INTRODUCTION TO TOPOGRAPHIC MAPS AND PROFILES

Objectives

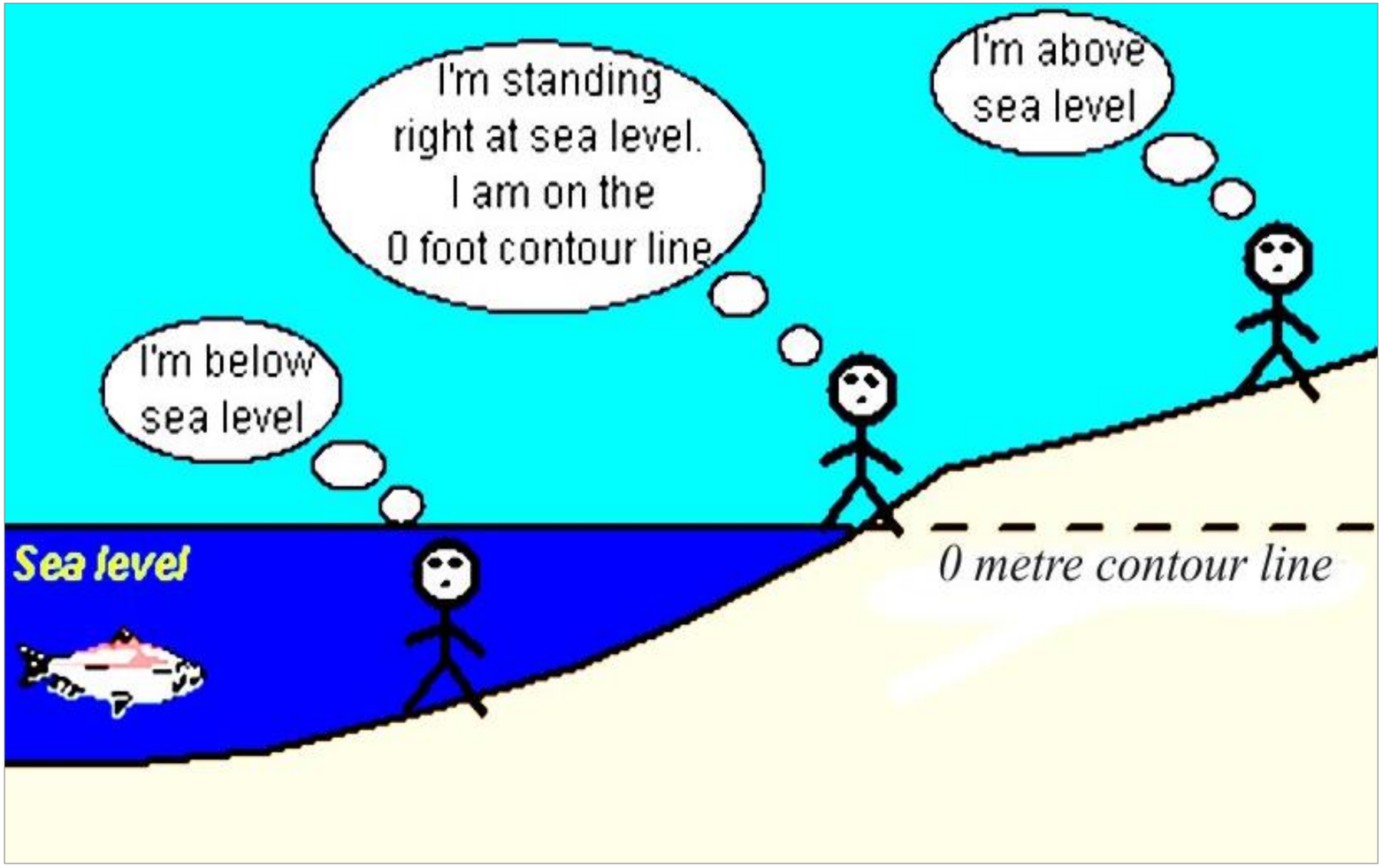
To:

- Define a topographic map and state its uses.
- Describe how contour lines show the elevations, shape, and slope of the land.
- Identify the meanings of some symbols and colors used on topographic maps.

What is a Topographic Map?

A topographic map:

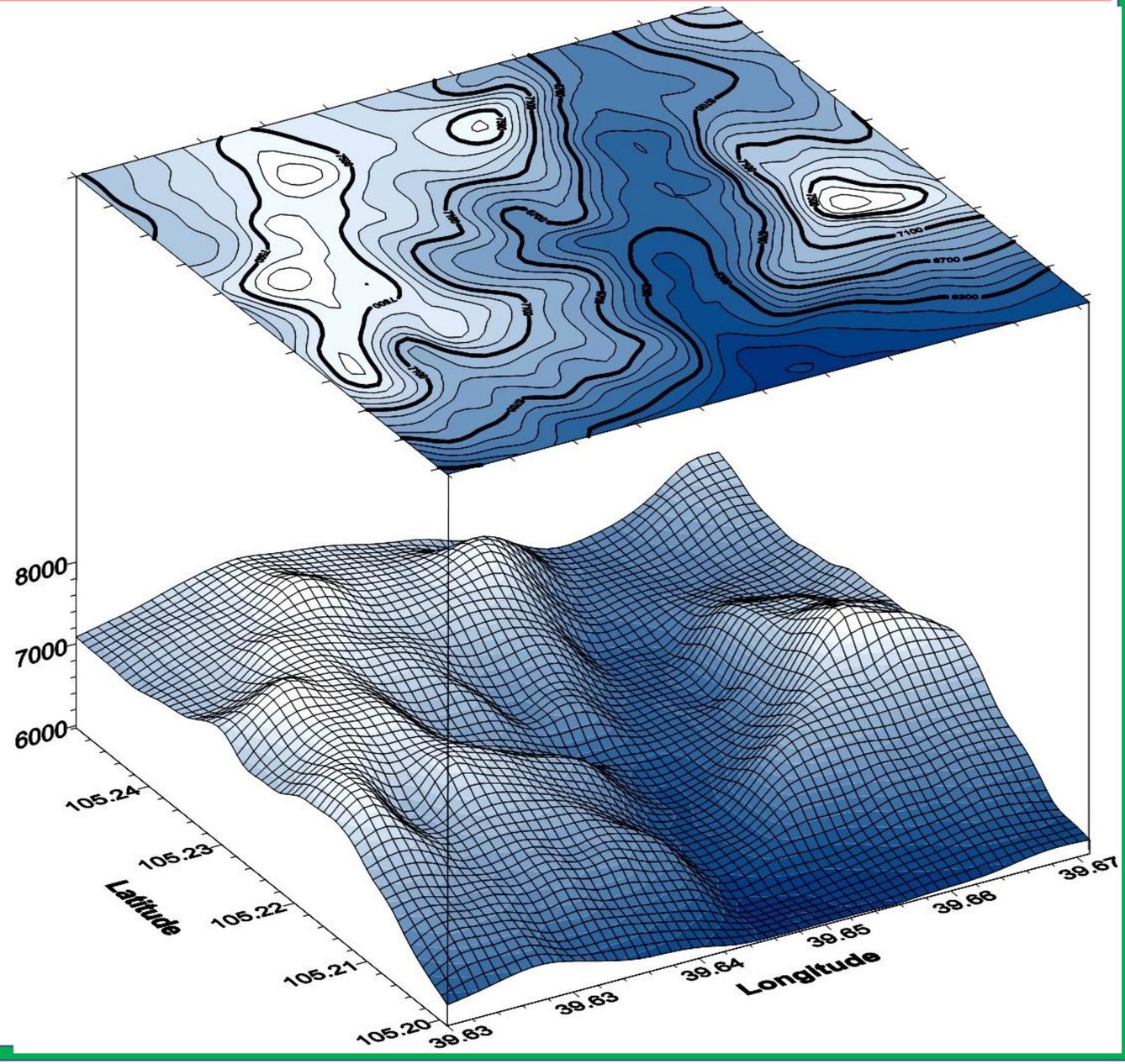
- is also known as a contour map.
- shows elevation of land above (or below) sea level and its shape.



Topographic Map.....contd.

- Is a two-dimensional (flat) representation of a three-dimensional land surface.
- shows three-dimensional information *(relief or height variation)* by using contour lines to represent elevations of hills and valleys.

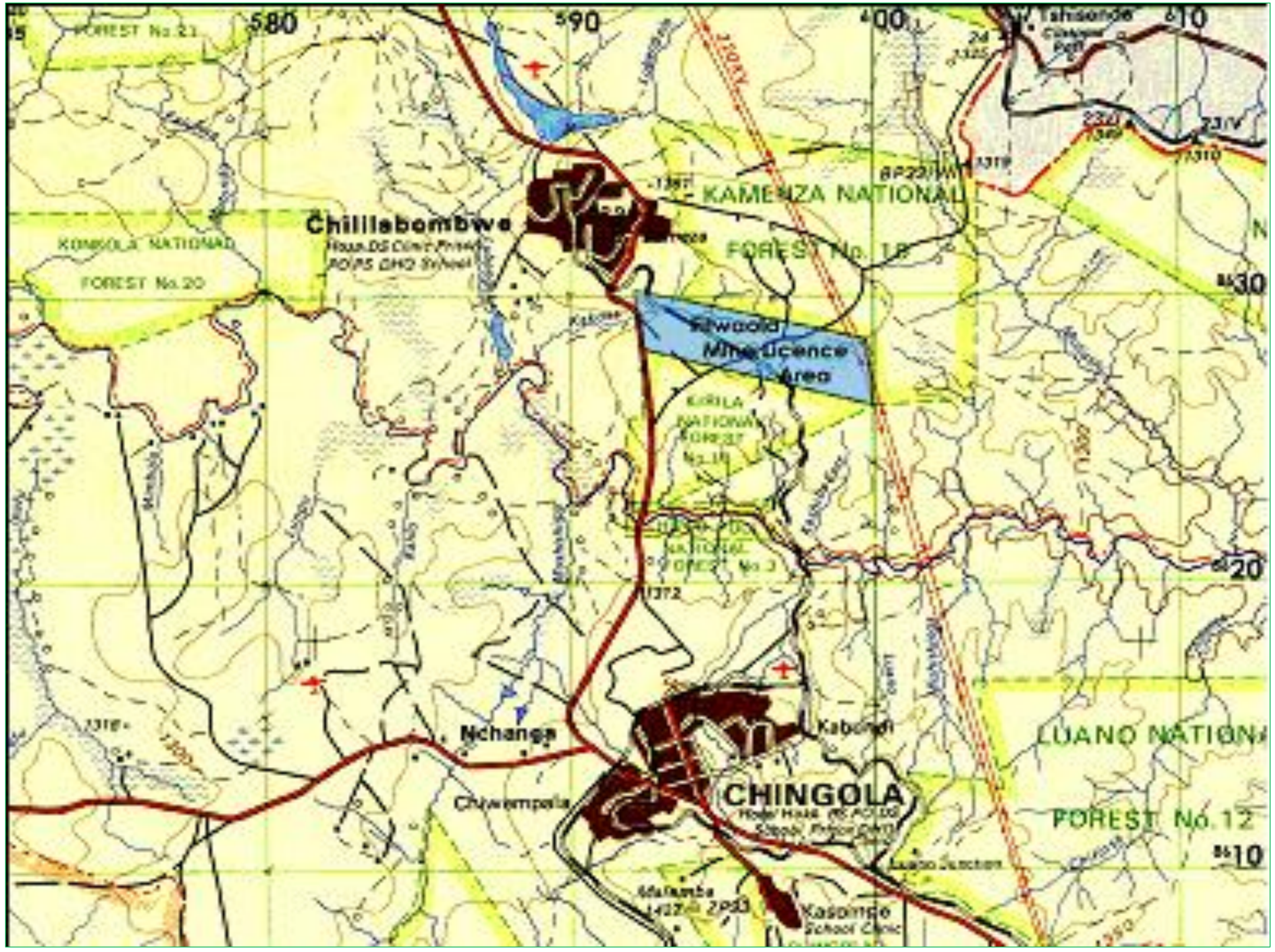
This vertical information is the distinguishing feature of any topographic map.



Topographic Map.....contd.

Topographic map:

- is a large scale representation of a portion of the earth's surface showing;
  - *relief, hydrography* and perhaps *vegetation*.
- shows projections of natural & man-made physical features.



Topographic Map.....contd.

Topographic map:

- differs from the more familiar *planimetric* map – e.g. highway map – which does not show relief.
  - This makes topographic maps a valuable tool in geological and engineering studies.
- are also used by anyone who needs to know the three-dimensional aspect of land surfaces.

Topographic Map.....contd.

On topo map, we generally see the following features:

a) **SCALE** – expresses ratio of **distance between two points** on map and **true horizontal distance**.

For instance:

Scale of 1:25,000 means distance of 1 cm on map = 25,000 cm on the ground.

Or 1 cm = 25,000 cm = 250 m

Thus, the smaller the scale of the map, the less detail can be shown on map.

SCALE 1:50,000

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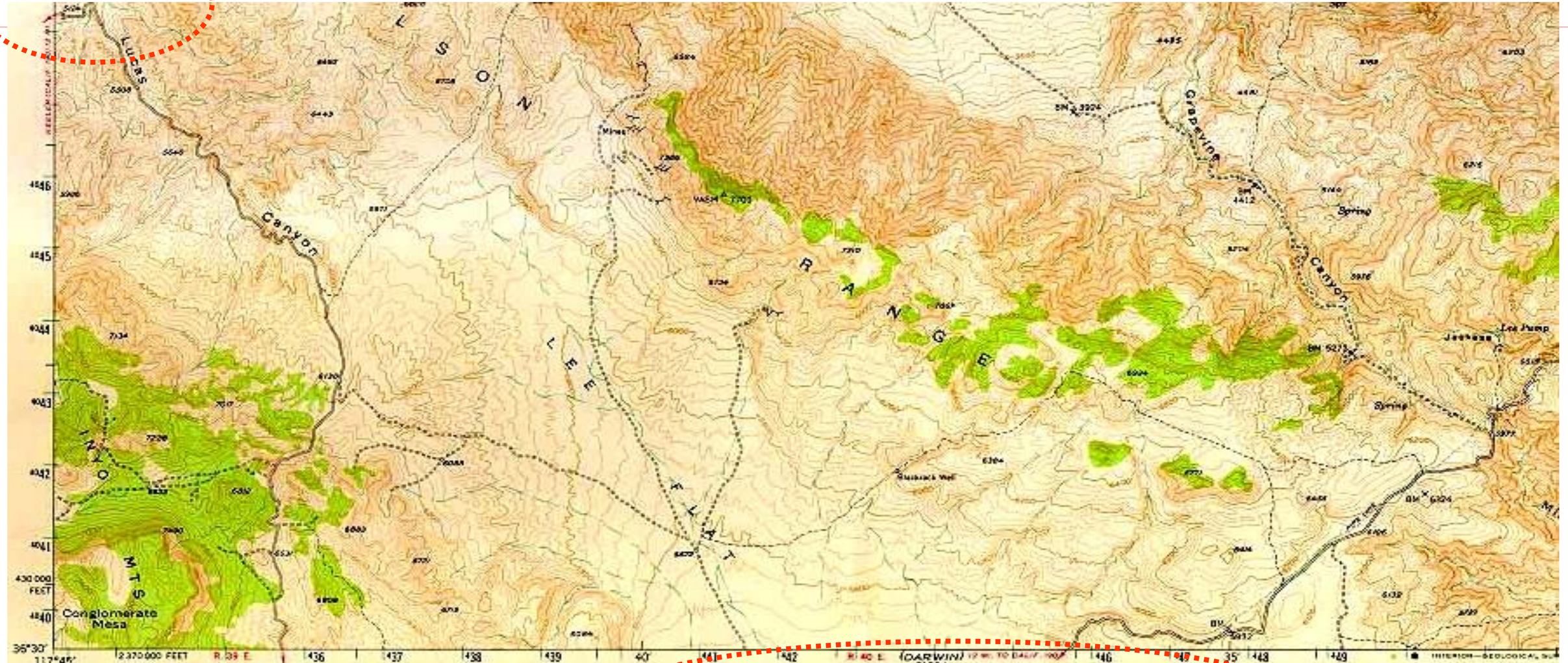


Mapped, edited, and published by the Geological Survey

Control by USGS and USC&GS

Topography from aerial photographs by multiplex methods and by plane-table surveys

Aerial photographs taken 1947. Field check 1950

Polyconic projection. 1927 North American datum

10,000-foot grid based on California coordinate system, zone 4

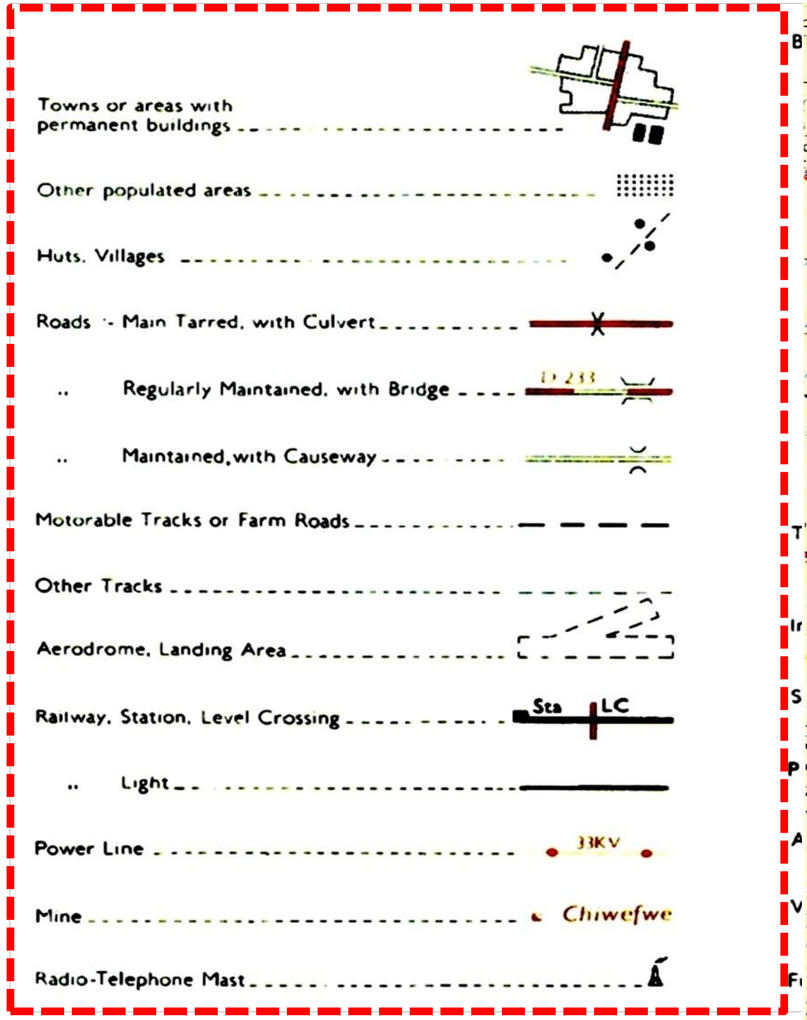
1000-meter Universal Transverse Mercator grid ticks, zone 11, shown in blue

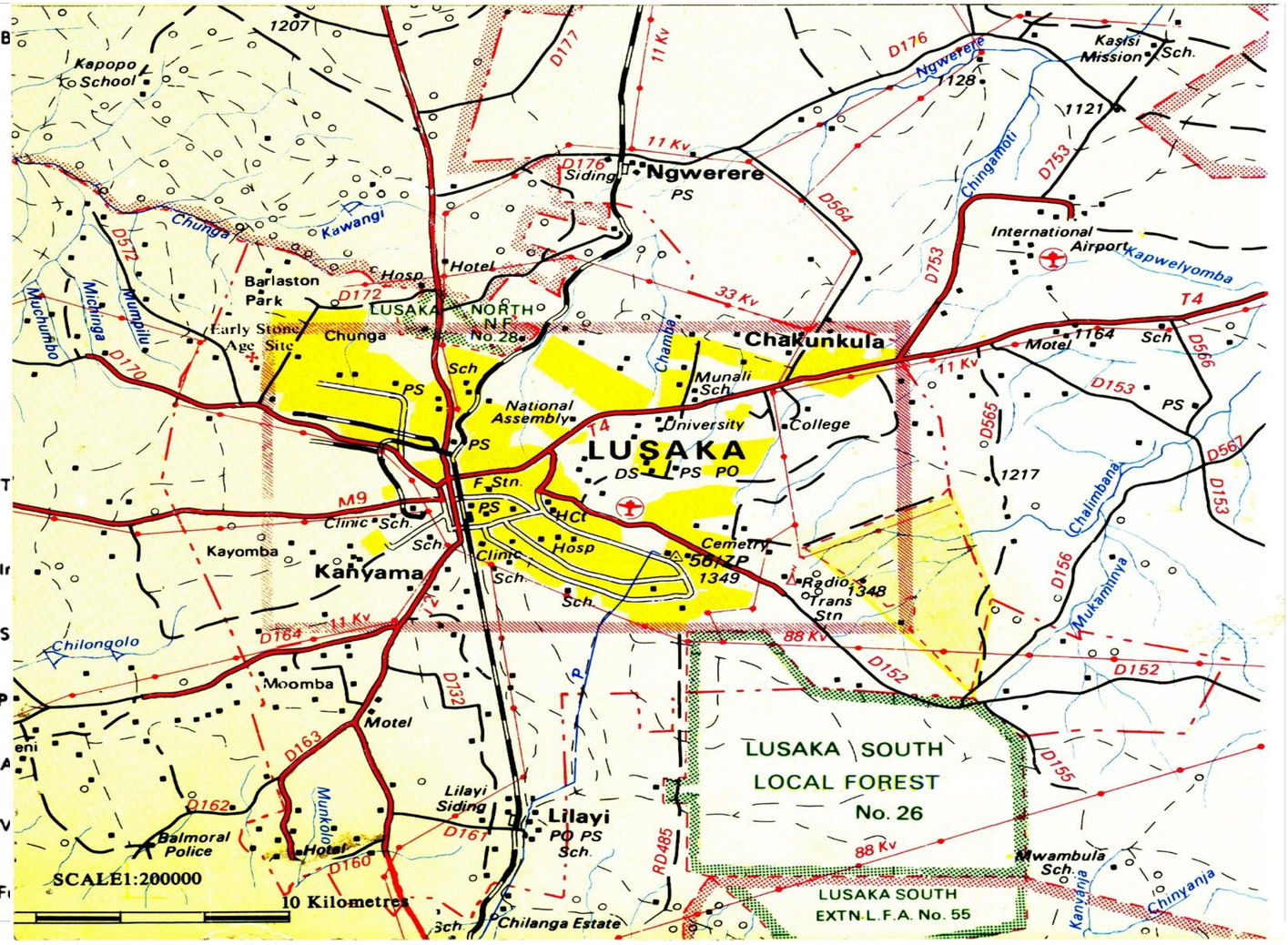
Dashed land lines indicate approximate locations

UTM GRID AND 1950 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

Topographic Map.....contd.

b) **LEGEND** – explains all symbols used on map – **must be studied before you attempt to read map.**

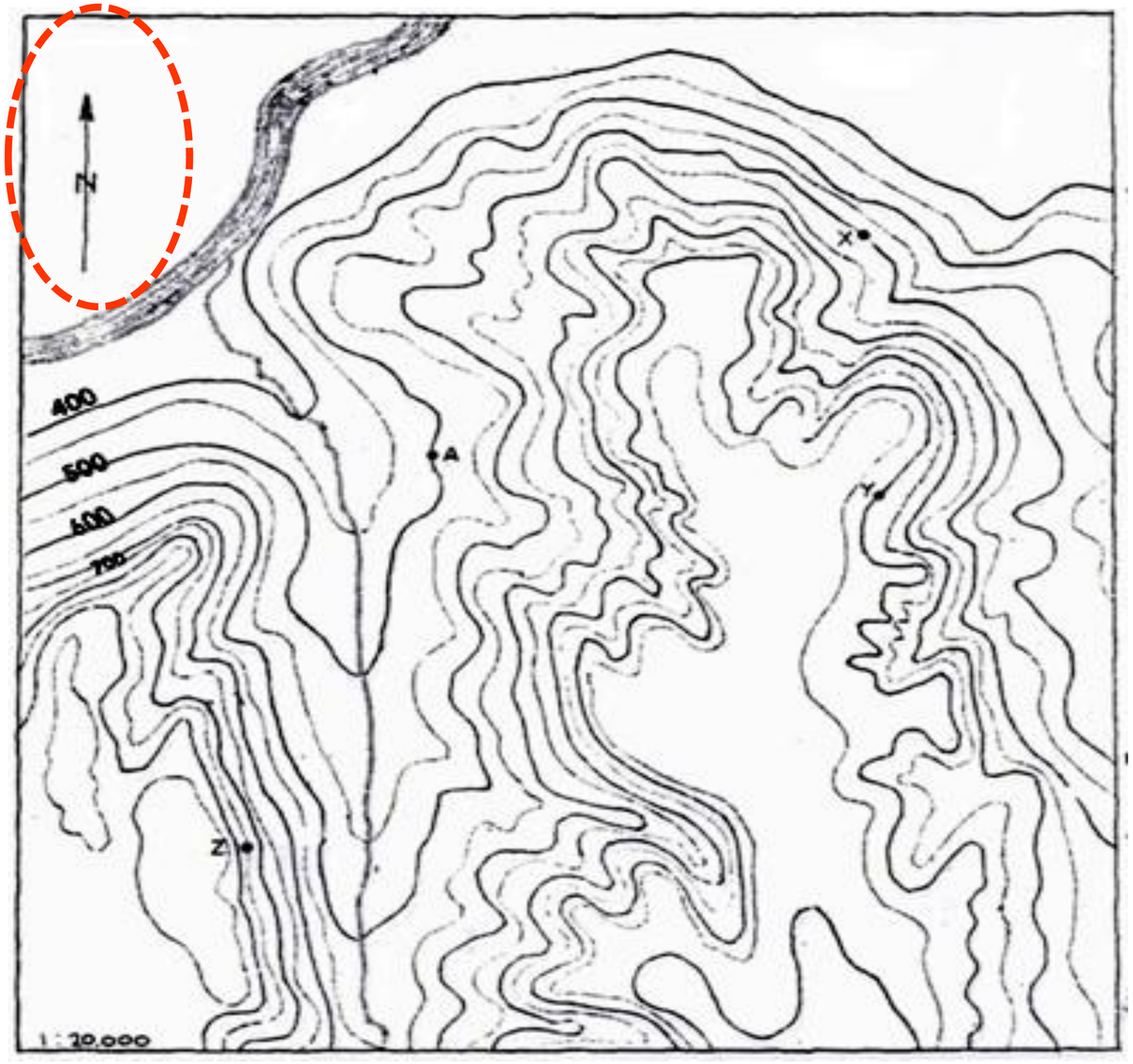




Topographic Map.....contd.

c) North arrow – mark, which points to geographic north.

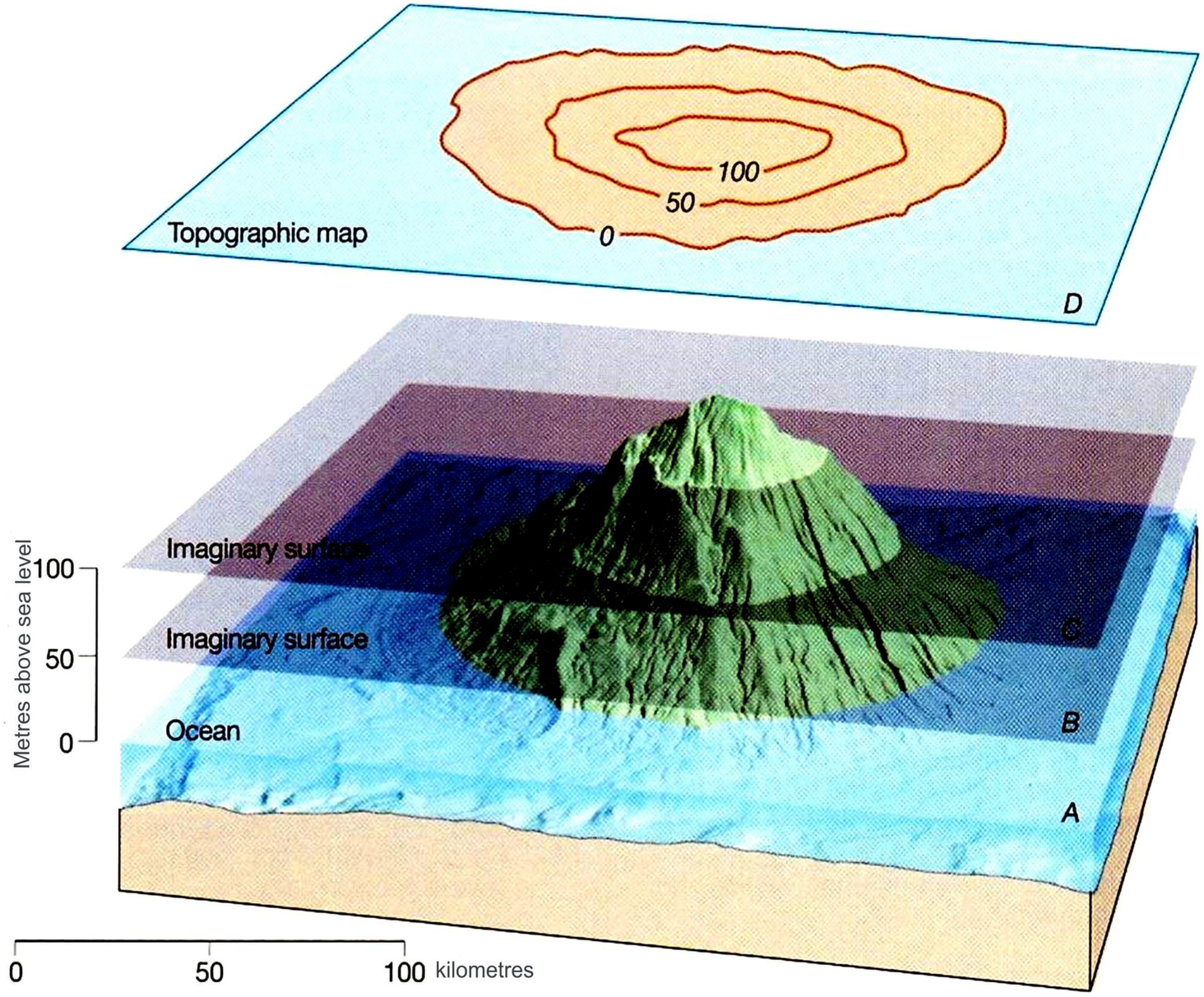
This makes it possible to plot and/or read orientations of features – beds, faults, joints, – on the map (with a protractor).



Topographic Map.....contd.

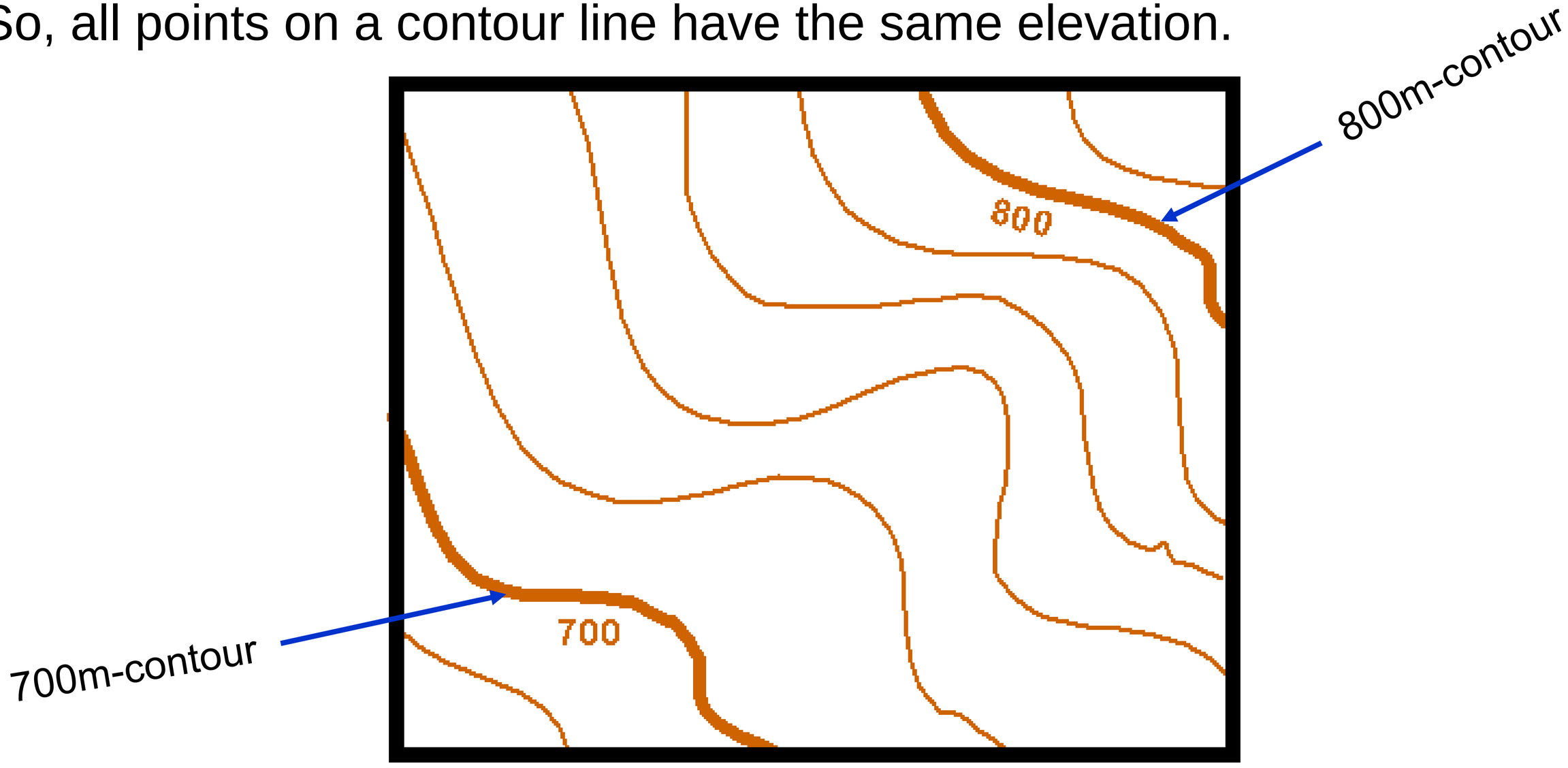
d) Contour lines – imaginary lines on map representing pts of equal elevation.

- ✓ Complete series of contour lines enable map reader to get an impression of topography of whole area of map.



Topographic Map.....contd.

So, all points on a contour line have the same elevation.



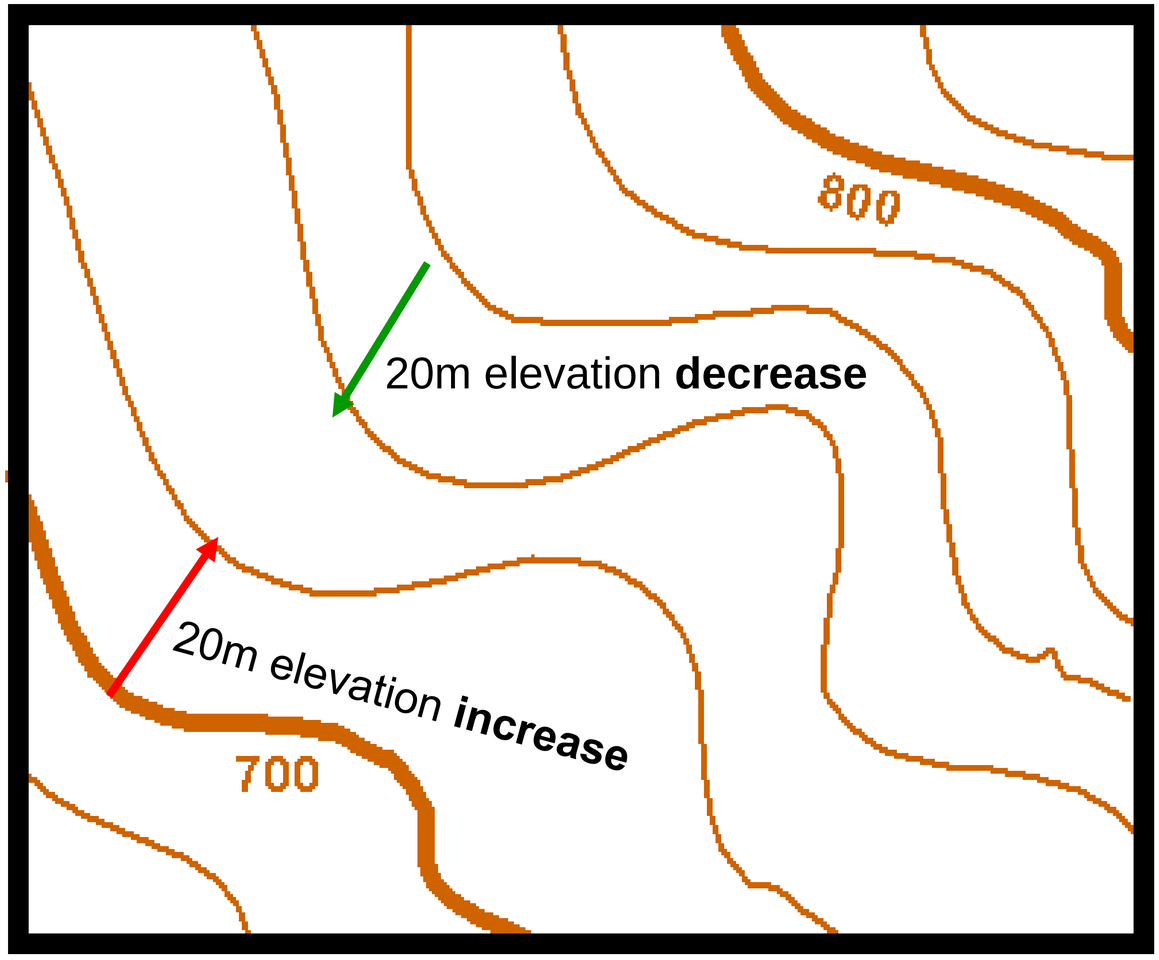
Elements of Topographic Maps

i) ***Contour Interval (CI)*** – elevation difference between contour lines. On map portion shown, CI is 20m.

Choice of **CI** depends upon:

- ✓ Scale of map: large-scale maps have small contour intervals.
- ✓ Relief of area: areas with low relief will have small contour intervals.

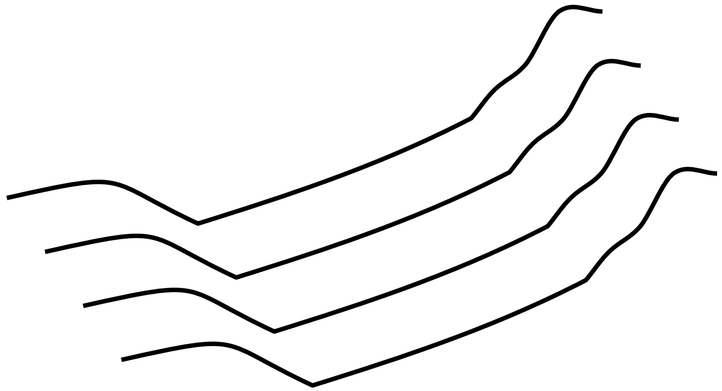
ii) ***Index Contour (IC)*** – is usually every fifth line that is printed ‘heavily’, and has an elevation printed on it *(e.g., the 700 and 800 lines in map).*



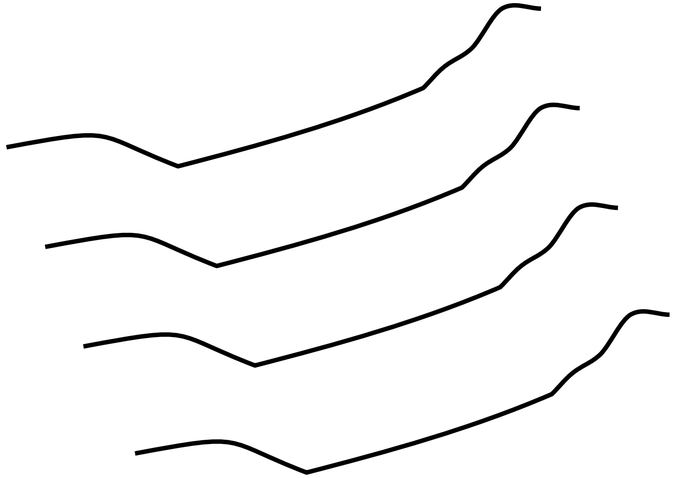
Elements of Topographic Maps…..contd.

iii) Contour Spacing – indicates steepness of Slope (Gradient), contours:

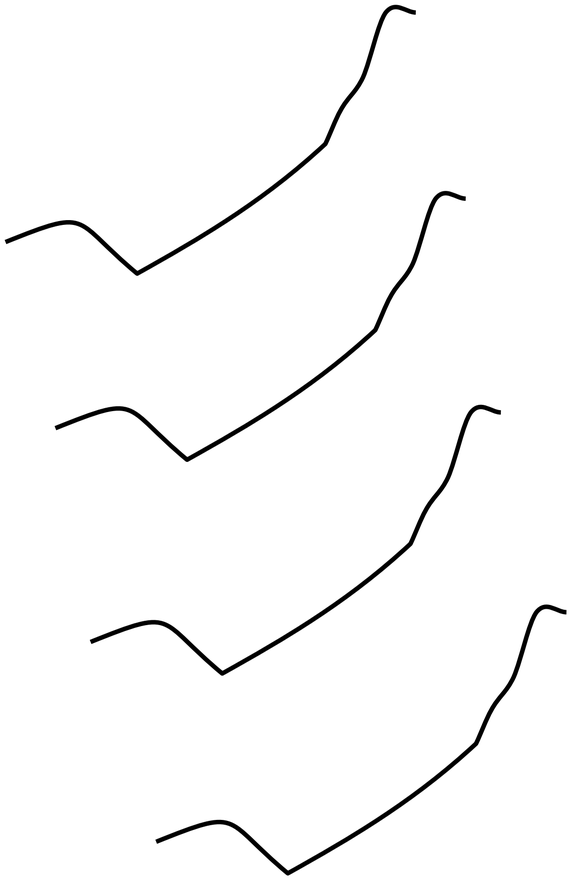
- closer together, means a Steep Slope.
- farther apart indicate gradual/gentle Slope



1. Steep Slope



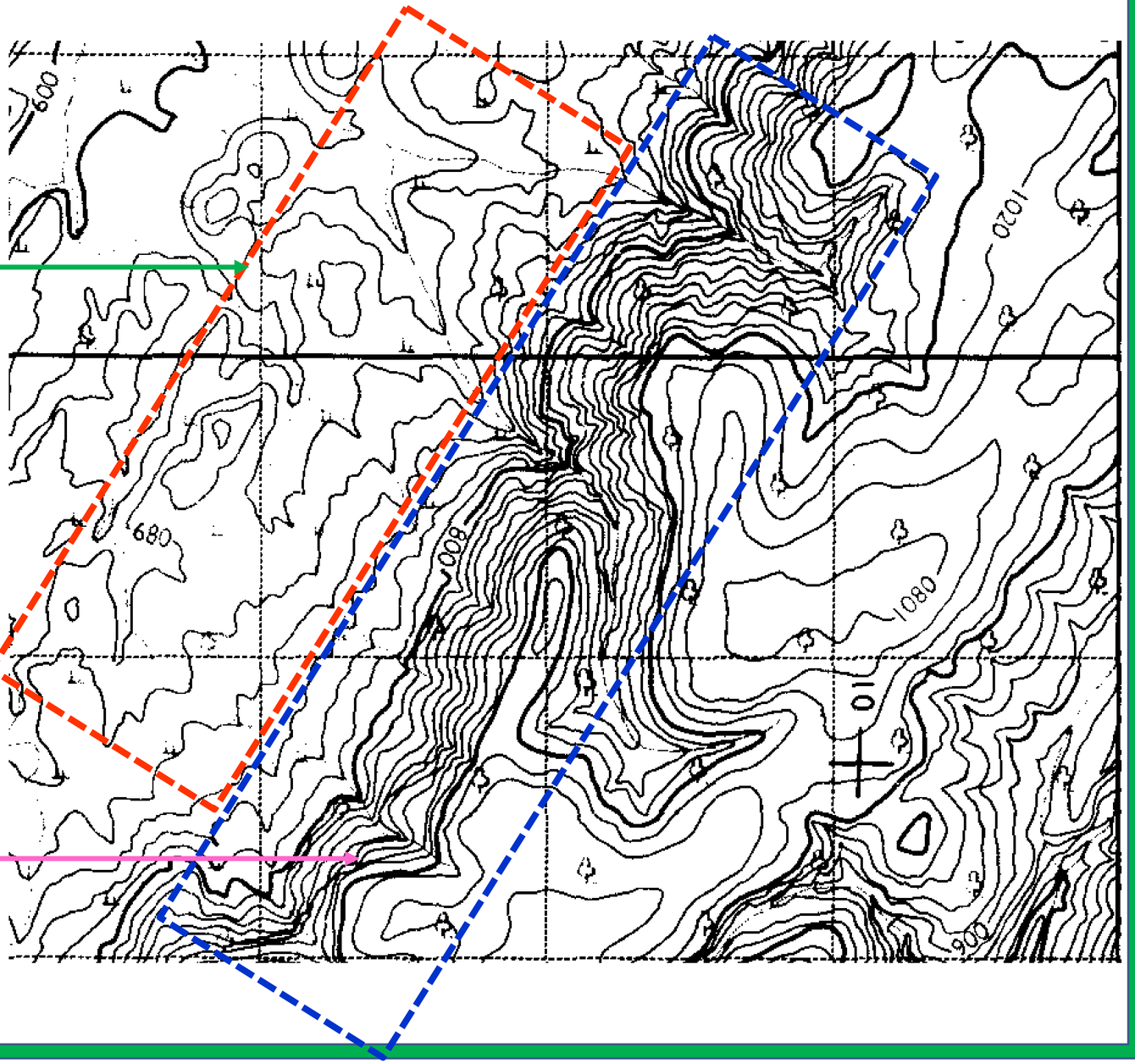
2. Gentle Slope



3. Very Gentle Slope

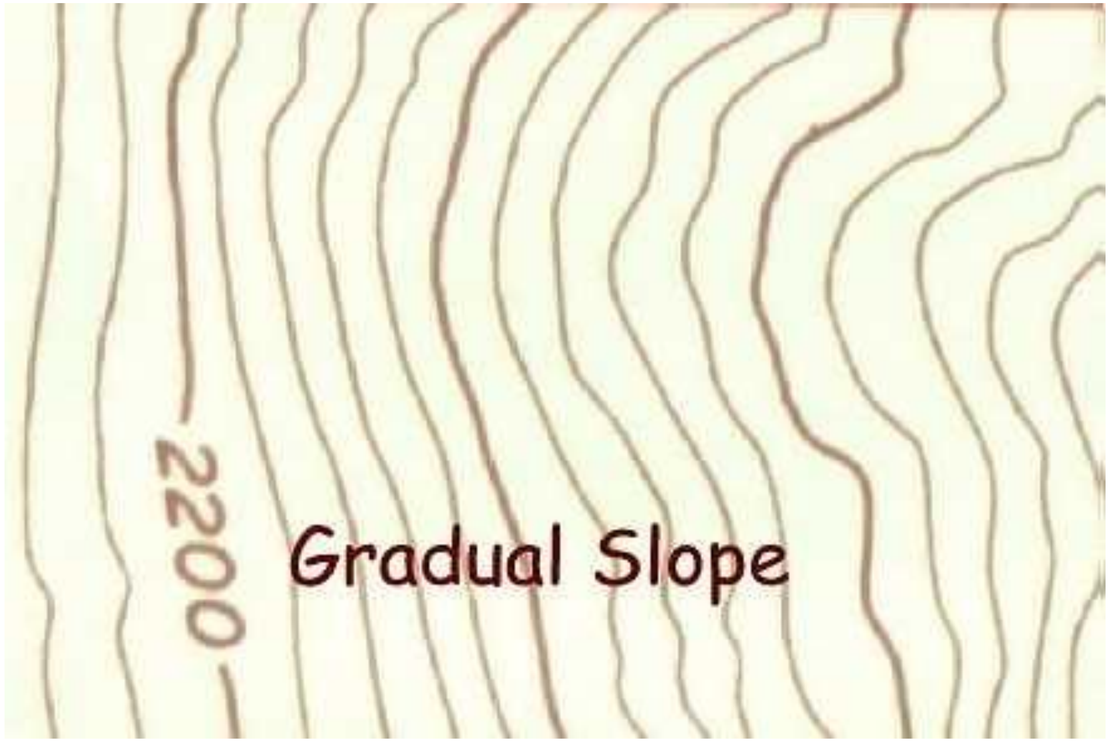
Elements of Topographic Maps…..contd.

- The further apart the contours, or the larger the interval, the more gradual the slope, or
- The closer together the contour lines, and the smaller the space between them, the steeper the land.

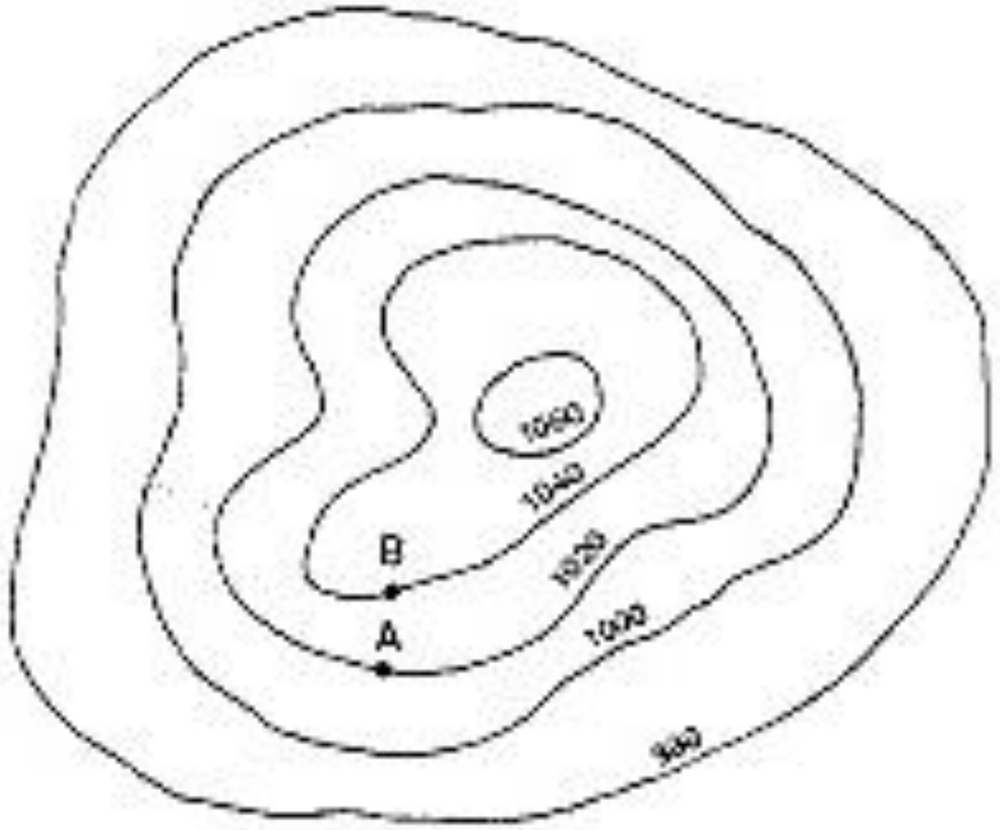


Rules for Contour lines

a) Contour lines never cross

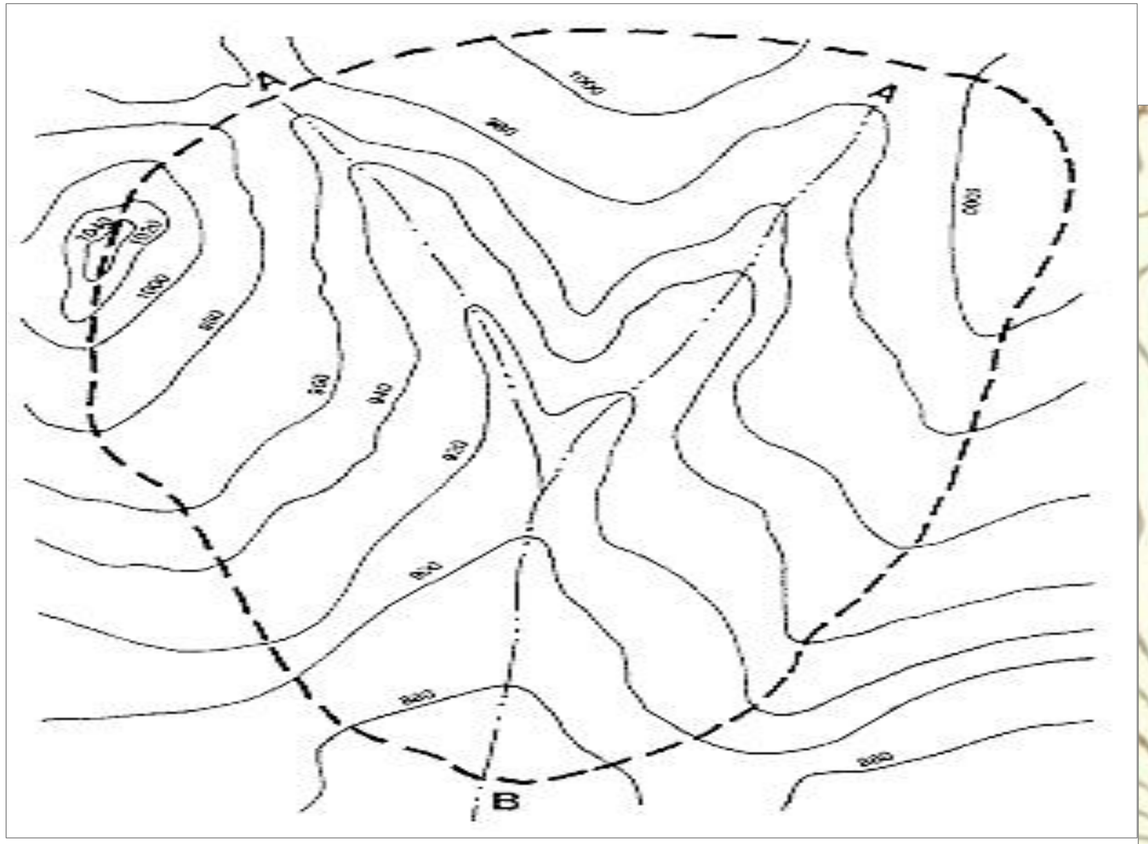


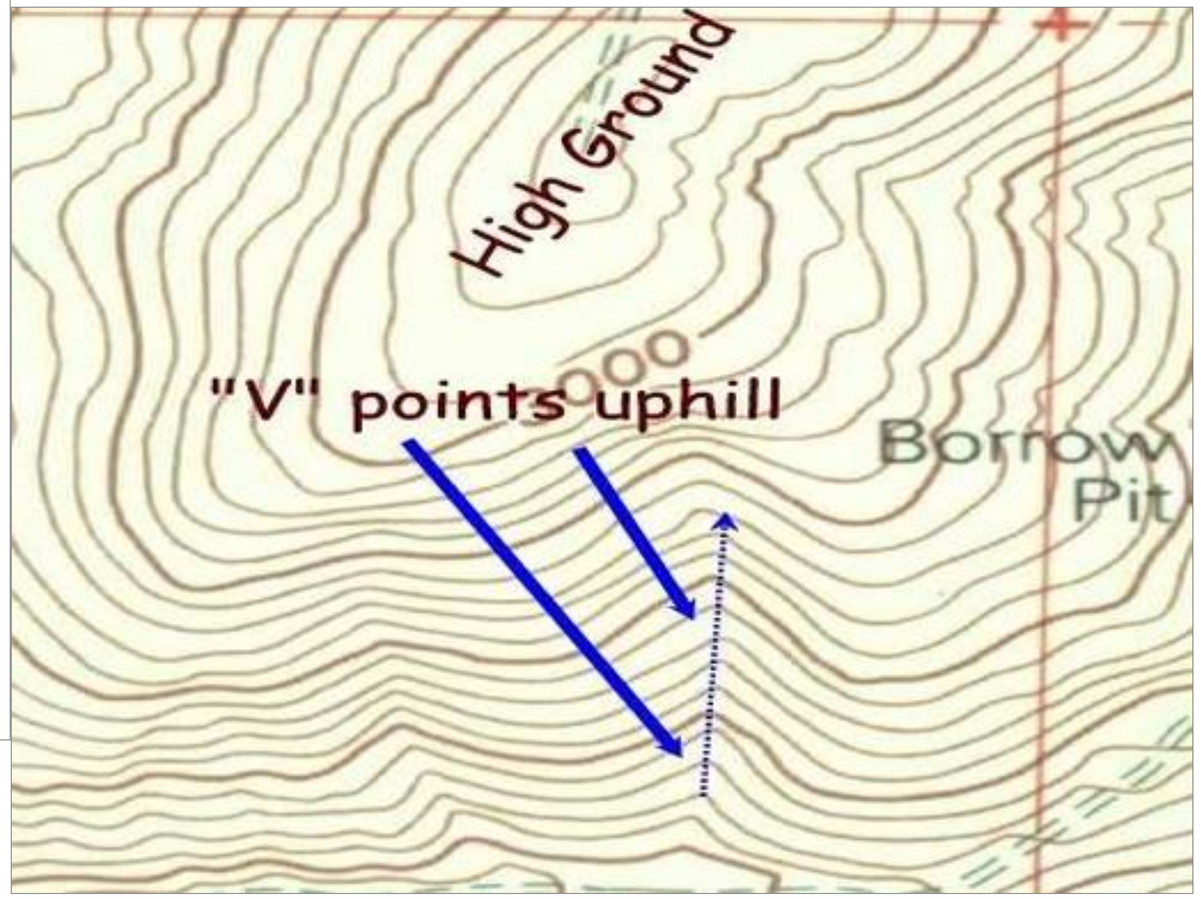
b) Contours form closed loops (even if not shown of the map.



Rules for Contour lines.....contd.

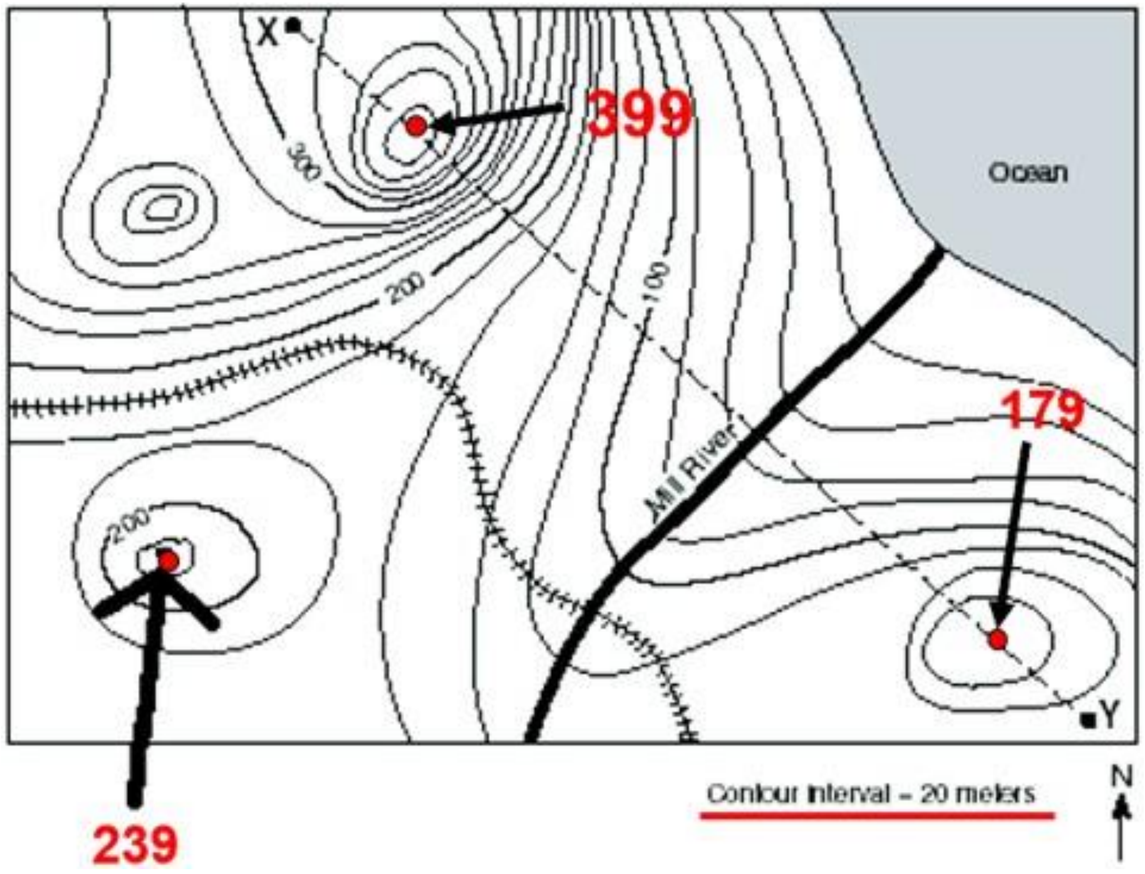
c) contours bend upstream (uphill), when crossing a stream.

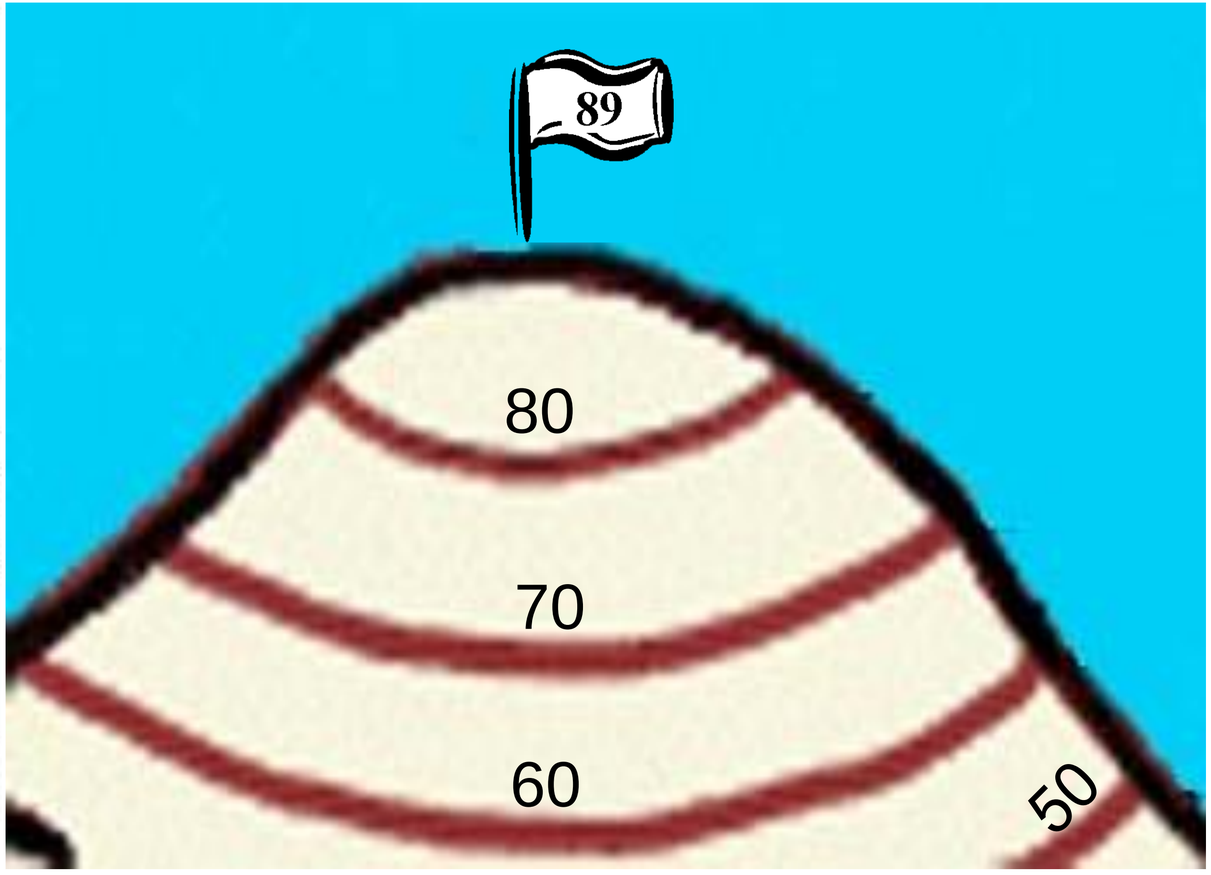




Rules for Contour lines.....contd.

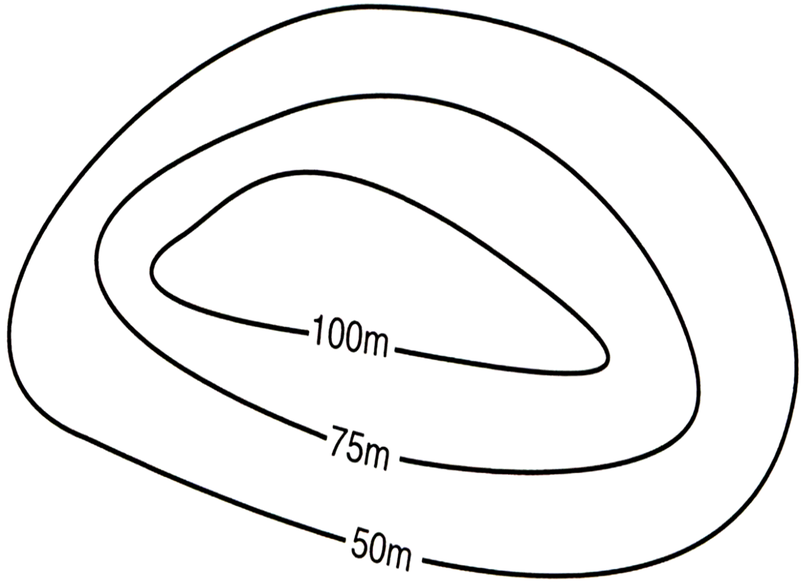
d) The maximum possible elevation for a hill is “1” less than what the next contour “should” be, i.e. highest possible elevation of hill is **just below** the value of next line <u>that is not shown</u>.

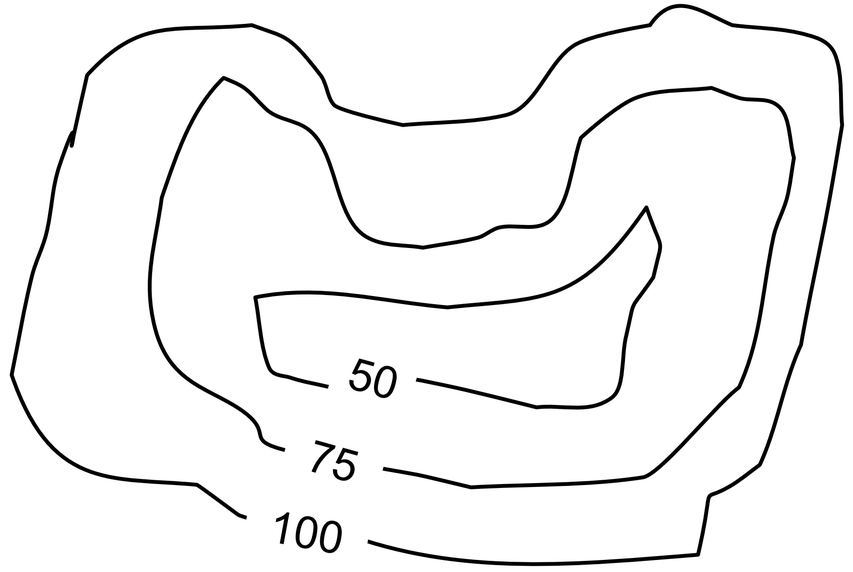




Rules for Contour lines.....contd.

iii) Contours are Closed in domes / basins





a) **Dome/Isolated Hill** – *closed curves decrease in size. Inner curves are at higher elevation than outer curves, and peak is within the innermost curve*

b) **Basin/Depression** – *closed curves increase in size. Inner curves are at lower elevation than outer curves, and depression is within the innermost curve.*

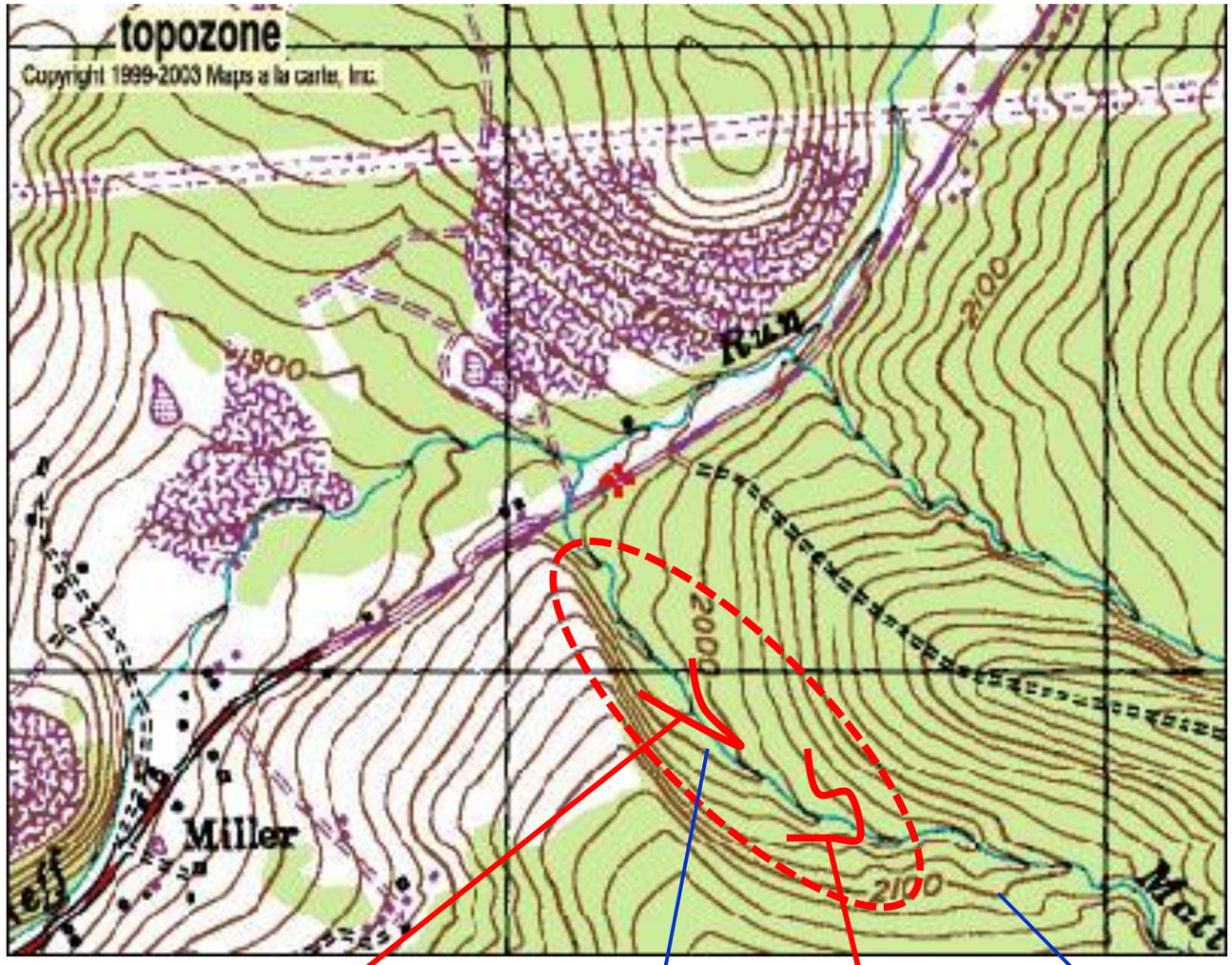
What to Read from a Topographic Map

i) Tracking River Flow direction

a) How does water flow? – usually DOWNHILL

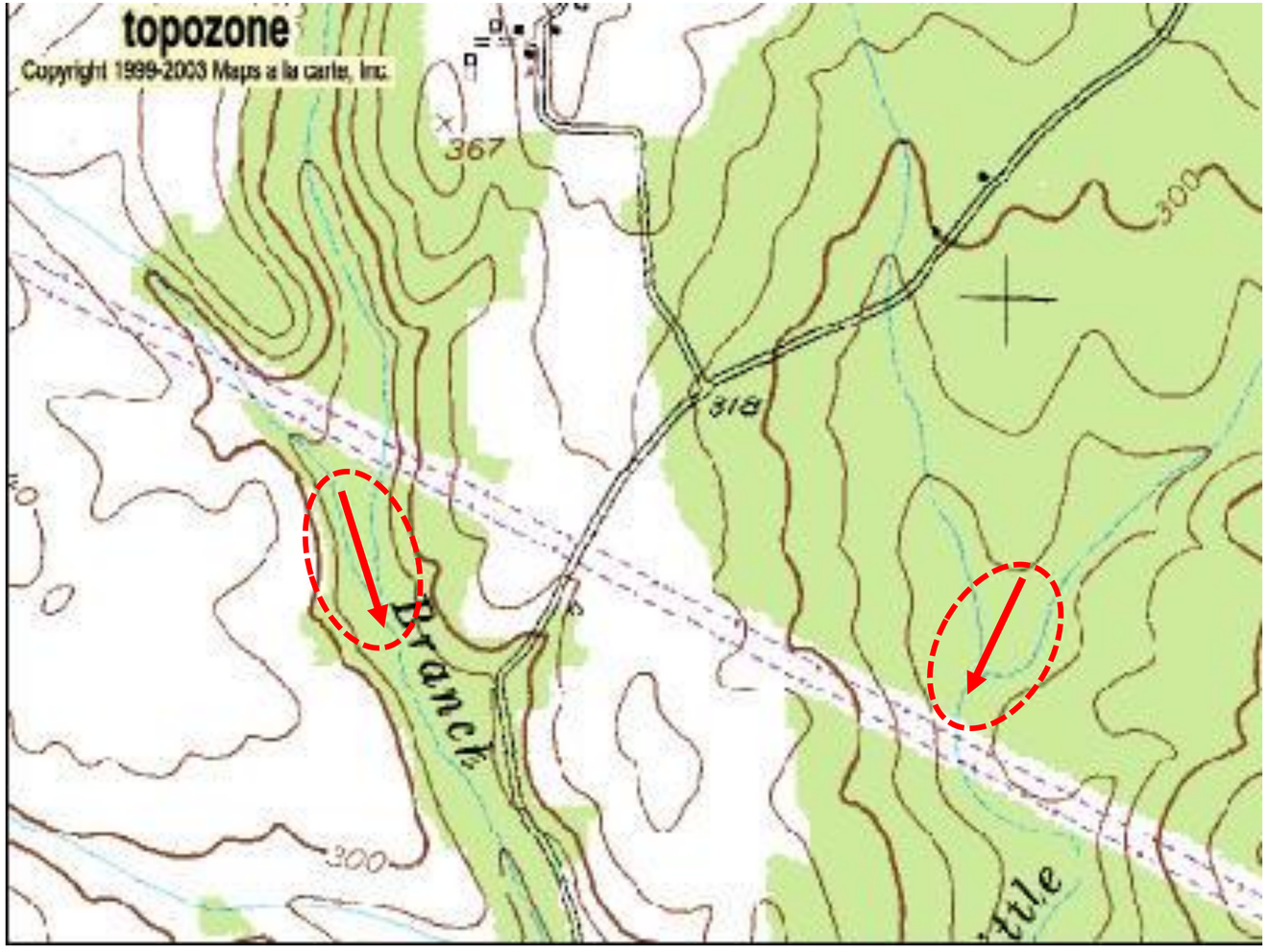
b) How can one tell, what direction (N, S, E,...) is downhill?

- Look for elevation changes since water will flow from higher to lower elevations.
- Look at the contour lines as they cross the stream – they always point upstream.



What to Read from a Topographic Map…..contd.

c) Also look at where two streams merge. The merge-point will form a V, which ALWAYS points downstream.



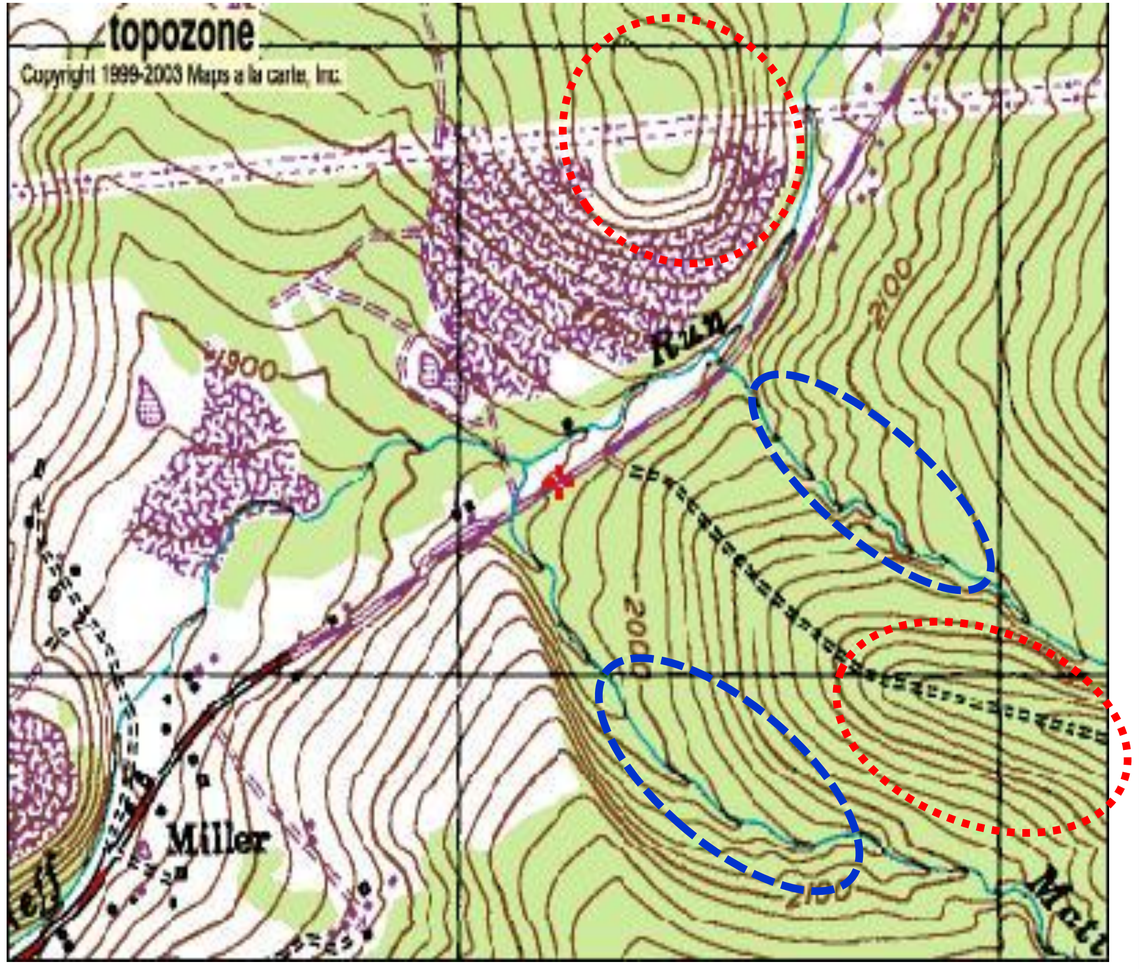
Direction of flow

What to Read from a Topographic Map…..contd.

ii) A 3-D view of topography

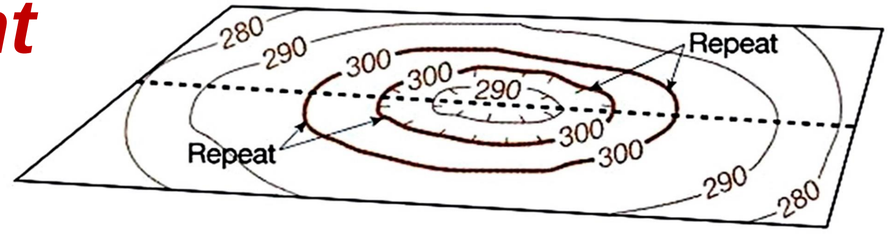
This is achieved by noting:

- spatial distribution of **rises** & **depressions** *for location of hills and valleys + their elevations.*
- courses of most important watersheds
- map distances (spacing) between contour lines **noting steep slopes** & **flat country**.

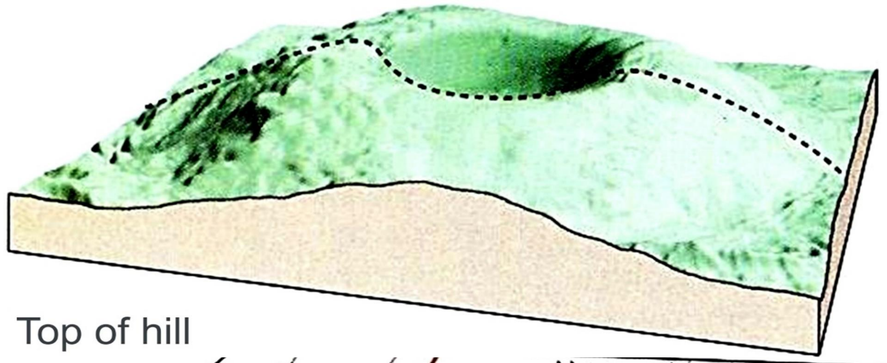


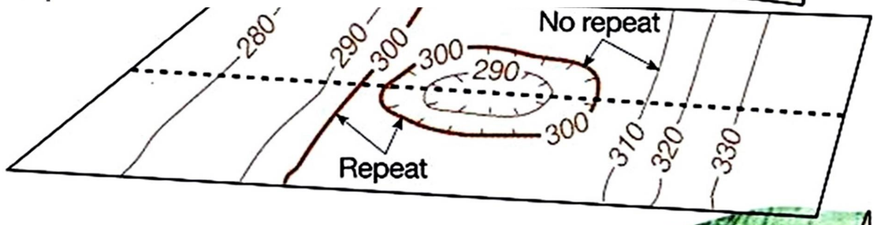
What to Read from a Topographic Map…..contd.

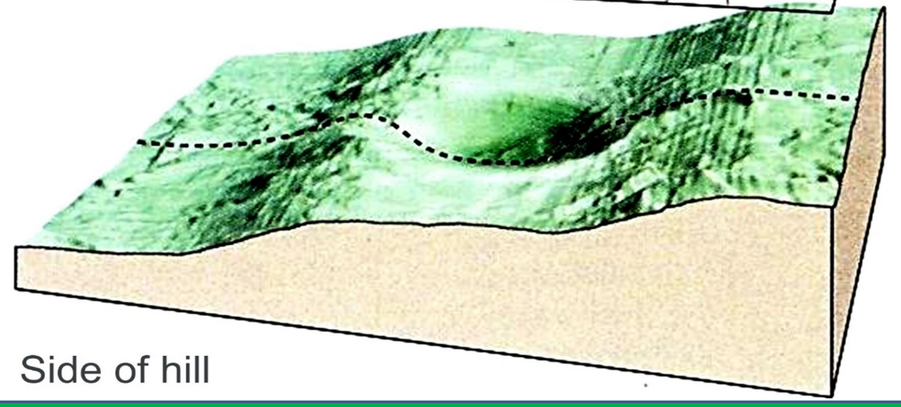
iii) Reading of contour lines in and adjacent to depression…..



- Hachure marks on some contour lines indicate presence of closed depression.
  - At top of a hill, contour lines repeat on opposite side of depression.
  - On side of a hill, contour lines repeat only on downhill side of depression.



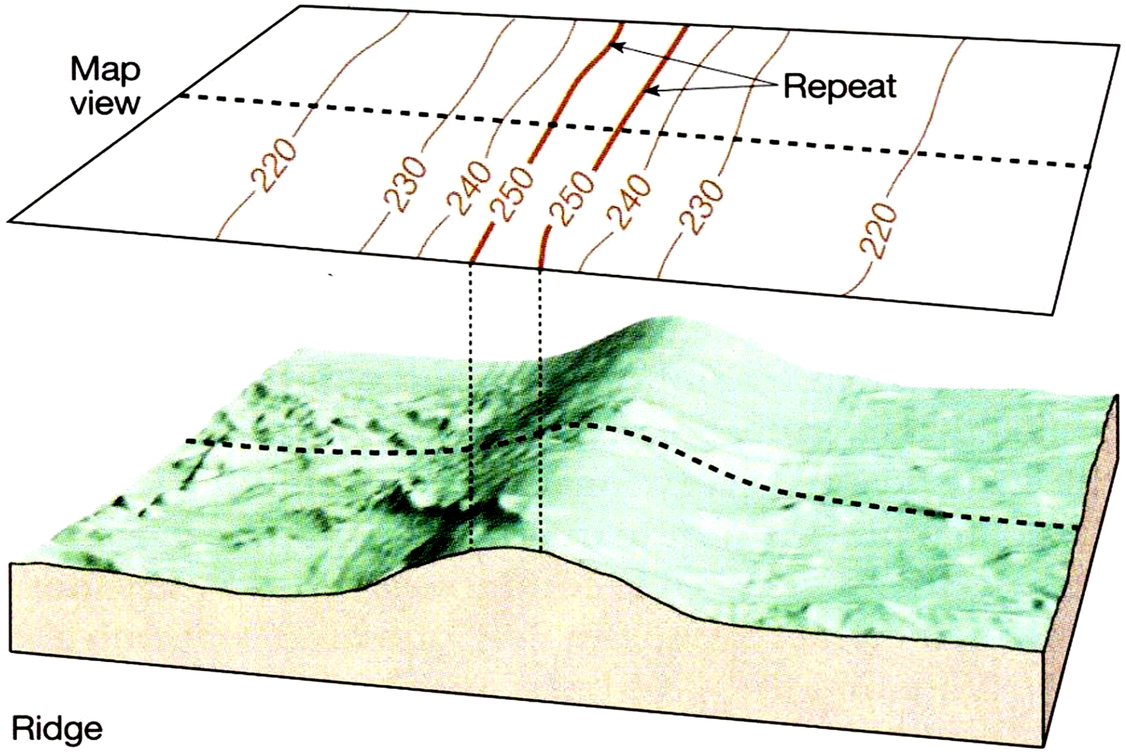


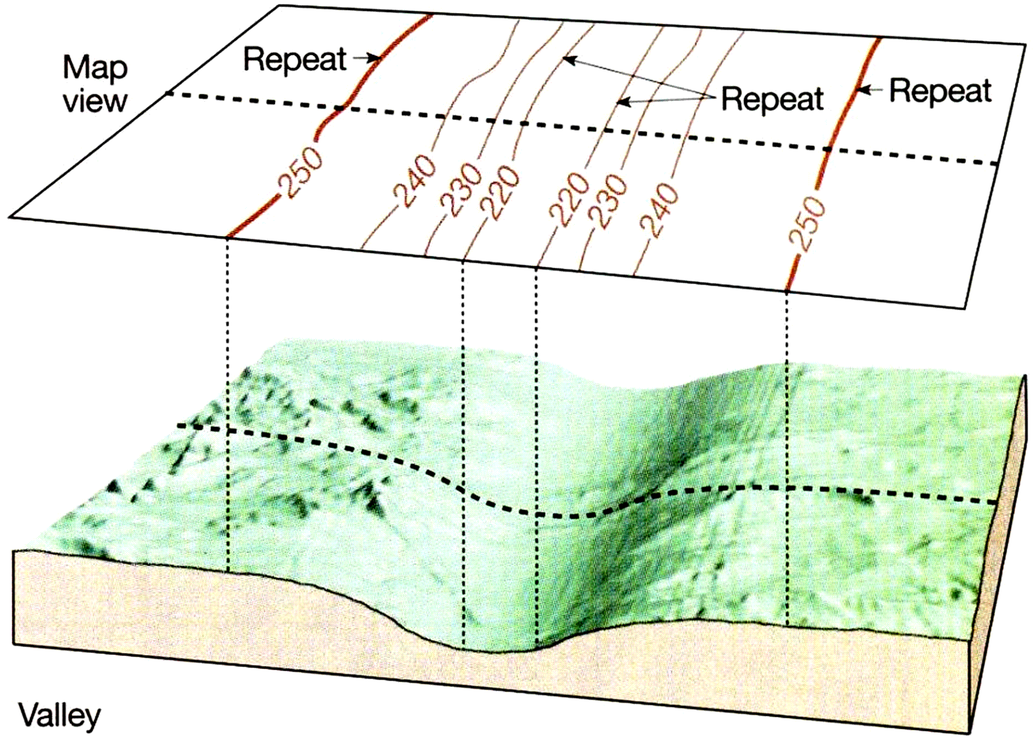


What to Read from a Topographic Map…..contd.

…..and/or adjacent to a domical / basin structure

Contour lines repeat (occur in pairs) on either side of linear ridges and valleys. *E.g. if you walked the dashed line from left – right, you'd cross 220- 230- 240- and 250-m contour lines, go over crest of ridge, and cross 250- and 240- 230- 220-m contours again as you walk down the other side.*



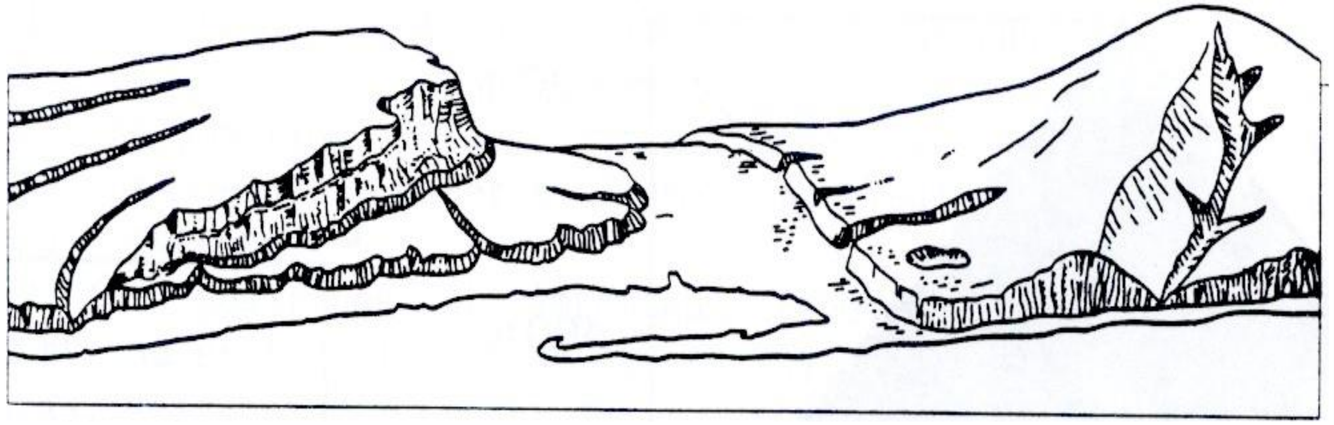


What to Read from a Topographic Map…..contd.

All these observations must be done automatically when studying a map.

It is only with a complete picture of topography in your head that you can start to interpret a geological map!!

A Topographic map



Corresponding landscape morphology

SUMMARY OF CONTOURS

1. Every point on a contour line is of the exact same elevation; that is, contour lines connect points of equal elevation.

2. Contour lines always separate points of higher elevation (uphill) from points of lower elevation (downhill). You must determine which direction on the map is higher and which is lower, relative to the contour line in question, by checking adjacent elevations.

3. Contour lines always close to form an irregular circle. But sometimes part of a contour line extends beyond the mapped area so that you cannot see the entire circle formed.

4. The elevation between any two adjacent contour lines of different elevation on a topographic map is the *contour interval*. Often every fifth contour line is heavier so that you can count by five times the contour interval. These heavier contour lines are known as *index contours*, because they generally have elevations printed on them.

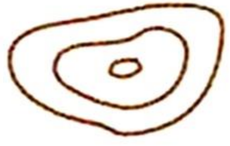
5. Contour lines never cross one another except for one rare case: where an overhanging cliff is present. In such a case, the hidden contours are dashed.

6. Contour lines can merge to form a single contour line only where there is a vertical cliff.

7. Evenly spaced contour lines of different elevation represent a uniform slope.

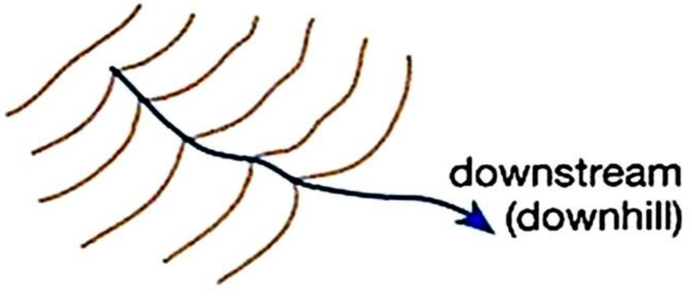
8. The closer the contour lines are to one another the steeper the slope. In other words, the steeper the slope the closer the contour lines.

9. A concentric series of closed contours represents a hill:



10. *Depression contours* have hachure marks on the downhill side and represent a closed depression:

11. Contour lines form a V pattern when crossing streams. The apex of the V always points upstream (uphill):



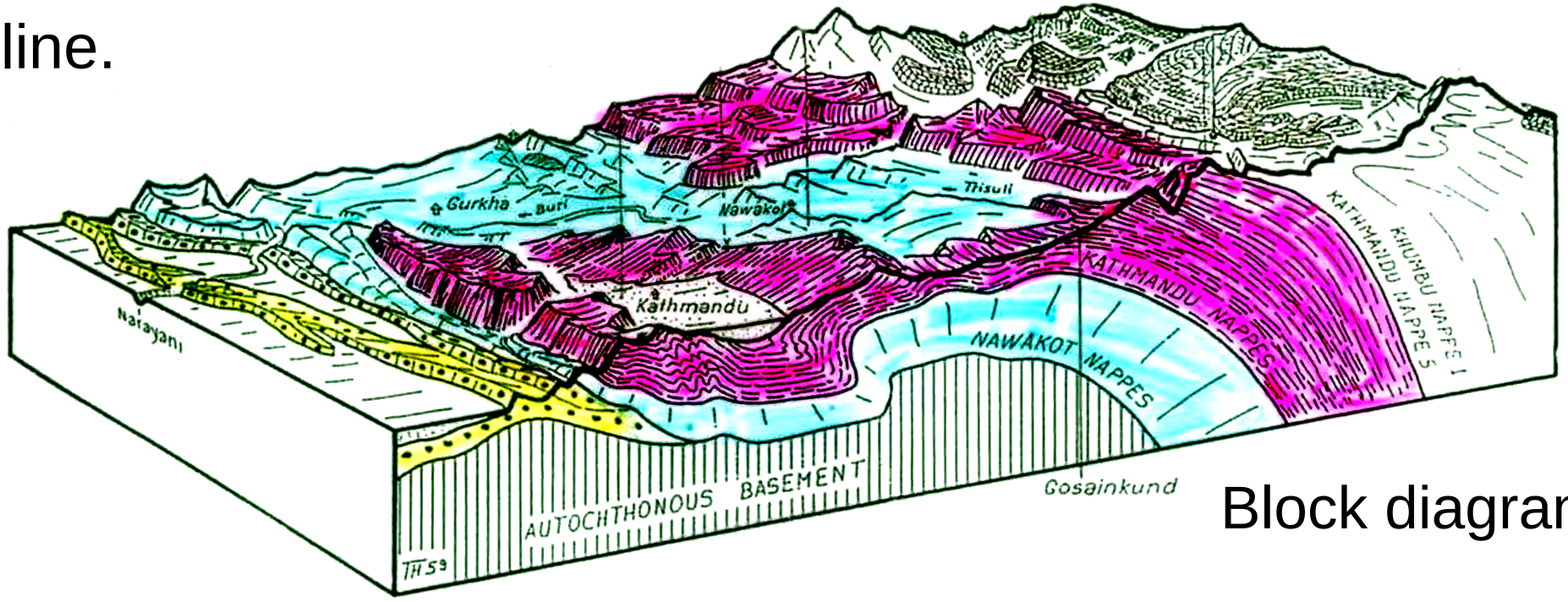
12. Contour lines that occur on opposite sides of a valley always occur in pairs.

13. Topographic maps are contoured in metres referenced to sea level

Construction of a Topographic Profile

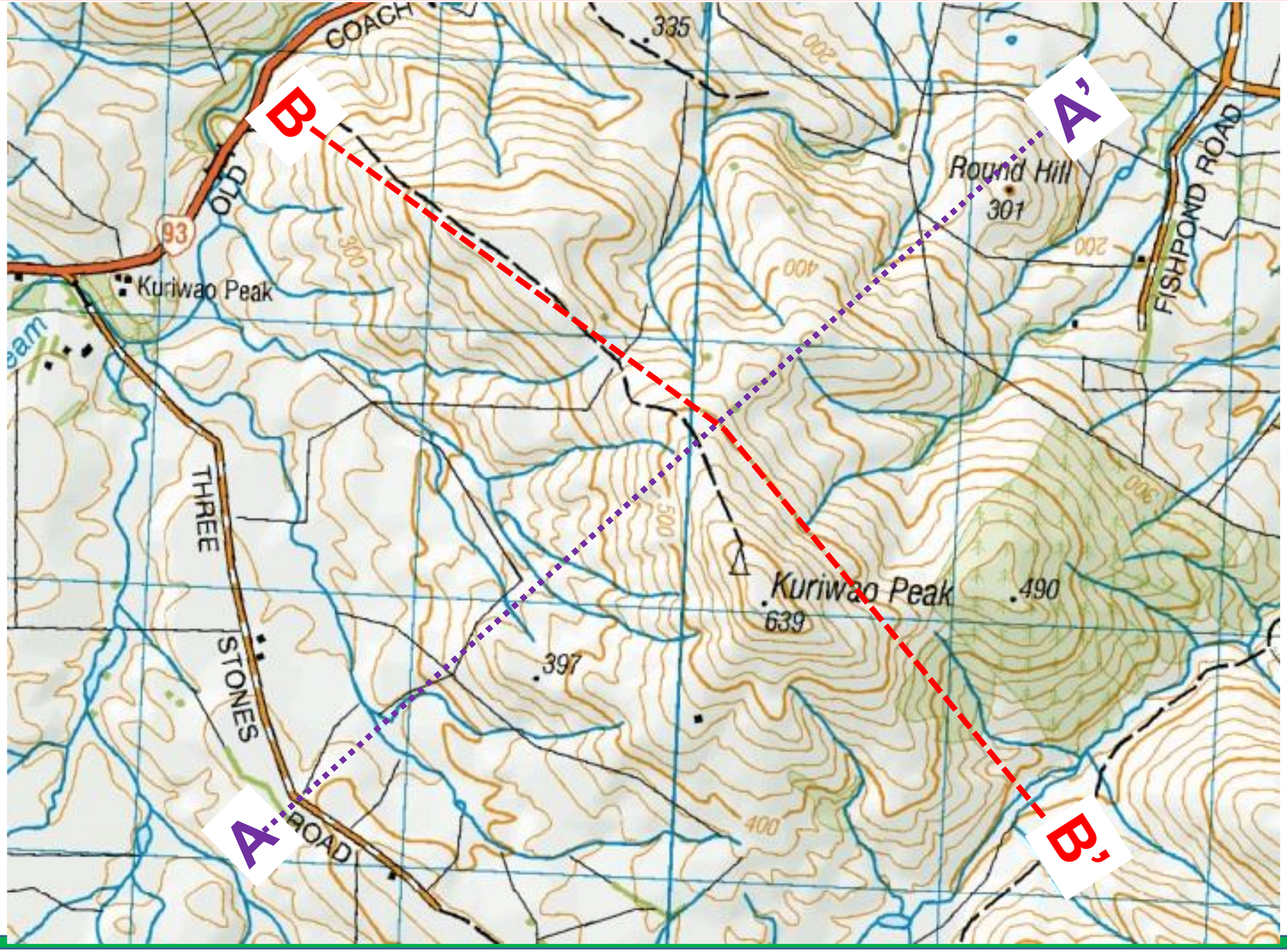
Topographic profile:

- is an outline of land as it would appear in a vertical slice along a particular line.



Block diagram

Construction of a Topographic Profile.....contd.

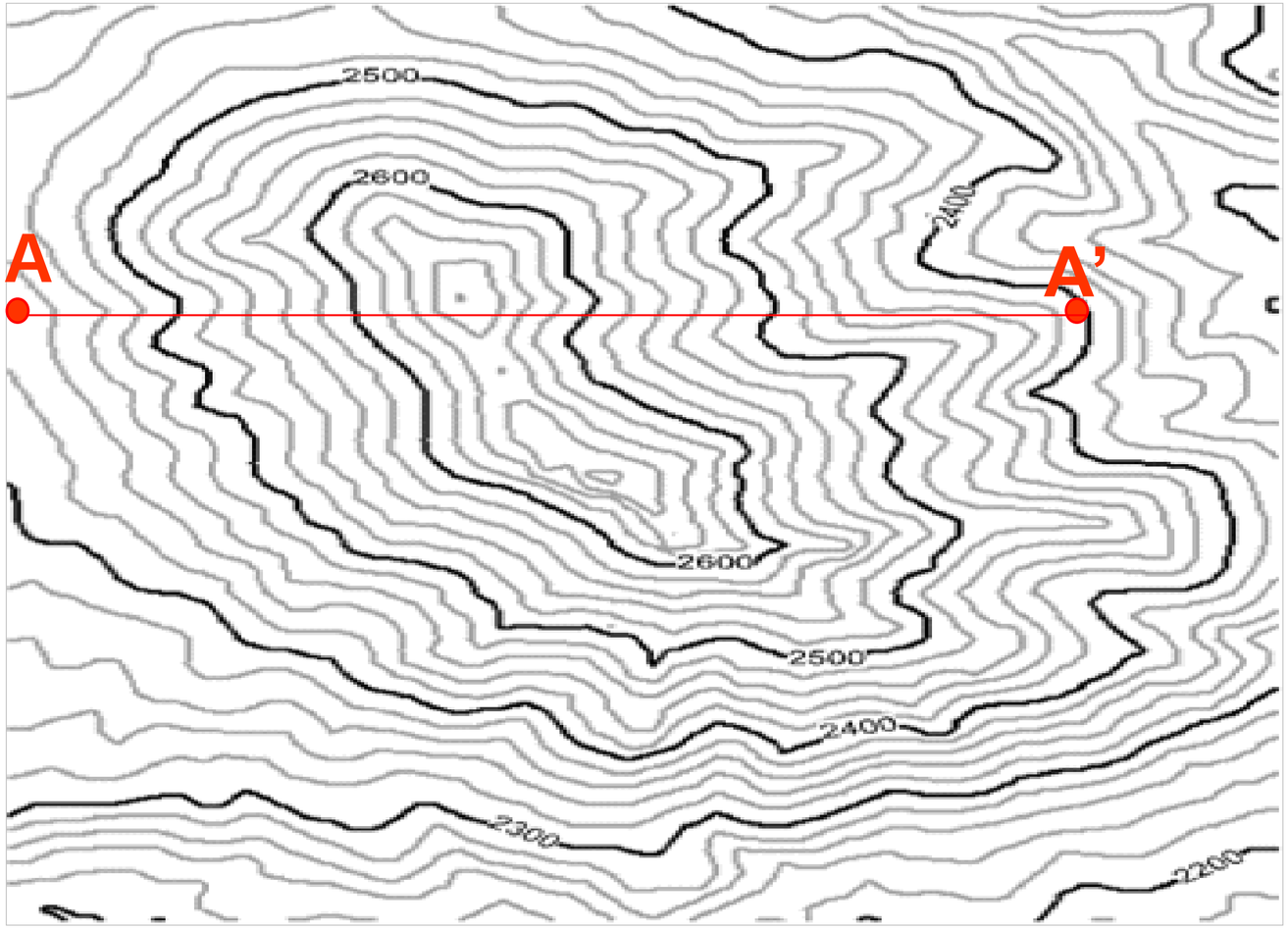


Construction of a Topographic Profile…..contd.

Example in drawing profile:

Step 1

1. On map, draw a line of section along which profile is to be constructed.
2. Label section line A-A‘
3. Be sure that line intersects all features (ridges, valleys, streams, etc.) that you wish profile to show.

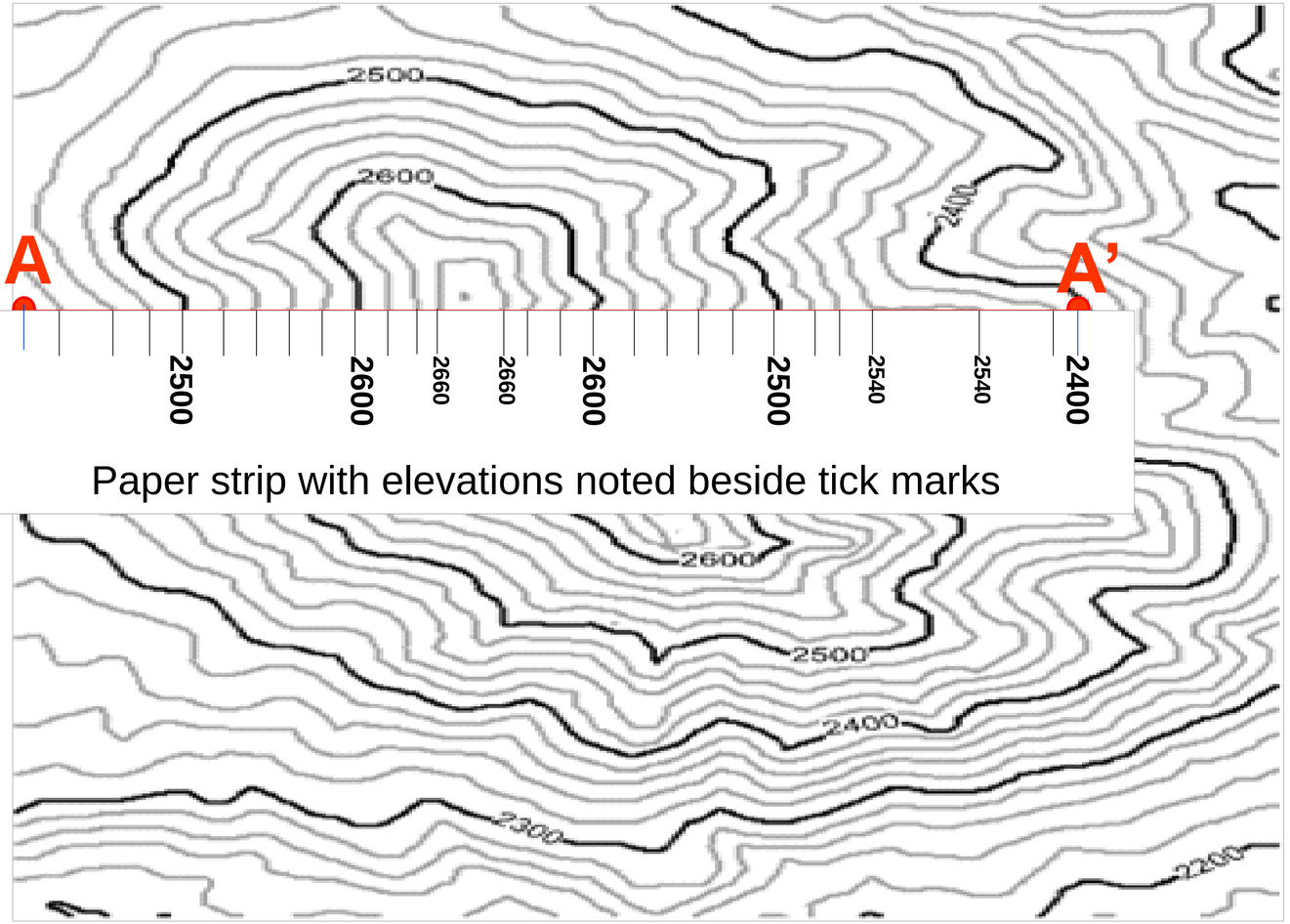


Construction of a Topographic Profile…..contd.

Step 2:

On a strip of paper placed along section line A-A‘:

- make tick marks at each place where a contour line intersects section line, and note
  - elevation at the tick marks.
  - location and elevation of points A and A' and any streams crossed.



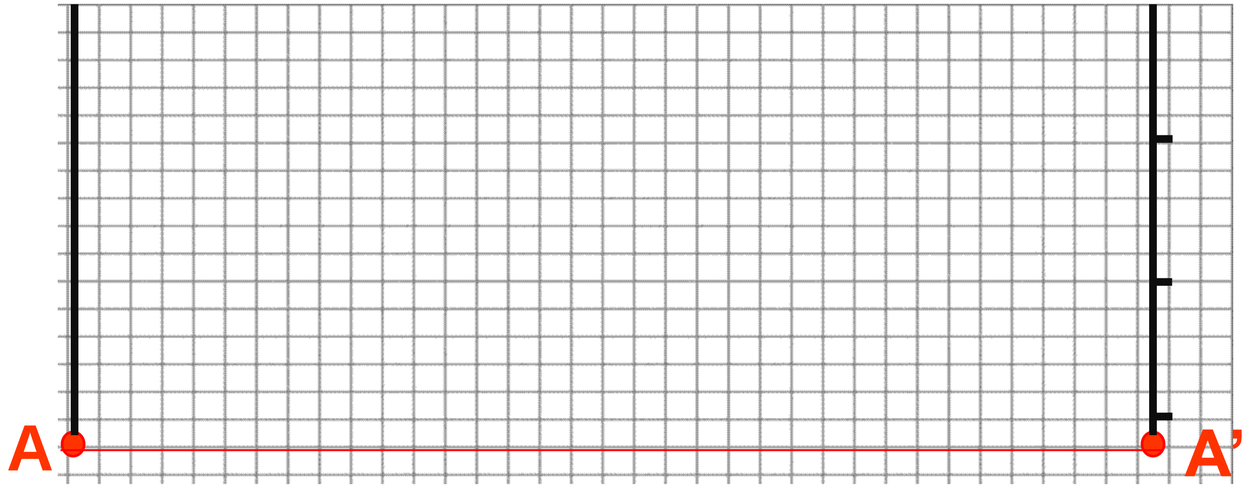
Paper strip with elevations noted beside tick marks

Construction of a Topographic Profile…..contd.

Step 3 – Drawing profile

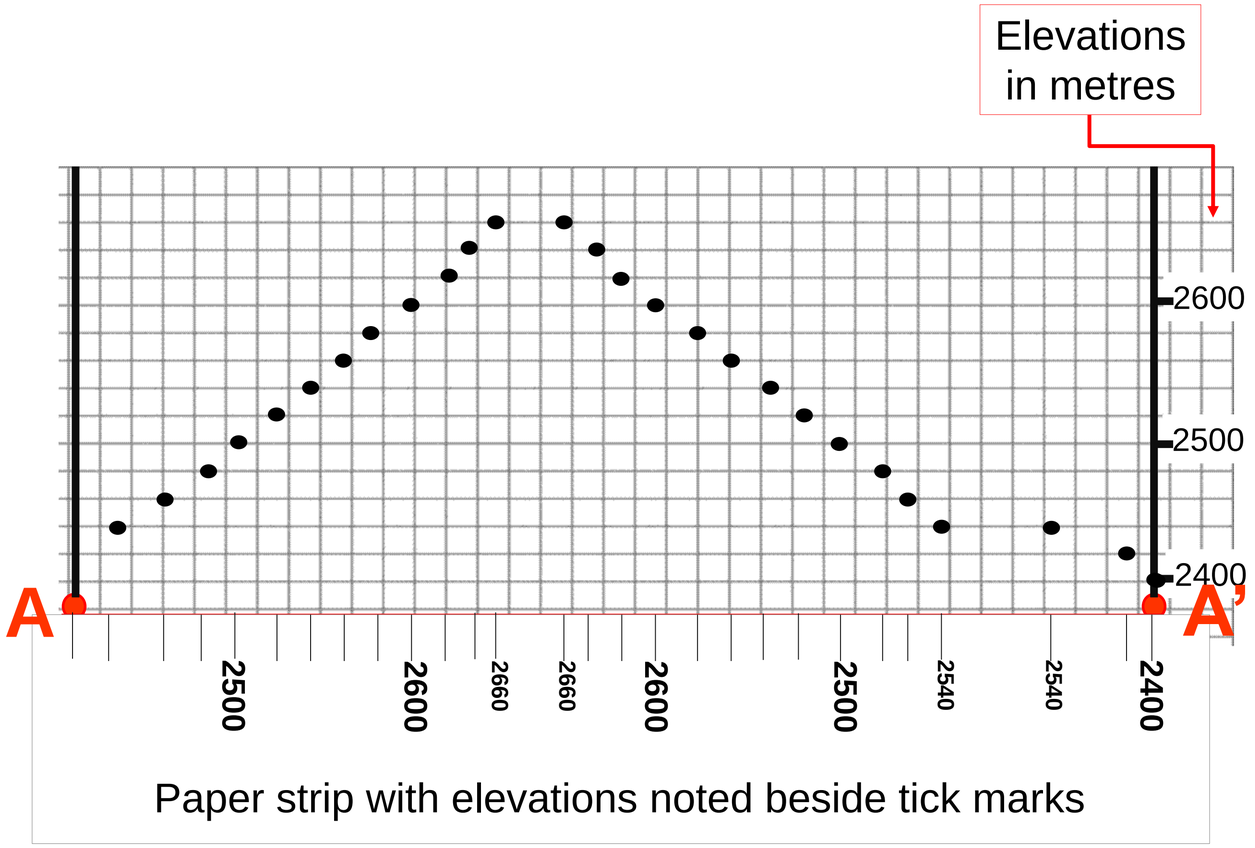
On a separate sheet of paper, preferably graph paper:

- Mark equally spaced points, with each representing a constant elevation, and thus corresponding to a contour line - total number of points needed and their elevations depend on:
  - total relief along line of section, and
  - space between lines equal to contour interval, or multiples of it (vertical exaggeration)



Construction of a Topographic Profile…..contd.

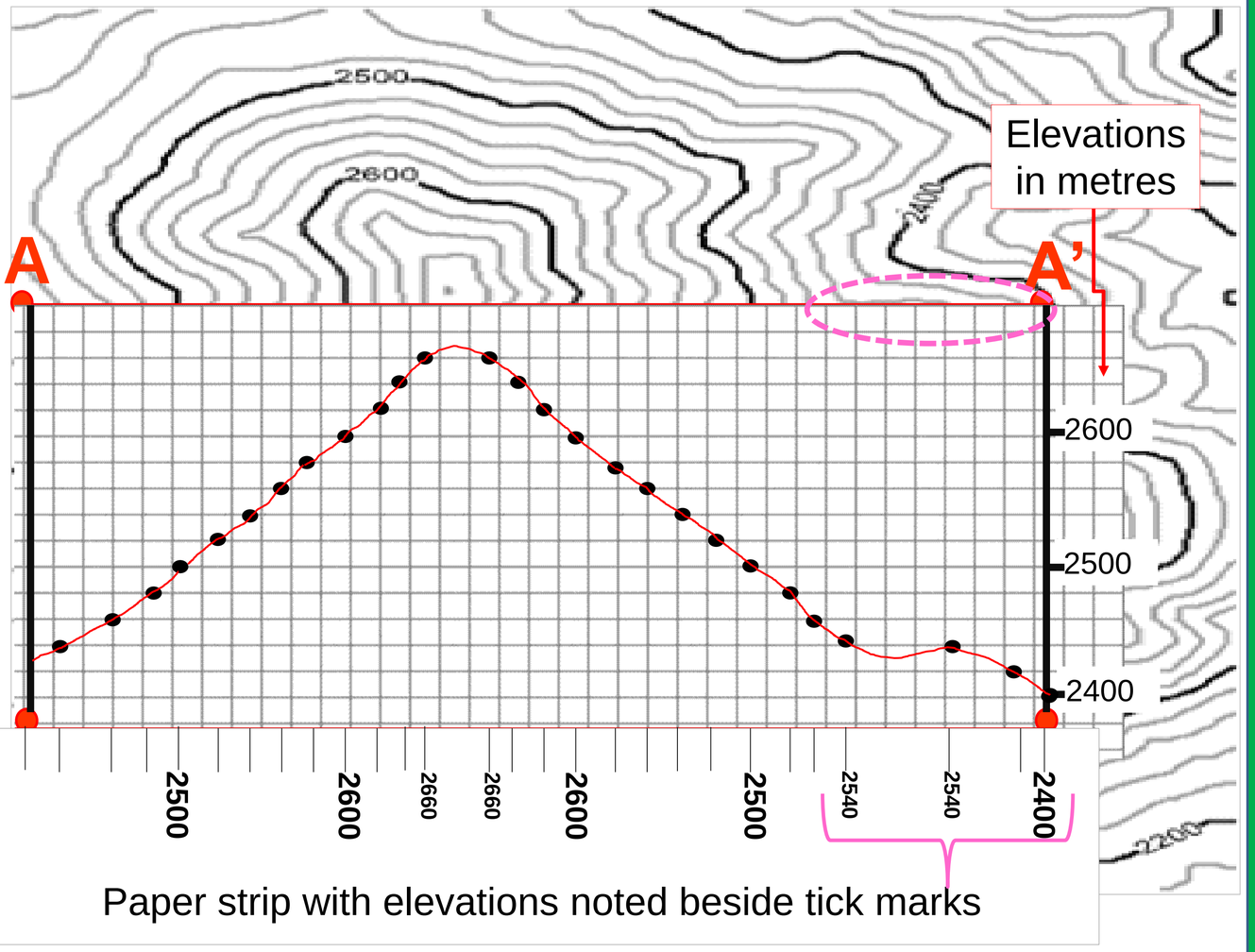
- Label your lines so that the highest and lowest elevations along the line of section will be within the grid.
- units on vertical axis should bracket highest lowest elevations to be shown on profile, and should be at same scale as the horizontal scale, which is that of the map.
- Then, take strip of paper you marked in Step 2, and place it along base of your profile.
- Mark a dot on grid above it for each elevation.



Paper strip with elevations noted beside tick marks

Construction of a Topographic Profile…..contd.

Smoothly connect these dots to complete the topographic profile. (This line should not make angular bends. Make it a smoothly curving line that reflects the relief of the land surface along the line of section)



Construction of a Topographic Profile…..contd.

The most realistic representation of topography is obtained when:

- vertical scale for profile is the same as horizontal scale, but
  - it is common practice to **exaggerate** vertical scale, especially in areas of low relief,
    - in order to make features stand out more clearly.

Construction of a Topographic Profile…..contd.

Step 4 – Vertical Scale

Vertical scale of your profile will vary greatly, depending on how you draw your grid. It almost certainly will be larger than horizontal scale of map. This difference causes an EXAGGERATION in vertical dimension.

Such exaggeration is almost always necessary to construct a readable profile, for without vertical exaggeration, profile might be so shallow that only highest peaks would be visible.

Construction of a Topographic Profile…..contd.

For example: If:

- Vertical scale is 1:1,440, and
- Horizontal scale is 1:24,000, then;

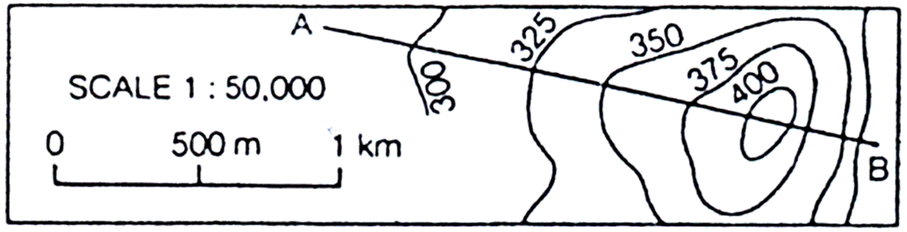
Vertical Exaggeration is determined by **dividing vertical fractional scale (1/1440) by the horizontal fractional scale (1/24,000)** giving a value 16.7

This number (sometimes written **16.7x**) indicates that relief shown on profile is **16.7 times greater** than true relief. This makes slopes on profile 16.7 times steeper than corresponding real slopes on ground.

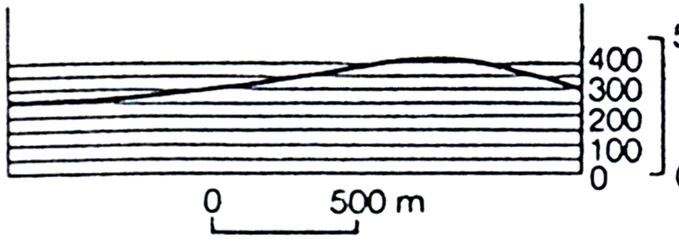
CONSTRUCTION OF A TOPOGRAPHIC PROFILE…..(11)

$$\text{vertical exaggeration} = \frac{\text{vertical scale}}{\text{horizontal scale}}$$

Horizontal scale = 1:50,000
Vertical scale = 5 * horizontal scale
= 5 * 50,000
So, V. Scale = 250,000

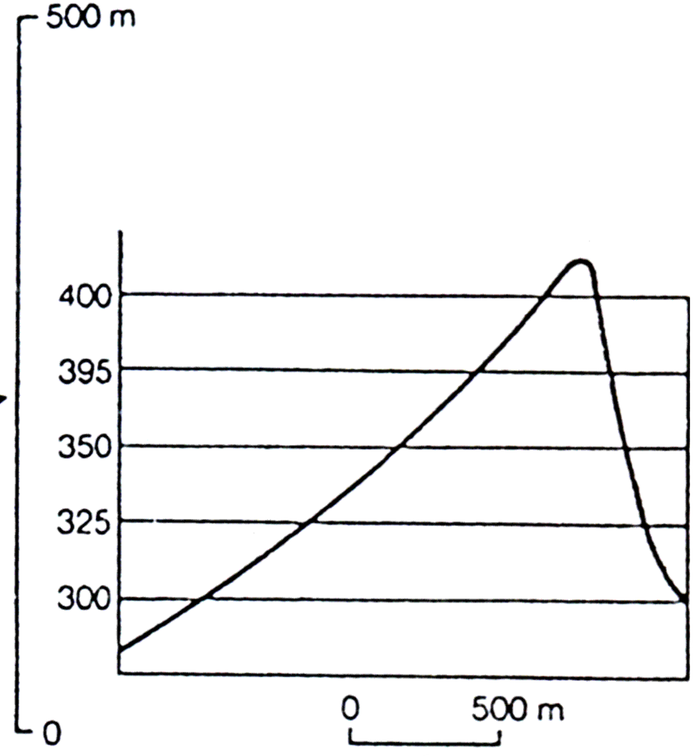


topographic profiles from a map

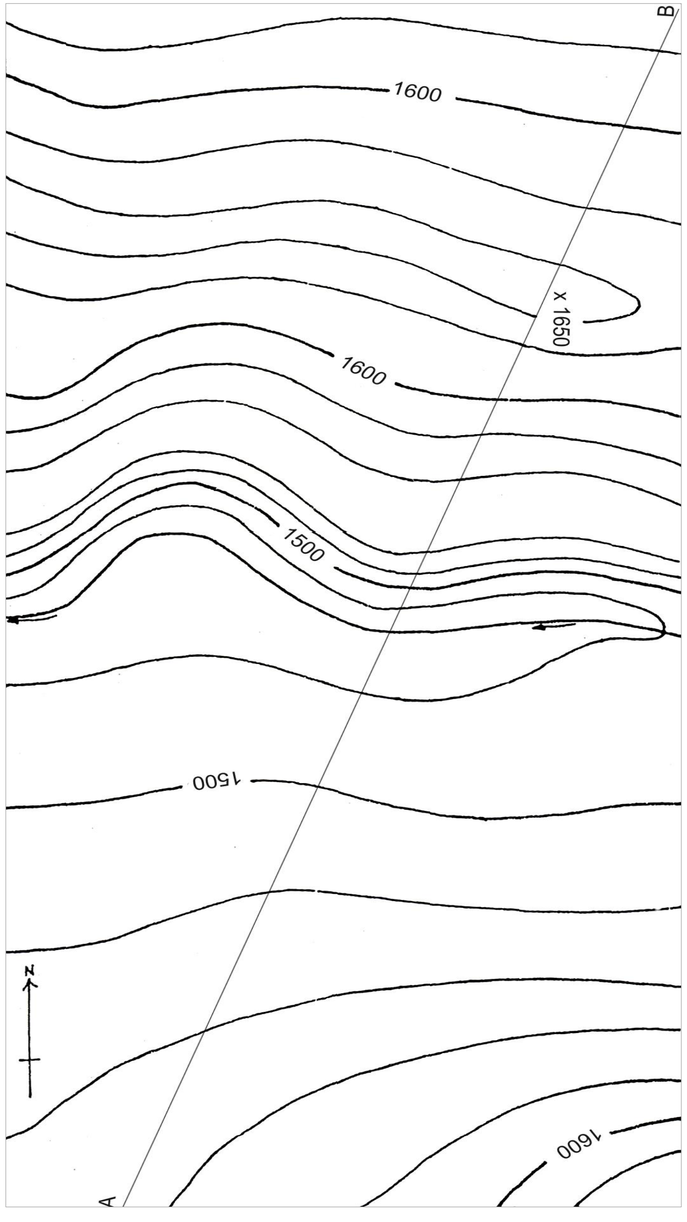


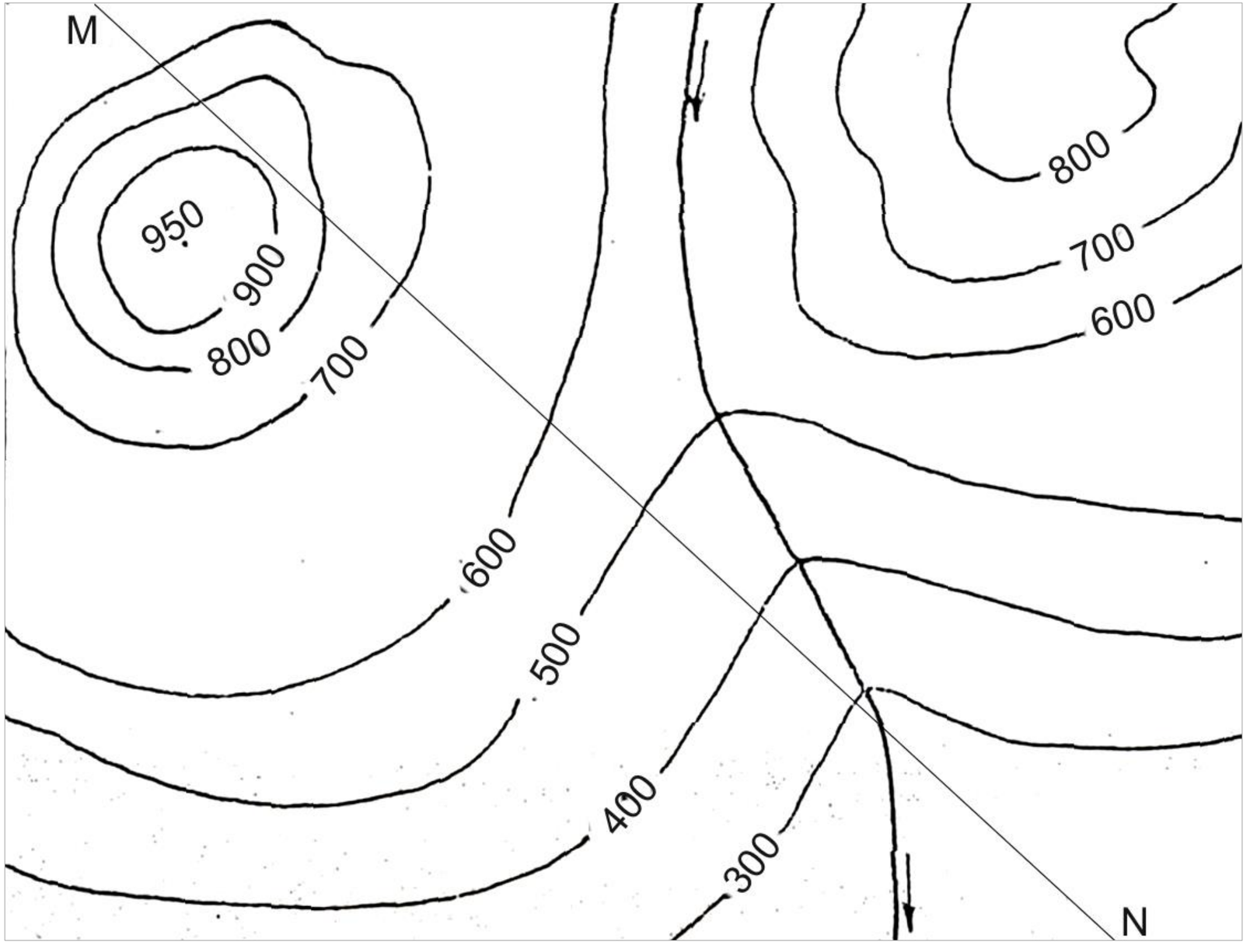
vertical scale same as horizontal: no vertical exaggeration

vertical scale 5× horizontal: 5× vertical exaggeration



Exercise 1:


B
1600
x 1650
1600
1500
1500
1600
N
A


M
950
900
800
700
800
700
600
600
500
400
300
N

Geological Maps

- Most useful information obtainable from topographic map pertains to:
  - **Shape,** and
  - **form**

  of the ground surface – **relief** – which determines:
    - Appearance of the map.
    - Outcrop pattern of rocks

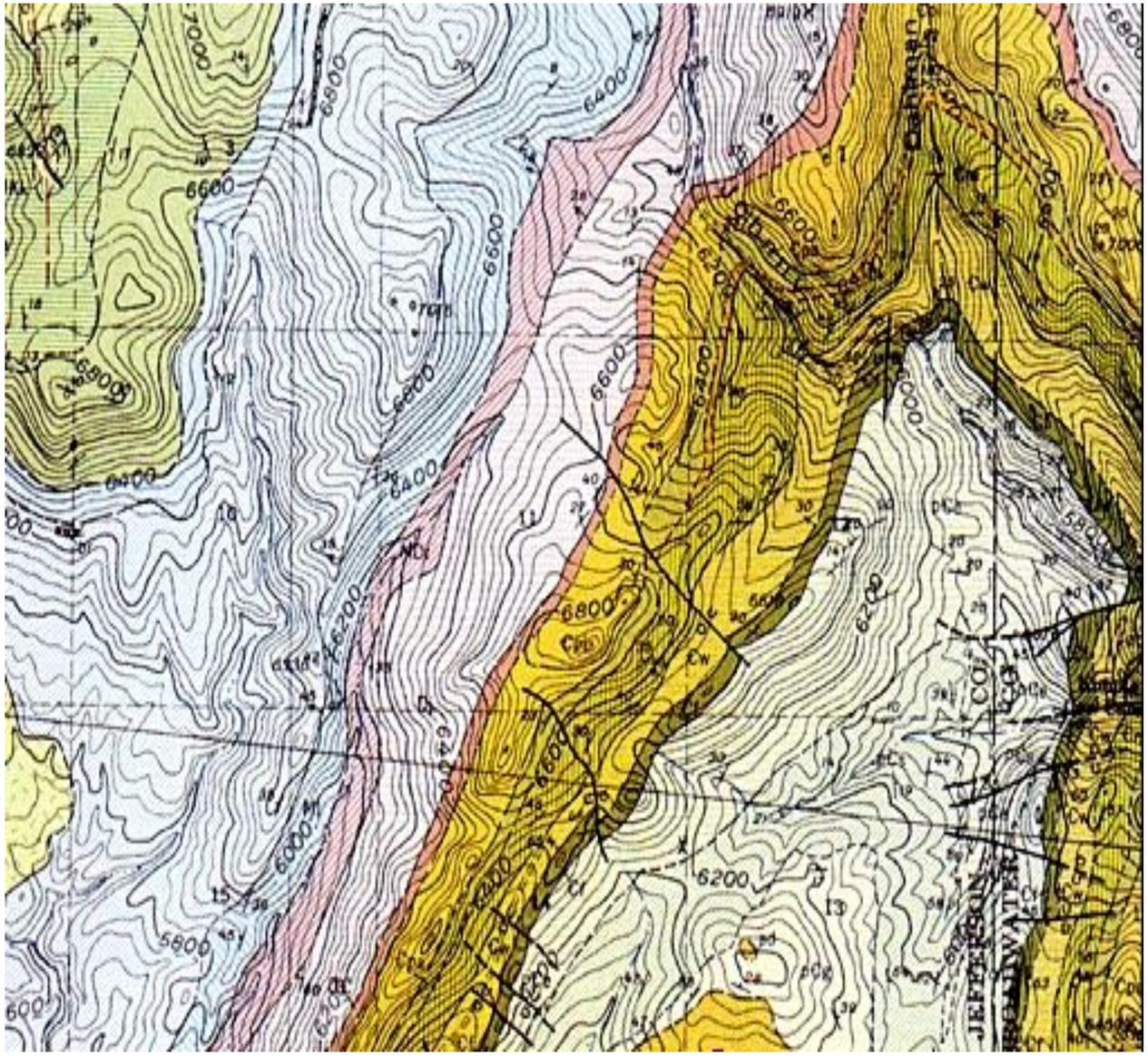
Thus, **relief is determined by underlying geology**.

Geological Maps…..contd.

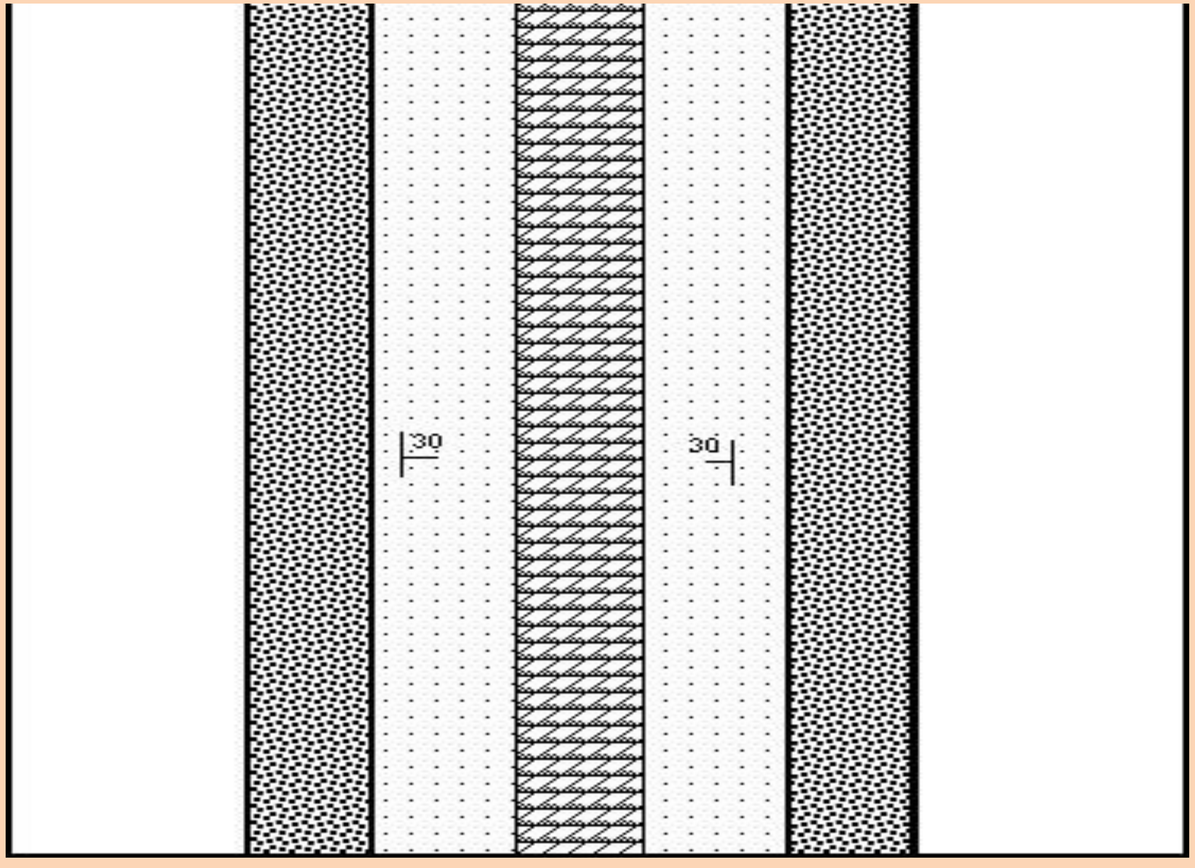
A Geological Map:

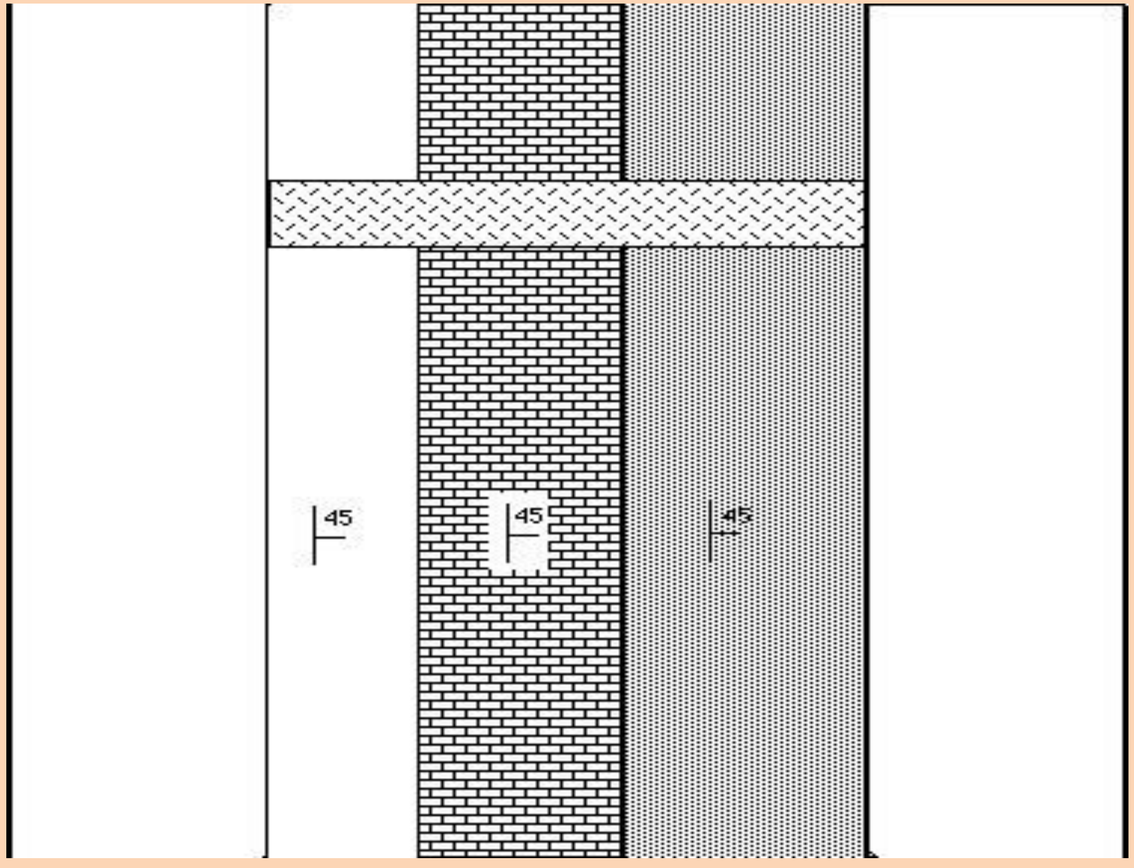
- is most basic & essential document for a geologist.
- gives overall picture of:
  - Occurrence, and
  - Distribution

of various rock types at ground surface.



Geological Maps.....contd.





From the symbols (dips and strikes) on the map, an impression can be made of the 3-D arrangement of rocks beneath ground surface.

Geological Maps…..contd.

From careful study of good geol. map, one can:

- **Deduce geological history of an area** – i.e., determine relative ages of rocks and successive geologic events like deposition, erosion, intrusion, metamorphism, deformation, etc.
- Tell where possible zones of weakness are located, which is important to know for construction of dams, towns, roads, etc.

Geological Maps…..contd.

Before construction of a geological map, **base map** is needed on which to plot the geological data – **a topographic Map**.

Horizontal Beds

We will now turn our attention to question of **how** rock layers/strata intersect Earth’s surface.

This intersection determines outcrop pattern & tells where strata will occur on Earth's surface.

Horizontal Beds.....contd.

- Firstly, let's look @ horizontal beds.
- Take simple example of flat horizontal Earth's surface – A horizontal rock layer may be imagined ***parallel*** to surface.

Horizontal Beds.....contd.

If the layer is @ surface;

- Whole surface will consist of this rock
- Rock forms one continuous outcrop.
- Geological map would show only one colour **and no contacts.**

Horizontal Beds.....contd.

Of course, Earth's surface is **NOT** flat. It has **topographic** relief, **produced by carving** action **of** erosion.

⇒ Outcrop pattern of horizontal layers will be different and dependent on nature of topography.

Horizontal Beds.....contd.

Recall:

- Topography is defined by **topographic contour lines**
  - intersections of **imaginary horizontal planes** with **Earth's surface.**

Horizontal Beds.....contd.

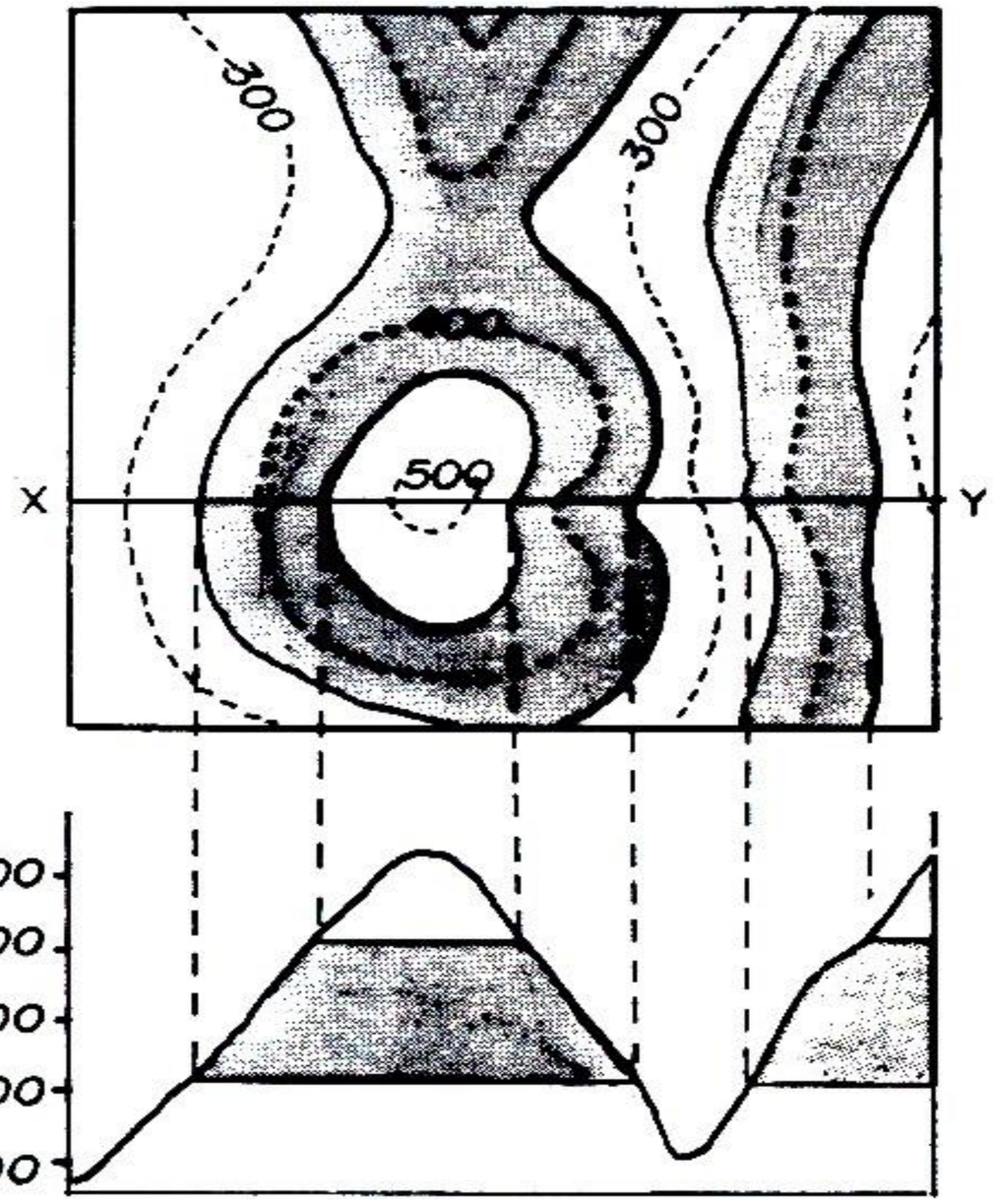
It follows that:

- A horizontal layer intersects the topography along lines parallel to the topographic contour lines. In other words:
- The outcrop of a horizontal layer is parallel to the contour lines.

Horizontal Beds.....contd.

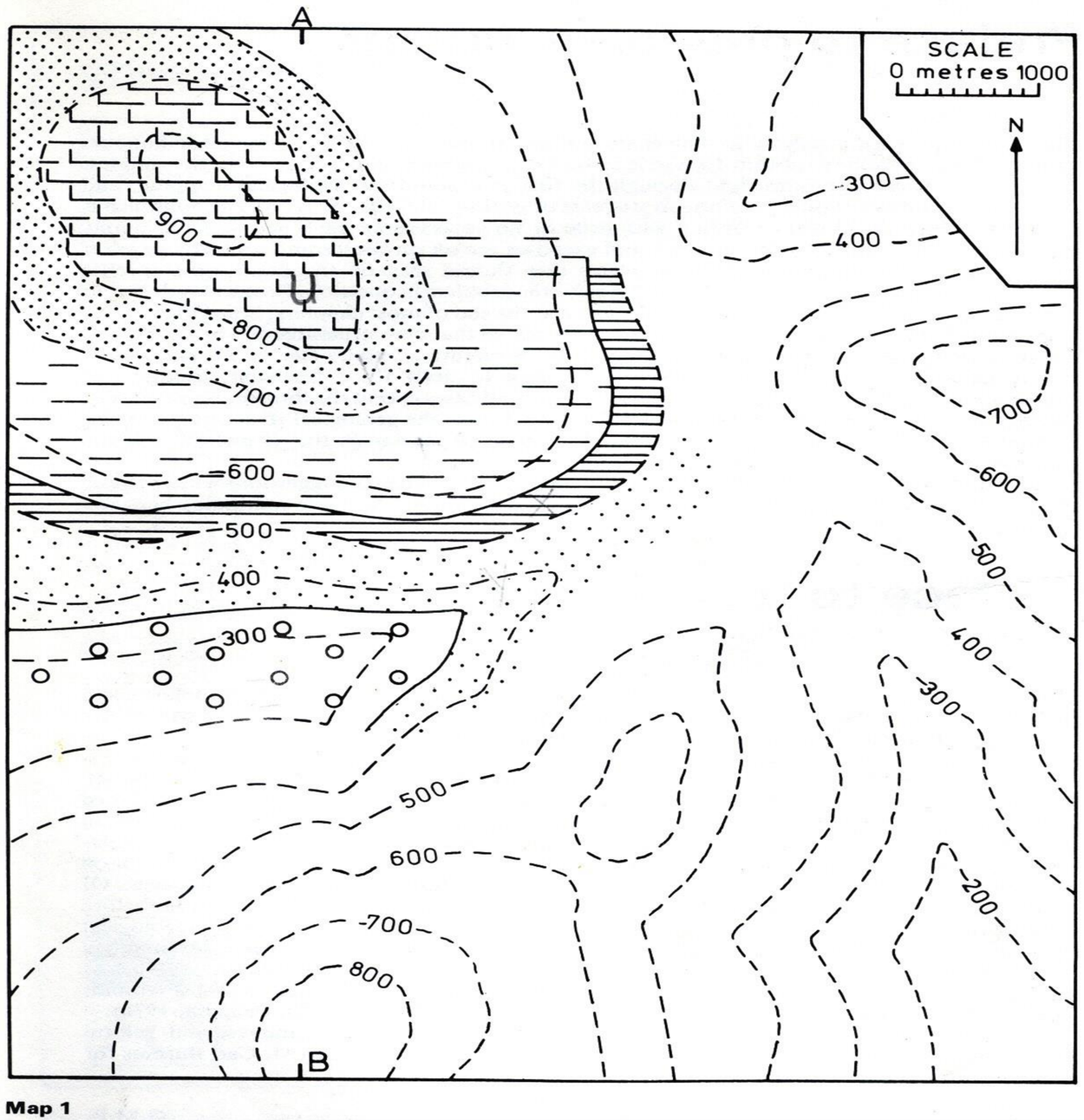
Section (Profile) Drawing

- Draw base line the exact length of line **A-B** on Map
- Mark off on baseline points at which contour lines cross line of section
- From baseline, erect perpendicular corresponding in length to height of ground



Exercise 1

The geological outcrops are shown in the north-west corner of the map. It can be seen that the beds are horizontal as the geological boundaries coincide with, or are parallel to, the ground contour lines. Complete the geological outcrops over the whole map. How thick is each bed? Draw a vertical column showing each bed to scale, 1 cm = 10 m. Draw a section along the line A-B. (Contours in metres)



Map 1

Exercise 2

Information

A vertical borehole located on a site at point C 170 m above sea level passed through the following rock Formations:

0 – 20 m Sandstone;

20 – 50 m Marble

50 – 80 m Schist

80 – 170 m Gneiss

All the bedding and foliation planes encountered in the borehole display a horizontal attitude.

Answer the following:

Complete the geological map of the area

Draw a vertical section (i.e. a geological cross-section) along the line A – B and mark on it the Formations intersected by the borehole.

Note: The solid geology is obscured by alluvium below the 60 m contour.