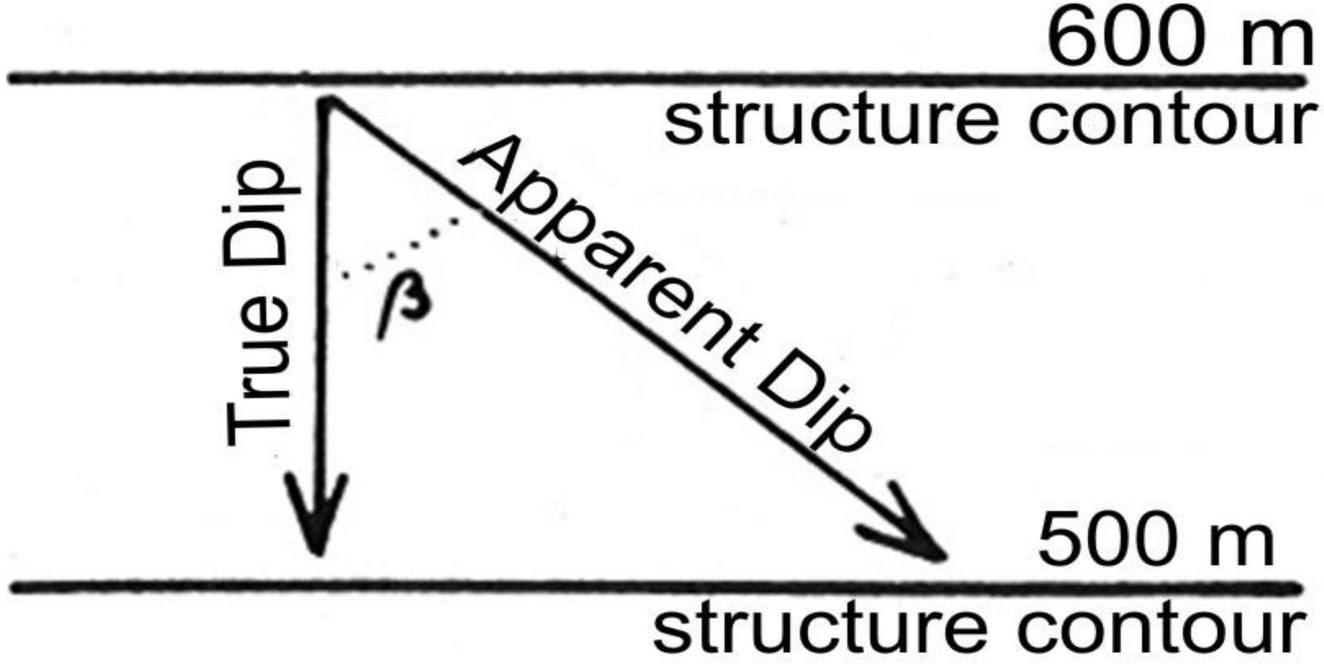
- If the slope of geological boundary is measured in any direction between strike direction and direction of maximum dip, angle of dip in that direction is known as an apparent dip.
- Its value will lie between 0° and value of maximum or true dip.



True and Apparent Dip.....contd.



True and Apparent Dip.....contd.



The trigonometrical relationship is given by:

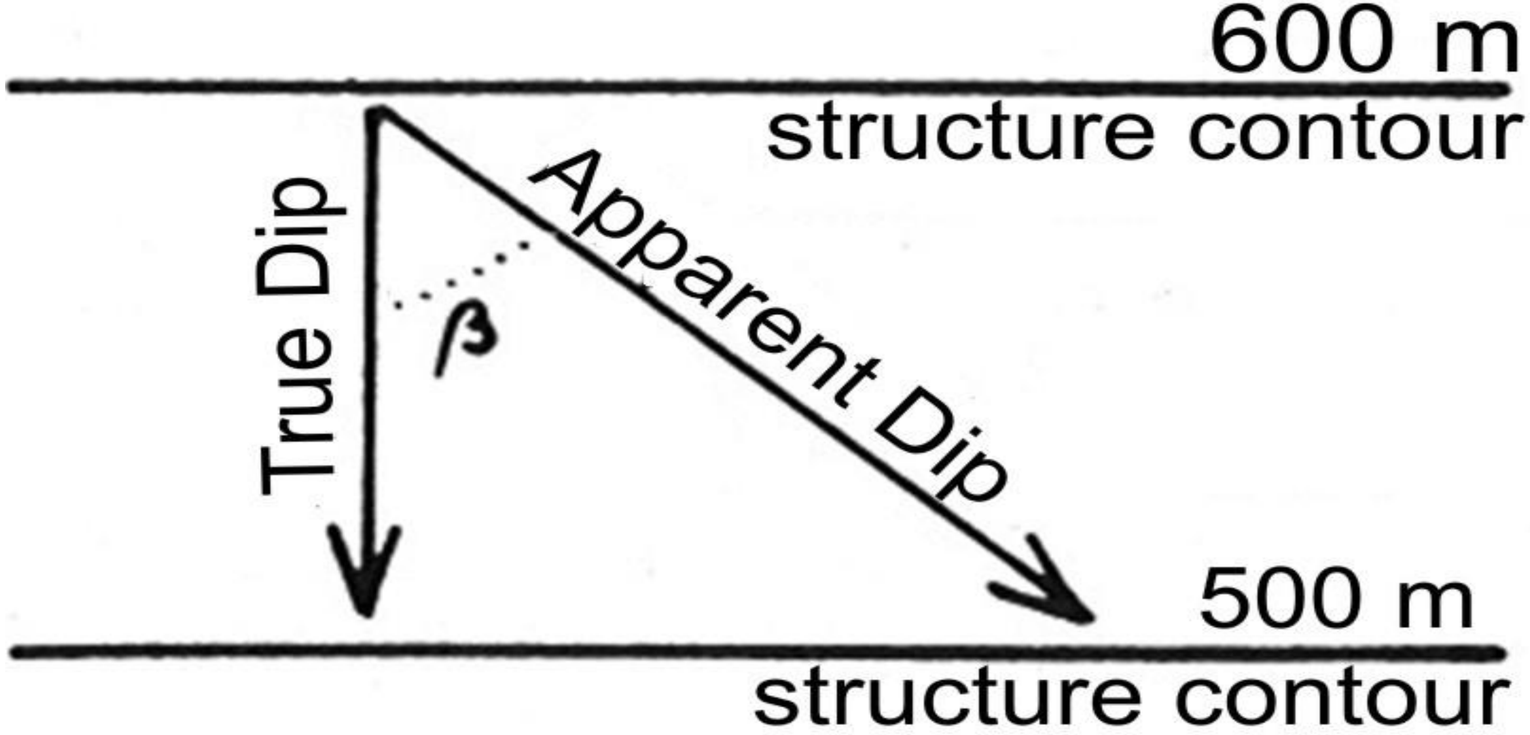
Tangent AD = Tangent TD x Cosine β

$\tan \alpha = \tan \theta \times \cos \beta$

where α = Apparent Dip, θ = True Dip and β = angular divergence between the two angles.

True and Apparent Dip.....contd.

- Put differently, the gradient in the direction in which we wish to obtain the apparent dip is given by the structure contour spacing measured in that direction.



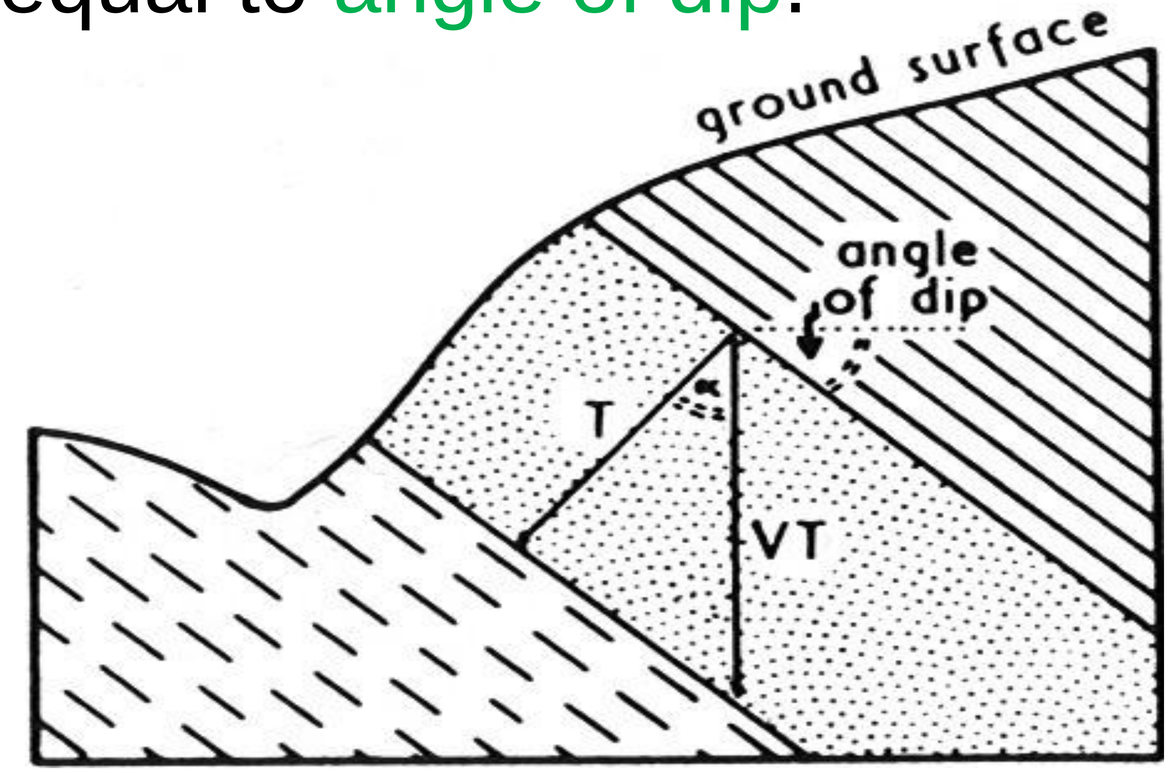
VERTICAL & TRUE THICKNESS

Vertical & True Thickness

- Since beds are inclined, vertical thickness (VT) penetrated by a borehole is greater than true thickness (TT) measured perpendicular to the geological boundaries.
- angle α between VT & TT is equal to angle of dip.

Cosine α = TT/VT

$\therefore$ TT = VT x Cosine α



vertical and True Thickness.....contd.

TT of a bed is equal to:

- vertical thickness multiplied by the cosine of the angle of dip.

Where dip is low (<5°) cosine is high (over 0.99) and TT & VT are approximately the same.

THREE-POINT PROBLEMS

Introduction

If the height of a bed is known @ three or more points, it is possible to:

- Find the direction of strike and
- Calculate the dip of the bed, provided dip is uniform.

THIS PRINCIPLE IS CALLED THE THREE POINT PROBLEM

This principle has many applications to mining, opencast and borehole problems encountered by applied geologists and engineers.

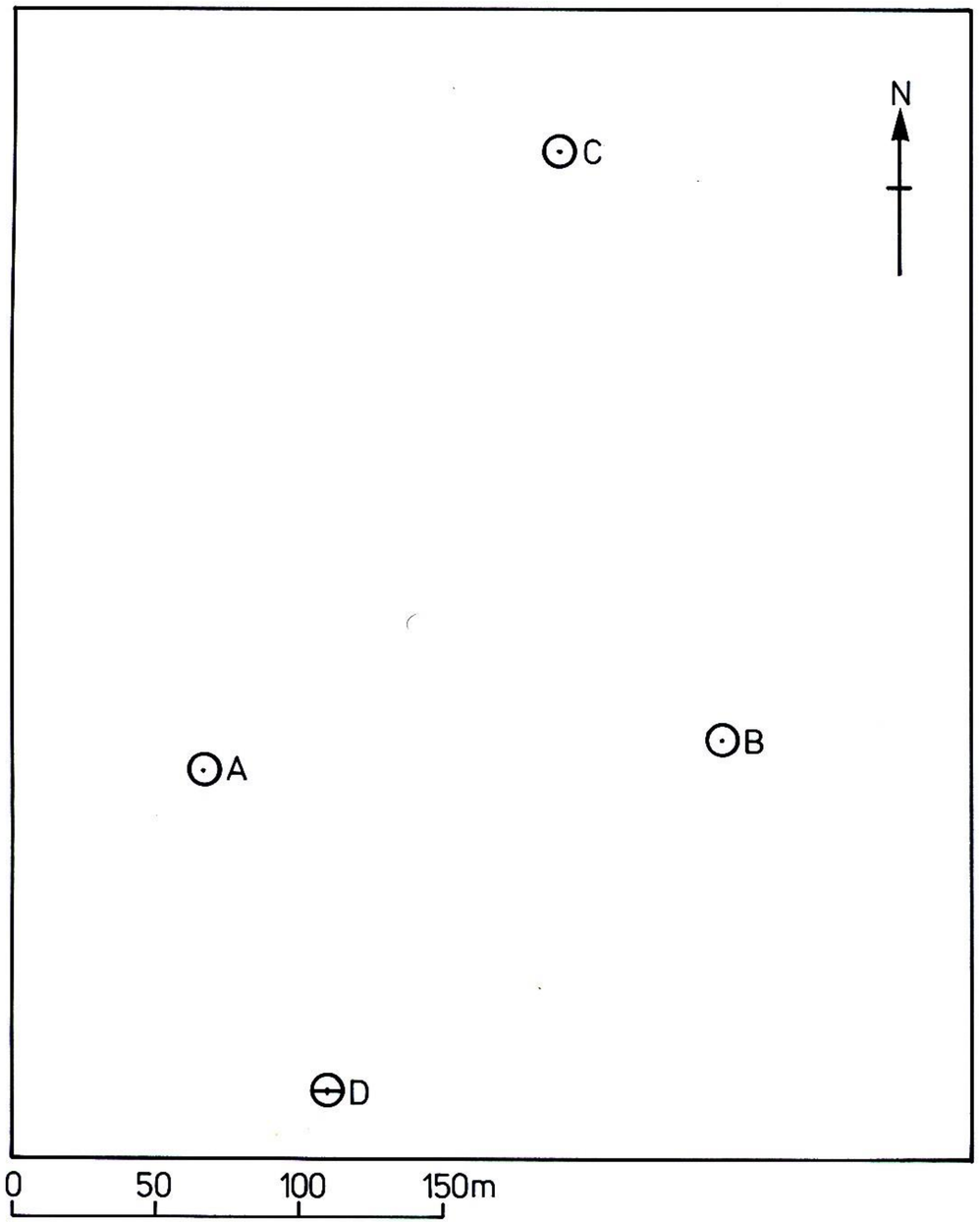
Exercise 3

Information

Map depicts a level land surface lying at an elevation of 30 m above sea level. Below the surface, a granite sill occurs, the top of which has been intersected in three boreholes, A, B and C, at depths of 40 m, 30 m and 15m, respectively.

Answer the following:

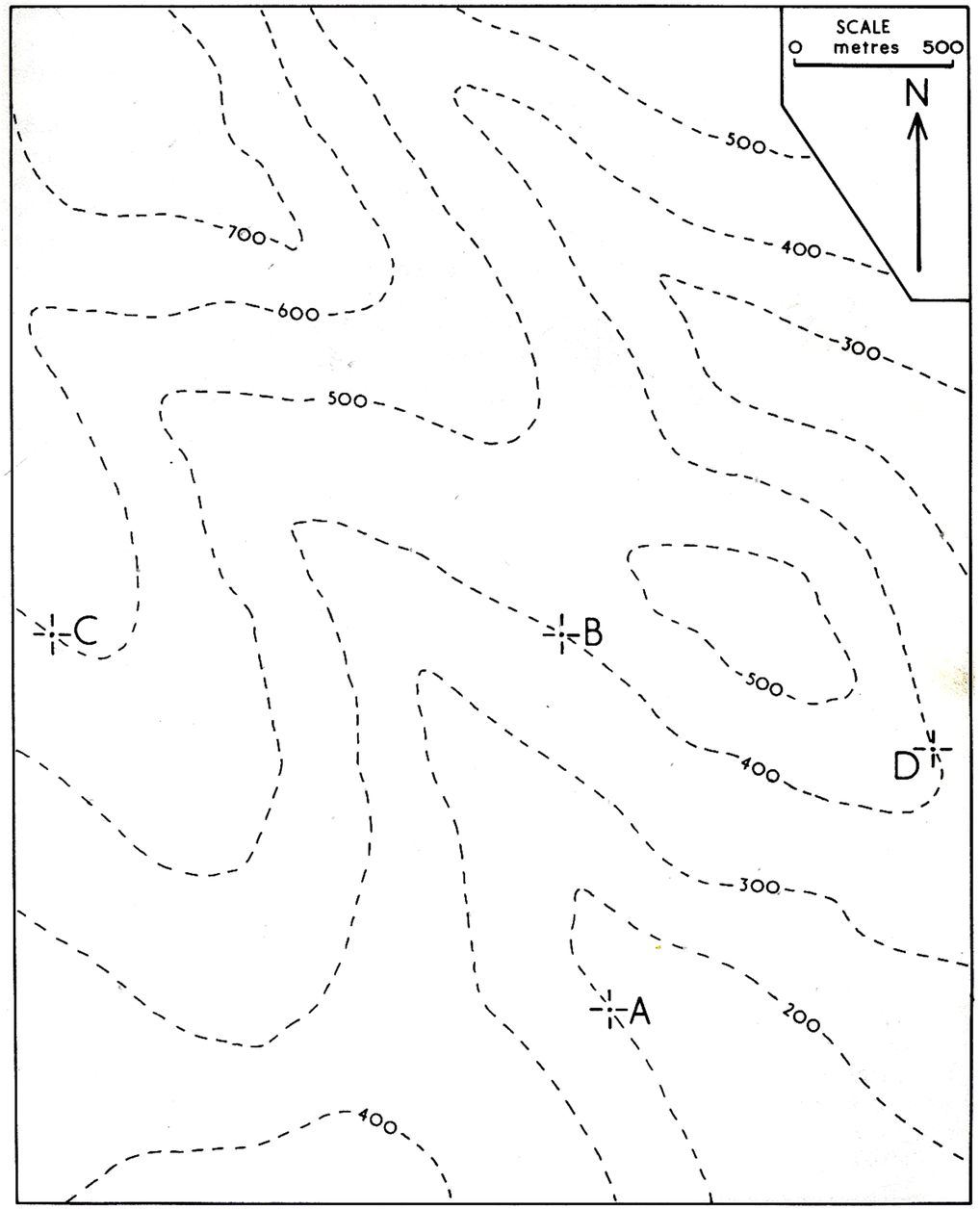
1. Assuming the sill to be planar, project onto the map contours on the sill (strike lines) above and below sea level, at 5m vertical intervals.
2. Determine the **magnitude** and **direction of true dip**.
3. Find the rate of apparent dip in the direction 270° (due west).
4. State at what depth the sill would be encountered in a shaft sunk at D.



Exercise 4

Granite sill is outcropping @ points A, B and C.

1. Deduce the dip and strike of granite sill
2. At what depth would the sill be encountered in a borehole sunk at point D?
3. Complete the outcrop pattern of the sill. (*Contours are in metres)*



Procedure to be followed to complete exercise

Observe heights of granite sill @ points A, B and C where it outcrops.

a) Join highest point on the sill, C (600 m) to lowest point on the sill, A (200 m).
b) Divide the line A-C into four equal parts (since 600 m - 200 m = 400 m).
c) As the slope of the sill is constant, we can find a point on AC where the sill is at a height of 400 m (the mid-point).
d) We also know that the sill is at a height of 400 m at point B. A straight line drawn through these two points is the 400 m structure contour.

Procedure to be followed to complete exercise.....(2)

e) We also know that the sill is at a height of 400 m at point B. A straight line drawn through these two points is the 400 m structure contour.

f) On a simply dipping stratum, such as this, all structure contours are parallel.

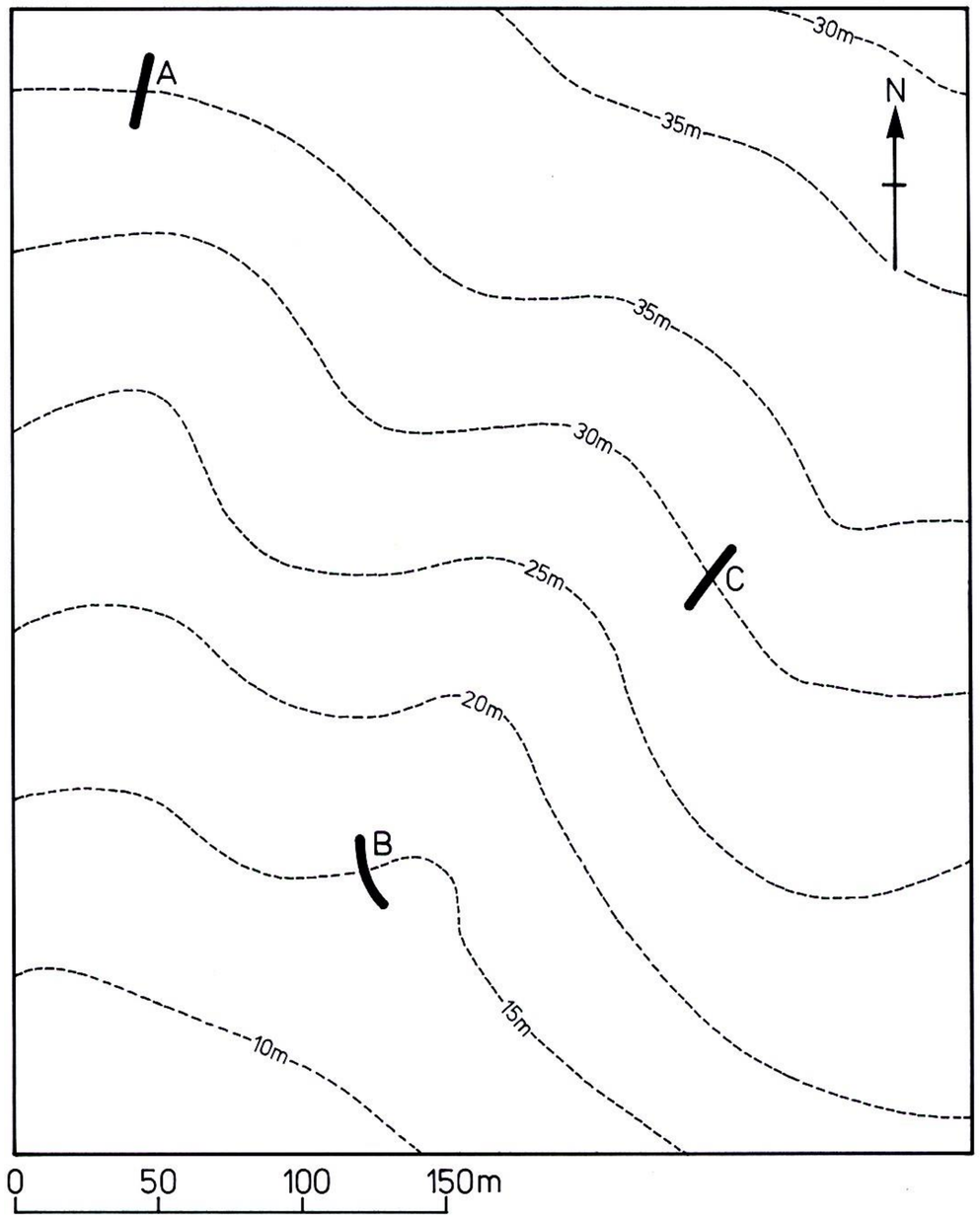
g) Construct the 200 m structure contour through point A, the 300 m, the 500 m and the 600 m structure contour - the latter through point C.

h) Having now established both the direction and the spacing of the structure contours, complete the pattern over the whole of the map.

Exercise 5

Information

The Map depicts a land surface contoured at 5m intervals, with a granite body outcropping at A, B & C.



Answer the following:

a) Indicate on the map the probable location of the remainder of the granite outcrop.

b) Shade the area underlain by granite.

Exercise 6

Information

The Map above depicts a land surface contoured at 5m intervals on which the outcrop locations of three bed boundaries are marked; the base of a sandstone outcrops at A, the base of a limestone outcrops at B, and the base of a mudstone at C. Assume that between B and C only limestone is present and that only mudstone is present in the succession above C.

<u>Answer the following:</u>

Complete the outcrops of the bed boundaries.

Shade the lithologies as appropriate.

Note: The rate of true dip of the beds is 1 in 10 on a bearing of 210°.