UNIT ONE

Map Reading

Direction on Maps

- **Direction is stated by <u>compass points</u> and <u>angular bearings</u>.**
- **<u>Compass points</u>: a compass is an instrument use for indicating direction in the field. Compass point consists of cardinal and subsidiary points. There are four cardinal points such as North, South, West and East.**

Types of North's

- 1. **True north(geographic north)**: the direction indicated by the north pointing meridians
- 2. **Magnetic north** : is the north direction indicated by north seeking freely moving magnetic needle of a compass. The angle difference between the true north and magnetic north is known as magnetic variation/declination
- 3. **Grid north**: is the direction in which grid lines point towards the top of the map. Such lines known as eastings.

- **Angular bearings**; direction stated in degrees. A bearing is an angle measured clockwise direction from a north-south line to a line connecting the observer position.

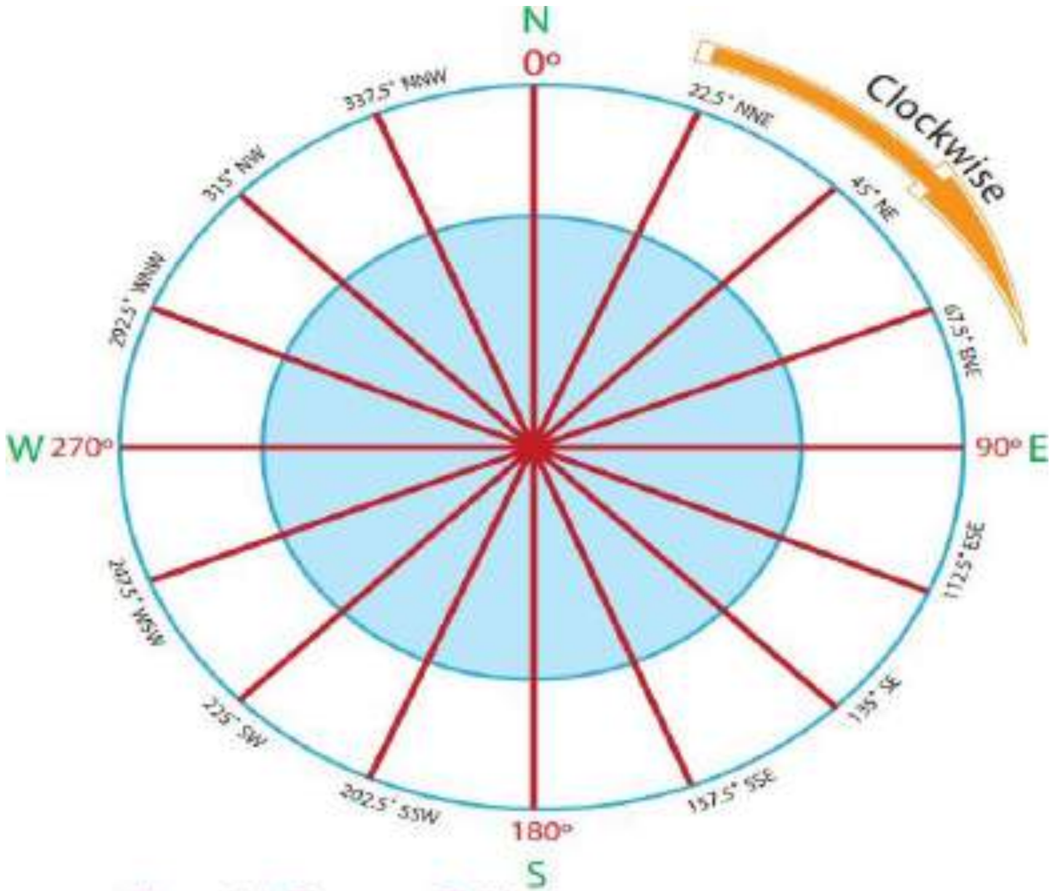
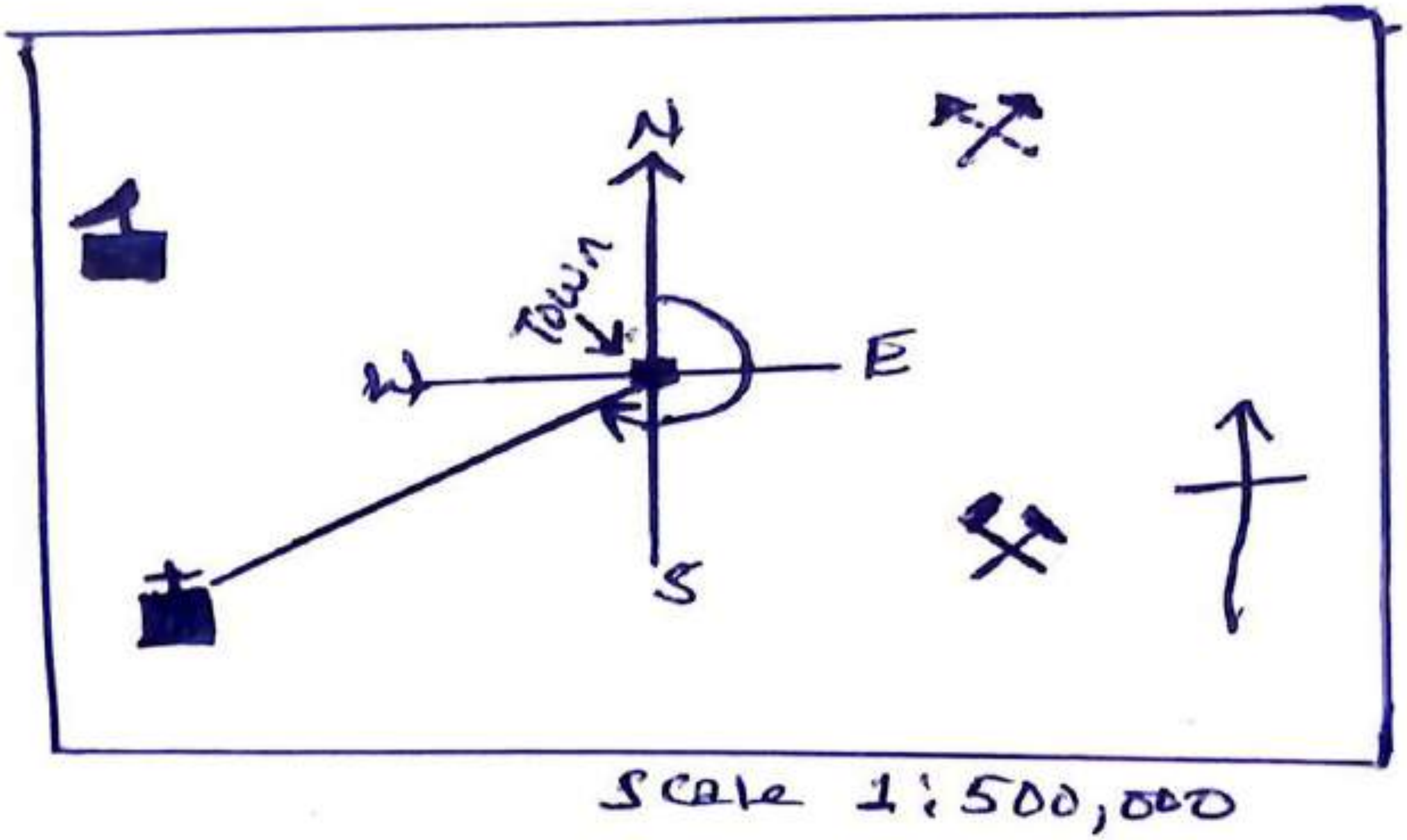


Figure 1.1: Compass Points

- **find the direction and bearing of the church from the town.**



Procedures

- ✓ draw a line to join two points on the map
- ✓ draw another line that pass trough ”town” towards the N and S.
- ✓ Use protractor to measure the bearing in clockwise direction.
- ❖ therefore, the bearing of the church from the town is 225^0. Thus, the direction of the church is southwest from the town.

Location and position on maps

- ➢ The position of places on the earth’s surface and upon maps can be given in a number of different ways.

- **The most important are through the use of:**
  - **Latitude and longitude(international grid references)**
  - **National Grid References (eastings and northings)**

Position by the Geographic Grid

- **This is a method by which the position of a place can be given accurately with the help of a grid composed of a network of lines known as parallels and the meridians.**
- **Meridians (longitude): lines run from north pole to south pole. They are intersect at poles and measures distance east and west of the prime meridians.**

- **Parallels(latitudes)**: lines run parallel to the equator. The parallel of latitude increasingly shorten closer to the poles. Thus, lines of latitude indicate the position of a place north or south of the equator.
- In identifying location, latitude is always stated first, longitude comes next.
- **Parallel**: an imaginary line joining all points with the same latitude.
- **Meridian**: An imaginary line joining all points with the same longitude.

- **find the geographical grid reference of:**
  - ✓ **Point 'C' = 10^0N 75^0W**
  - ✓ **Point 'O' = 20^0S 60^0E**

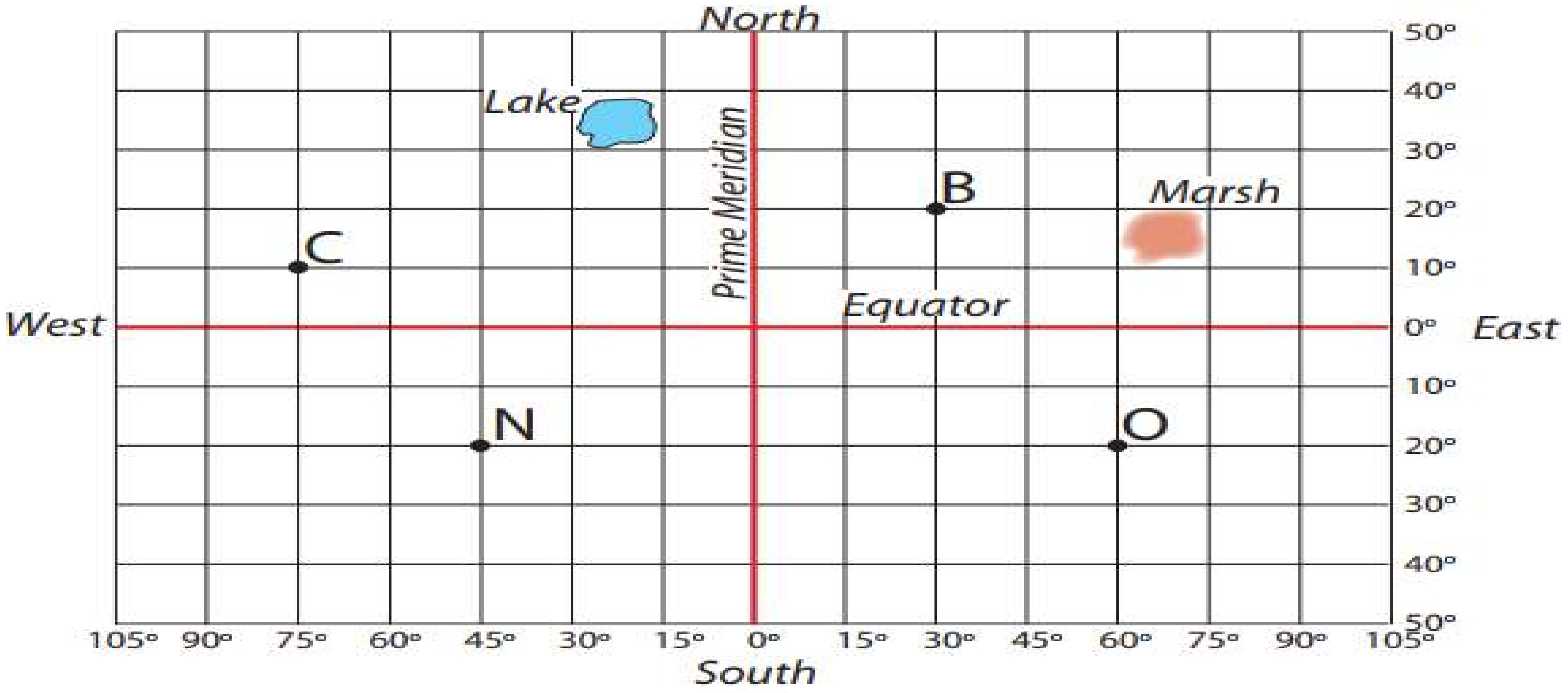


Figure 1.8: Geographic Grid

Procedure

- ✓ Identify whether point C is North or South of Equator.
- ✓ Read the latitudes of C, North of the equator i.e., 10^0N.
- ✓ Read the longitude of C, East of the prime meridian i.e., 75^0W.
- ✓ The complete geographic grid of point C is 10^0N 75^0W.

National Grid Reference System

- A National grid is a network of horizontal and vertical lines printed on the face of a map.
- Depending on the scale of the map, national grid lines are drawn at different intervals of 100km(small scale),10km(medium scale) and 1km(large scale).

- **Grid lines running from west to east are called <u>Horizontals or Northings</u>. Those grid lines which run from north to south are known as <u>Verticals or eastings</u>.**
- **each country uses its own grid origin. Usually it is located in the southwestern most corner of the country. <u>For example</u>, the grid origin used on Ethiopian map is located the point where the $34^{0}30'$E meridian cross the equator.**
- **In case of geographical grid reference, a single grid origin is used for the whole world, i.e. the intersection of the equator and the prime meridians.**

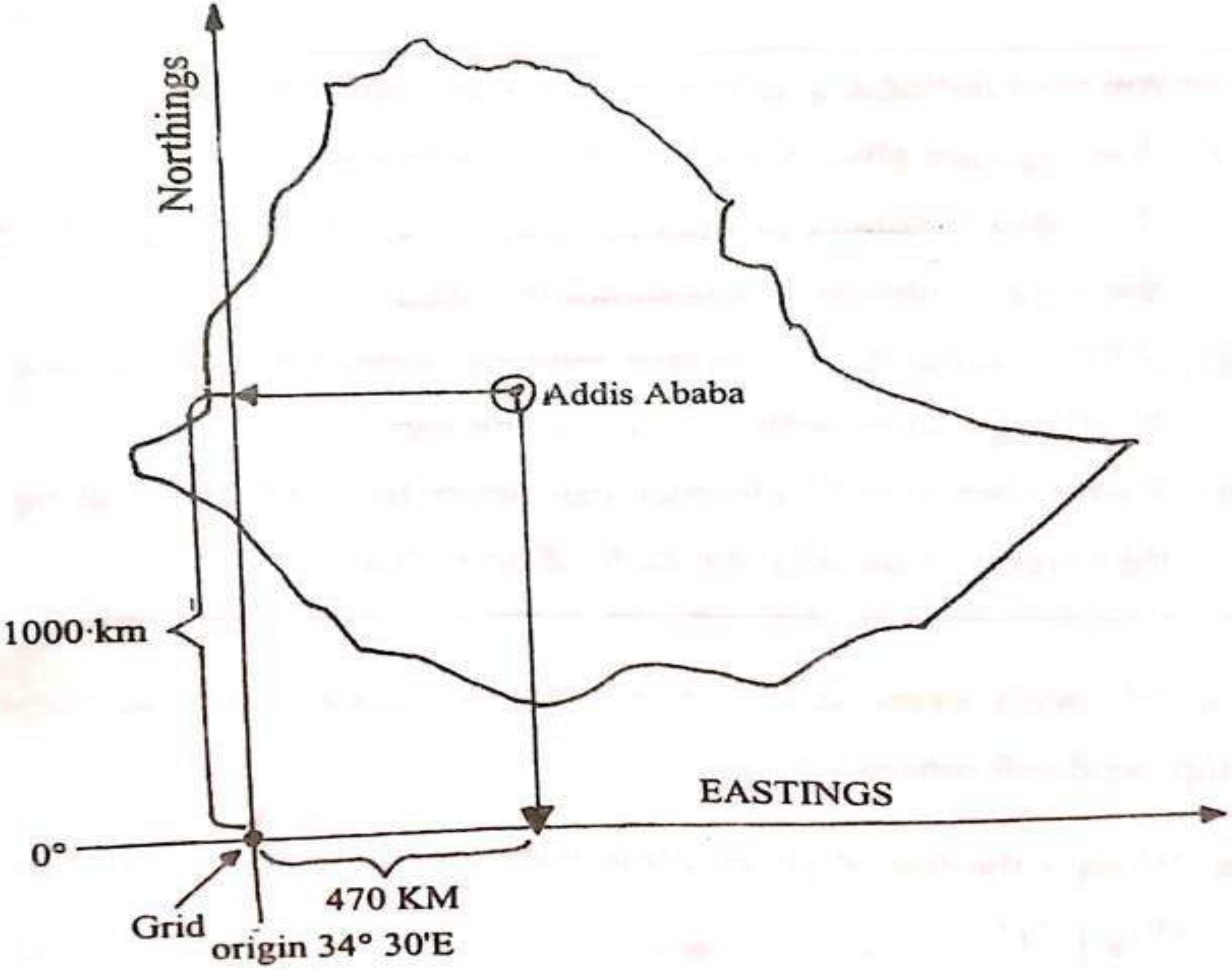


Fig. 1.6 The origin of Ethiopian national grid reference

- There are two ways of giving national grid reference. They are four digit and six digit grid reference.

The Four Digit Grid Reference

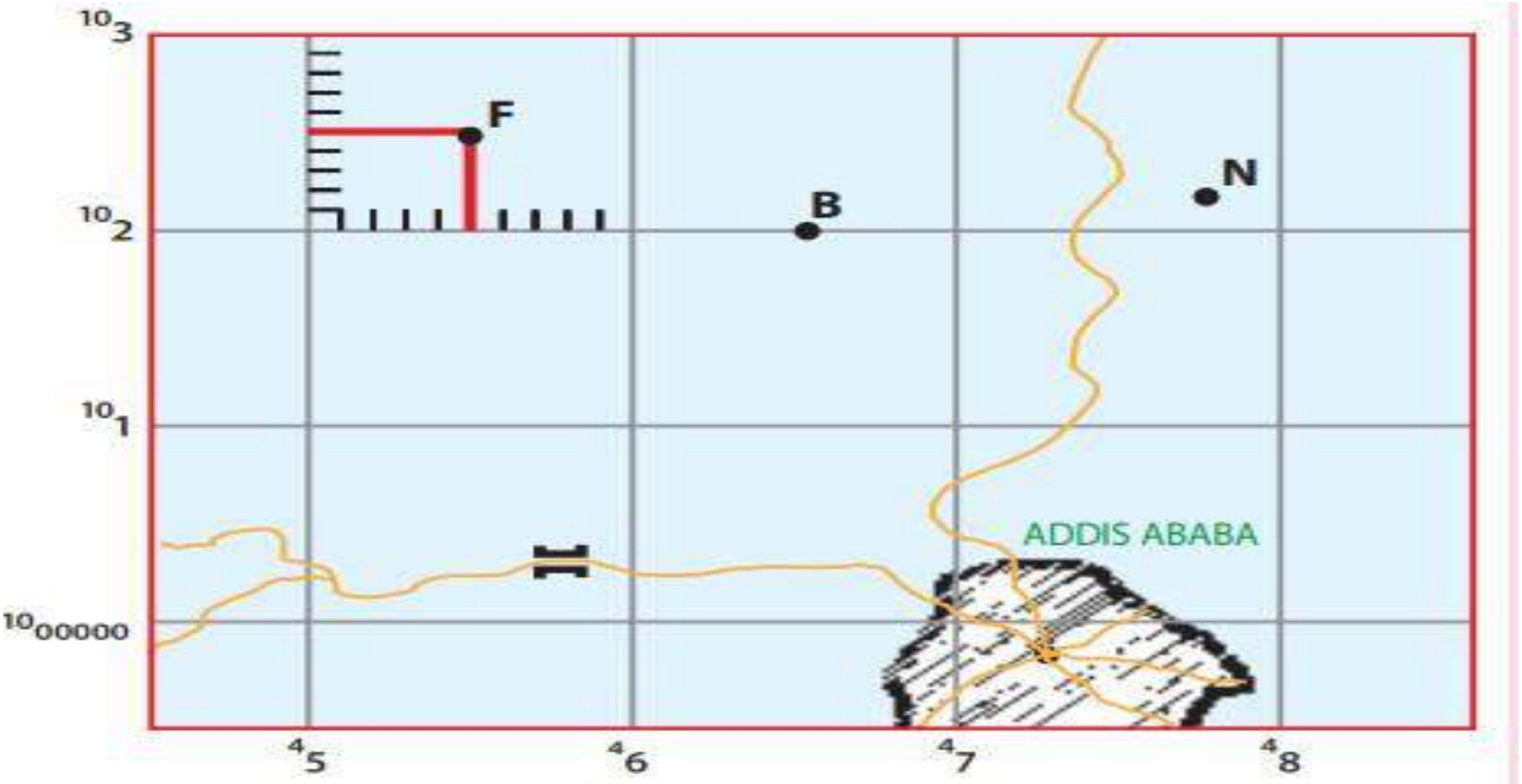
- It is usually used on small scale map. The grid line drawn at interval of 100km. Also, the grid reference contains four numbers, the first two indicate eastings and the second two show northings.

The Six Digit Grid Reference

- It is usually used on large scale map. The grid line drawn at interval of 1km. The grid reference contains six numbers, the first three indicate eastings and the second three show northings.

- **when you read national grid reference for any point feature:**
    - **Eastings are always given before Northings.**
    - **The grid number printed in small size should be ignored and only the bigger number prints should be used.**
    - **After taking necessary reading, combine the Easting and the Northing values without leaving any gap.**
    - **Remember a grid reference can never be used for locating an area, the reference usually stands for a point of feature.**

- **Find the four grid reference of point 'F'**



Procedures

- ✓ Locate the vertical grid line to the left of the point 'F' and read the large number = 5
- ✓ Divide the square into ten equal divisions and pick the tenth of the point = 5
- ✓ Locate the horizontal grid line below the point 'F' and read the large number = 2
- ✓ Again divide the square into ten equal divisions and pick the tenth = 5

➢ Therefore, the grid reference of point 'F' is 5525

The Six Digit Grid Reference

- **Exercise: Find the national Six digit grid reference for the points B on the map (Figure 1.11)**

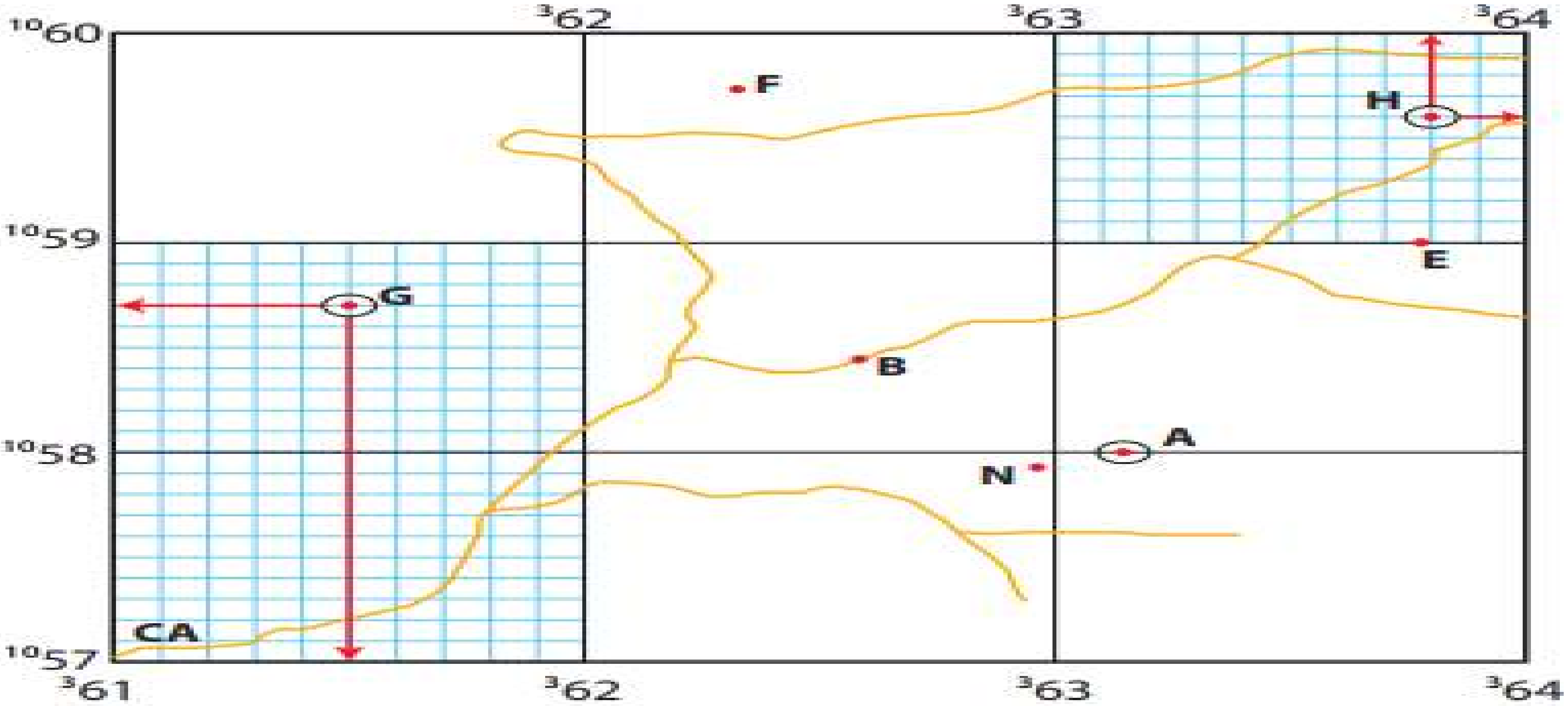
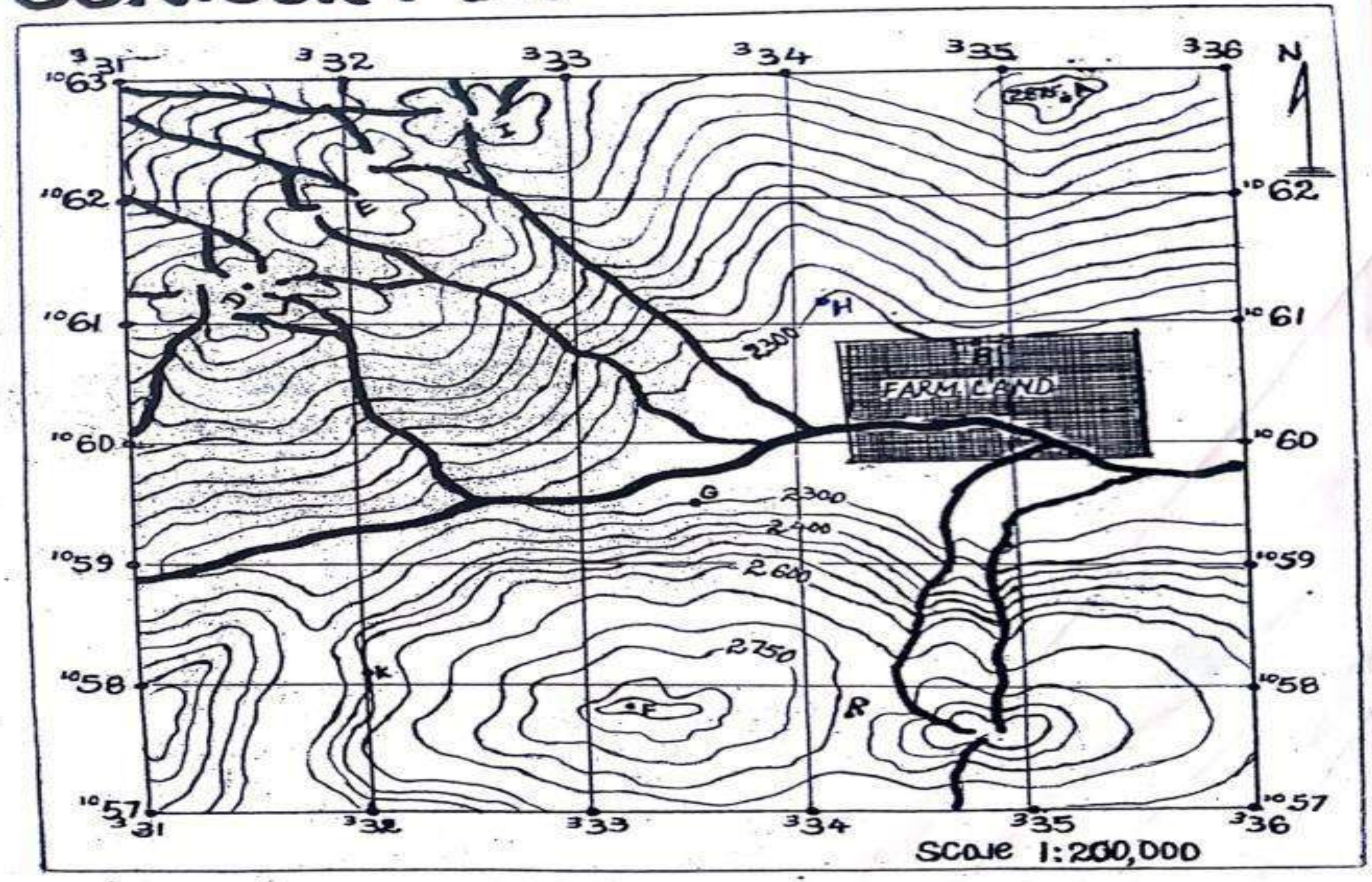


Figure 1.11: 6-Digit grid reference

Procedure

- ✓ **Locate the vertical grid line to the left of the point 'B' and read the large number = 62**
- ✓ **Divide the square into ten equal divisions and pick the tenth of the point = 6**
- ✓ **Locate the horizontal grid line below the point 'B' and read the large number = 58**
- ✓ **Again divide the square into ten equal divisions and pick the tenth = 5**
- ✓ **Therefore, the grid reference of point 'B' is 626585**

CONTOUR MAP



331
332
333
334
335
336
N
1063
1062
1061
1060
1059
1058
1057
A
E
H
2300
FARM LAND
G
2300
2400
2600
2750
F
R
K
Scale 1:200,000

1. **The six digit grid reference of point "G" is**

   A. 595335 B. 335595 C. 333460 D. 605345

1. **The direction and bearing of point 'G' from point'K'is**

   A. NE /45^0 C. SW/125^0

   B. NW/315^0 D. SE/135^0

Map Enlargement and Reduction

- **We enlarge and reduce maps for different reasons i.e. either to add details or reduced selected information on a map.**

Methods of enlarging and reducing maps

- **Maps are enlarged and reduced by graphical(Square method (free-hand) and Pantograph method (uses an instrument).**
- **Enlargement: We enlarge a map when we need to show more details (features) about the area it shows. In case of enlargement we multiply the original R.F scale with the number of times that we intended to enlarge. If a map is to be enlarged x times, the new map will be x times the scale of the old map.**

- **Example**: If a map whose scale is 1:400,000 is enlarged 2 times, then the new scale would be

$$\frac{1}{400{,}000} \times 2 = \frac{1}{200{,}000} \text{ or } 1{:}200{,}000$$

- The amount of increase of scale can be obtained by applying the following formulae:

$$\text{Amount of enlargement} = \frac{\text{Denominator of small scale}}{\text{Denominator of large scale}}$$

- **Example**: A map at 1: 400,000 is to be enlarged to a map at 1:200,000. By how many times is the scale increased?

$$\text{Amount of increase} = \frac{400{,}000}{200{,}000} = 2 \text{ times}$$

- **Reduction**: We reduce maps when we need to be selective and to generalize the information that the map presents. When the scale of the map decreases, the size of the map also decreases accordingly.
- **If you need to reduce a map , you divide the original R.F. Scale with the number of times that you have enlarged that map.**
- **If you reduce a map by 1/x, the scale of the new map will be 1/x times the scale of the old map.**
- **Example: If we reduce a map with a scale 1:25,000 by two, what will be the scale of the new map?**

$$\frac{1}{25,000} \div 2 \sim \frac{1}{25,000} \times \frac{1}{2} = \frac{1}{50,000} \text{ or } 1:50,000$$

- **Example 2:** **If we reduce a map with a scale 1:50,000 by half($\frac{1}{2}$), what will be the scale of the new map?**

✓ **in this case, we divide the original scale by $\frac{2}{1}$**

$$\frac{1}{50,000} \div \frac{2}{1} \sim \frac{1}{50,000} \times \frac{1}{2} = \frac{1}{100,000} \text{ or } 1:100,000$$

- **The amount of reduction of scale can be obtained by applying the following formulae:**

$$\text{The amount of reduction} = \frac{\text{Denominator of large scale}}{\text{Denominator of small scale}}$$

- **<u>Example</u>: A map with a scale of 1: 50,000 is reduced to 1:1000,000. How many times is the scale reduced?**

$$\textbf{Amount of reduction} = \frac{50{,}000}{100{,}000} = \frac{1}{2}\ \text{times}$$

Activity 1.6

Answer the following questions.

1. Enlarge the following map scales as indicated:
   - a 1: 50,000 (twice)
   - b 1: 100,000 (4 times)
   - c 1: 50,000,000 (5 times)
   - d 1: 10,000,000 (4 times)
2. A map with a scale of 1:400,000 is enlarged to 1: 100,000. How many times is the scale increased?
3. Reduce the following map scales as indicated:
   - a 1: 250,000 (2 times)
   - b 1: 500,000 (5 times)
   - c 1: 800,000 (4 times)
4. A map with a scale of 1:25,000 is reduced to 1:75,000. How many times is the scale reduced?

Relief on Maps

- **Relief refers to the difference in altitude between the highest and lowest points in an area or surface structure of any part of the earth. It relates to land features like plains, hills, plateaus, valleys, ridges, etc.**
- **These relief features have three dimensions (length, breadth and height), but a map on which they are represented has only two dimensions, (length and breadth).**

Methods of Showing Relief on a Map

- **There has been various means of showing relief features on a map. These are: Physiographic diagrams, Hachures, Layer coloring, Hill shading, Form lines and Contour lines.**

Traditional Methods

- **A. Physiographic Diagrams: attempt show different kind of relief features three dimensionally(as they are observed really on the surface). It is simple and easily understandable.**
- **B. Hachures: Hachures are short disconnected lines that represent slopes. Basically, hachures show the steepness of slopes. When slopes are steep, hachures are put close together.**
- **C. Hill shading(oblique illumination): It is a method of showing relief on a map from an oblique position i.e. often from the northwestern corner of the landscape to be shown**

- **D. <u>Layer Coloring</u> (Layer Tinting): It is a method of showing relief by using colors. The series of colors for showing different altitudes starts from sea level.**

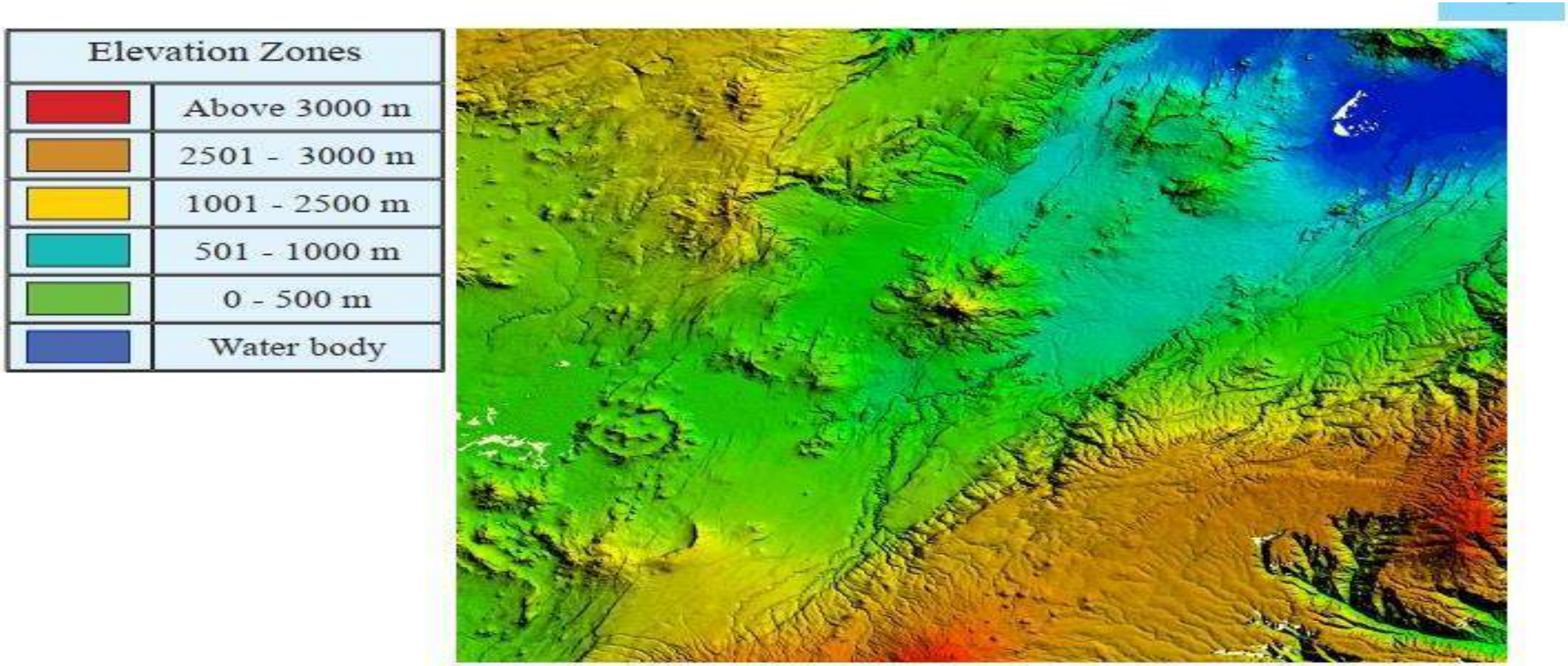


Figure 1.18: **Map with layer coloring**

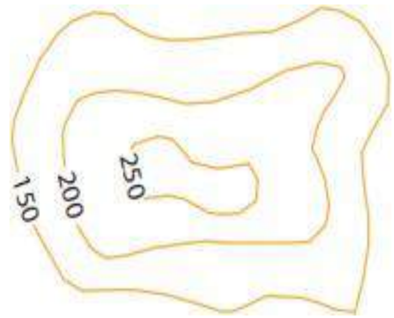
- **E. Formlines: A formline is imaginary pecked or broken line joining points with the same approximate height on a map.**
- **Usually they are drawn on topographic maps to show where survey work is incomplete or poorly accomplished. Also, these lines are useful for showing sea depths.**

Modern Methods

- **F. Contour Lines (Isohypses): are lines drawn on a map joining places of the same elevation above mean sea level. They give almost true altitudes. They also indicate different slopes and land forms.**
- **Contour lines are the most common and accurate way of showing relief on modern maps.**

Properties of Contour Lines

- Contour lines are imaginary lines used on a map to represent relief, i.e., contours do not really exist on the earth's surface. The only contour line that exists both on the map and in the field is the sea level.
- A set of contour lines is drawn at a fixed height interval. The difference in altitude between two successive contour lines is known as vertical interval (V. I.) or contour interval (C. I.). For example in Figure below, contour lines are drawn at 50-meter intervals.



- Contour lines cannot merge or cross one another on maps except at vertical cliffs, waterfalls or over hanging cliffs. For example, two or more contour lines run together and then separate to represent the cliff shown in the figure below

Figure 1.20: **Contour lines showing a cliff**

- The cliff in the preceding diagram is a vertical mountain wall. The crossing of contours occurs only in the case of an overhanging cliff. Usually contours representing a cave under an overhanging cliff are shown with pecked lines.

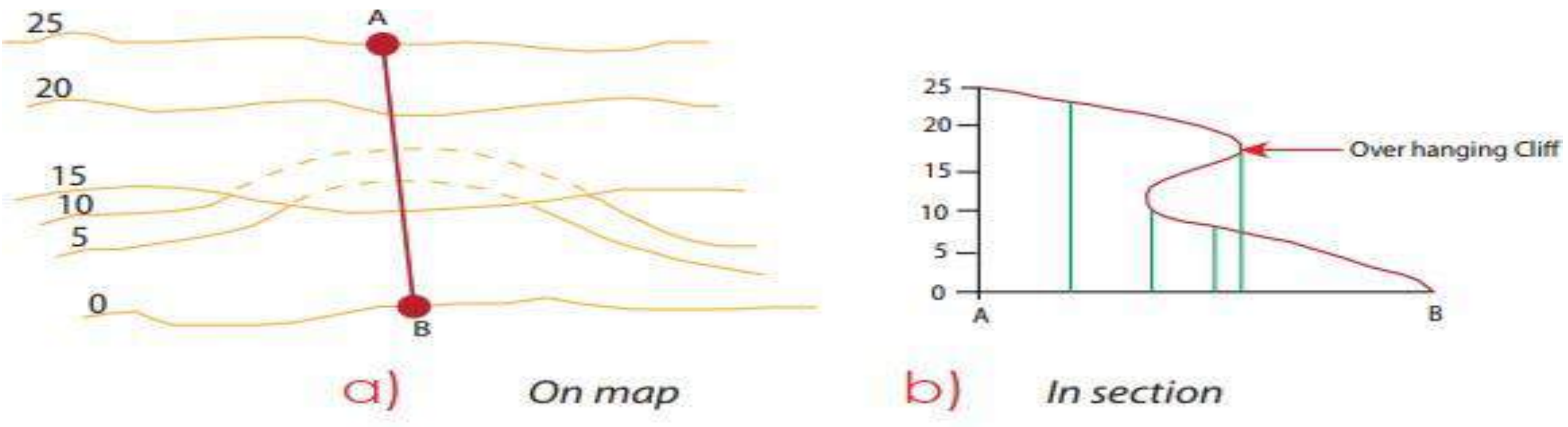


Figure 1.21: An overhanging cliff

- **Contour lines never branch. If you see branching lines on a map, they represent features such as rivers, roads, boundaries, etc.**
- **A contour line joins all points of the same altitude. For example, an altitude of 250 m will be on the 250 m contour line.**

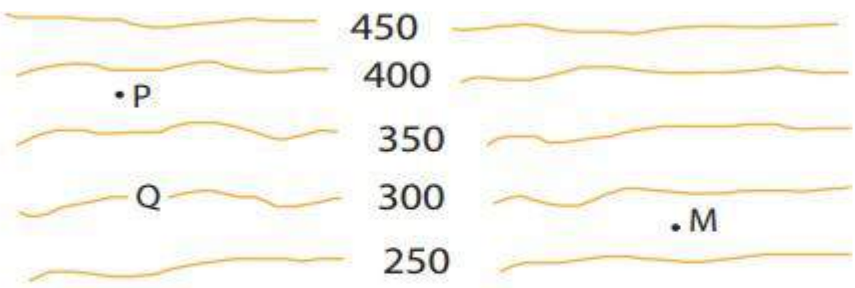


Figure 1.22: **Heights shown by contour lines**

- **Contour lines are always numbered in the direction towards which altitude increases. These numbers can be shown with or without breaking contour lines (see Figure 1.23).**

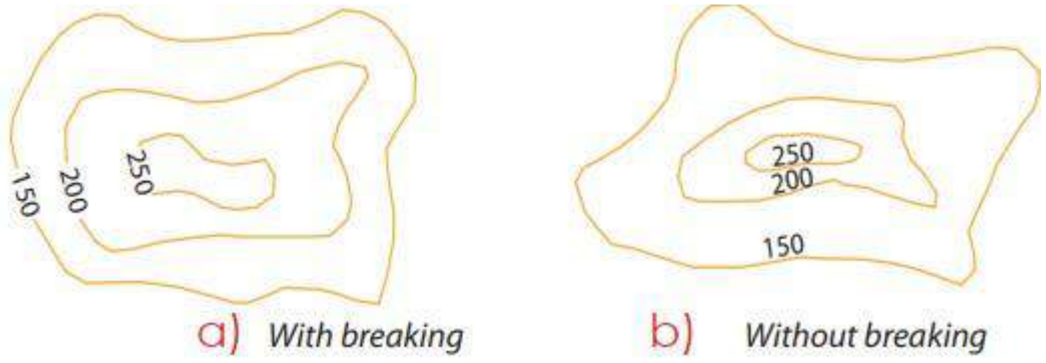


Figure 1.23: **Numbering of contours**

- **Contour lines indicate the nature of slopes. When contour lines are far apart, they show gentle slopes. But when contour lines are close together, they show steep slopes.**

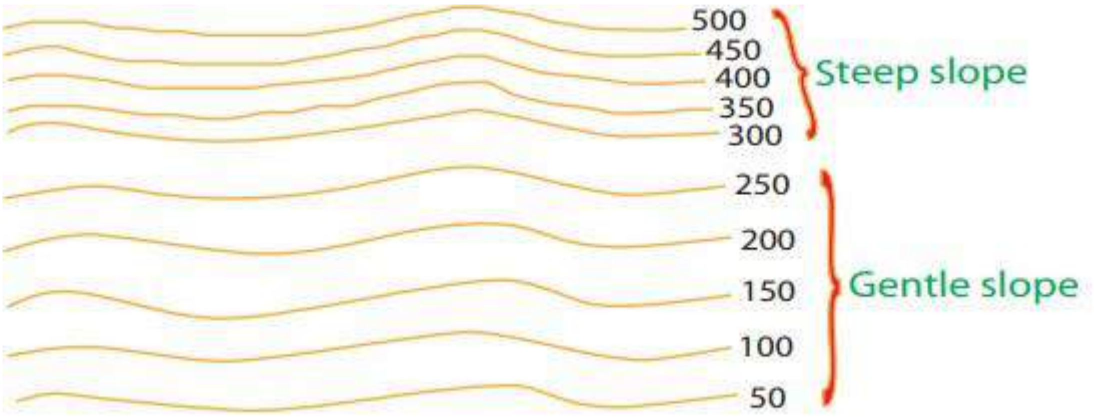


Figure 1.24: Contour-line spacing indicating slope steepness

- **Contour lines can be printed with different thicknesses on a map.**

- **In order to make the reading of contour maps easier, every fifth or tenth contour line is printed thicker than the rest. Such contour lines are called index contour lines, while the rest are called regular contour lines.**

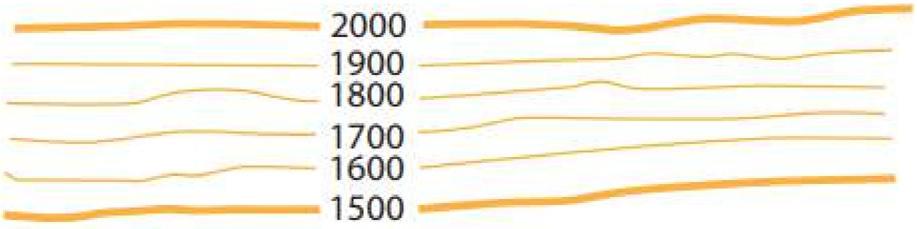
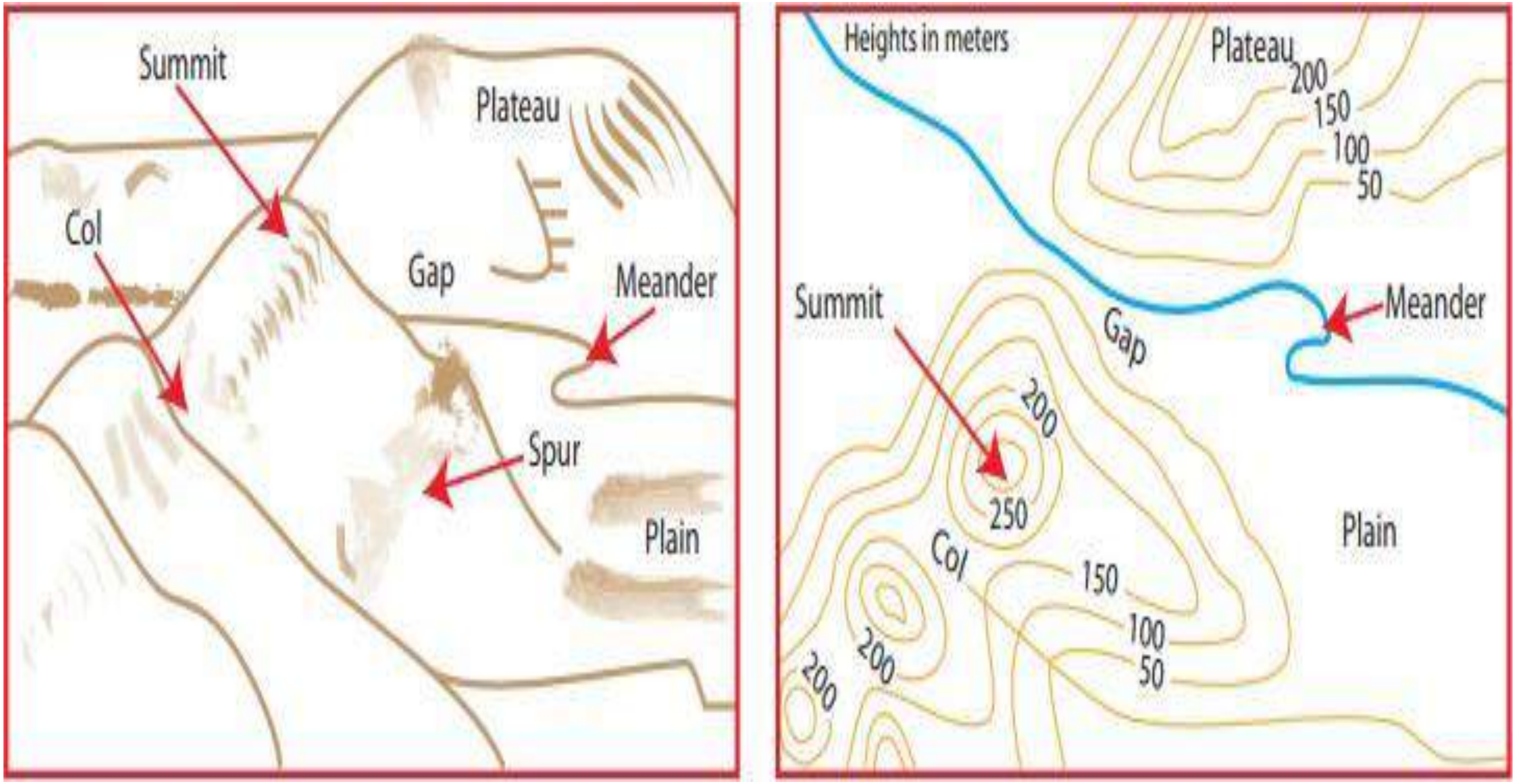


Figure 1.25: Contour lines with a difference in thickness

- **Contour lines can show different types of landforms, such as mountains, hills, plateaus, depressions, valleys, spurs, ridges, gorges, passes, plains, etc. Many of these relief features are readily recognized from the shapes of their contour lines.**


Summit
Plateau
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Meander
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Heights in meters
Plateau
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50
Summit
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150
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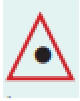
200
200
Plain

- **G. Different Methods of Showing Altitudes on Contour Maps**: Contour lines show altitude and relief on modern maps. However, they do not show the specific heights of individual features such as mountain peaks, hilltops, valley floors, towers, towns, roads or railways. Such heights are indicated on maps, using the following methods:

- **Spot heights**: They are marked on the map with a dot followed by an altitude number: **Example**: • 1940 meter
- They provide accurate altitudes for individual points, such as those along a road, on a mountain top, or between contour lines. They exist only on maps.

❖ Trigonometrical points: They exist both on maps and in the field.

- ✓ On the ground, the relevant feature is permanently marked with a pillar (concrete).
- ✓ On maps, they are shown with a small triangle enclosing a dot, followed by the exact altitude in meters

➢ Example: The top of Mt. Ras Dashen can be shown as .  4620 meters on a topographic map.

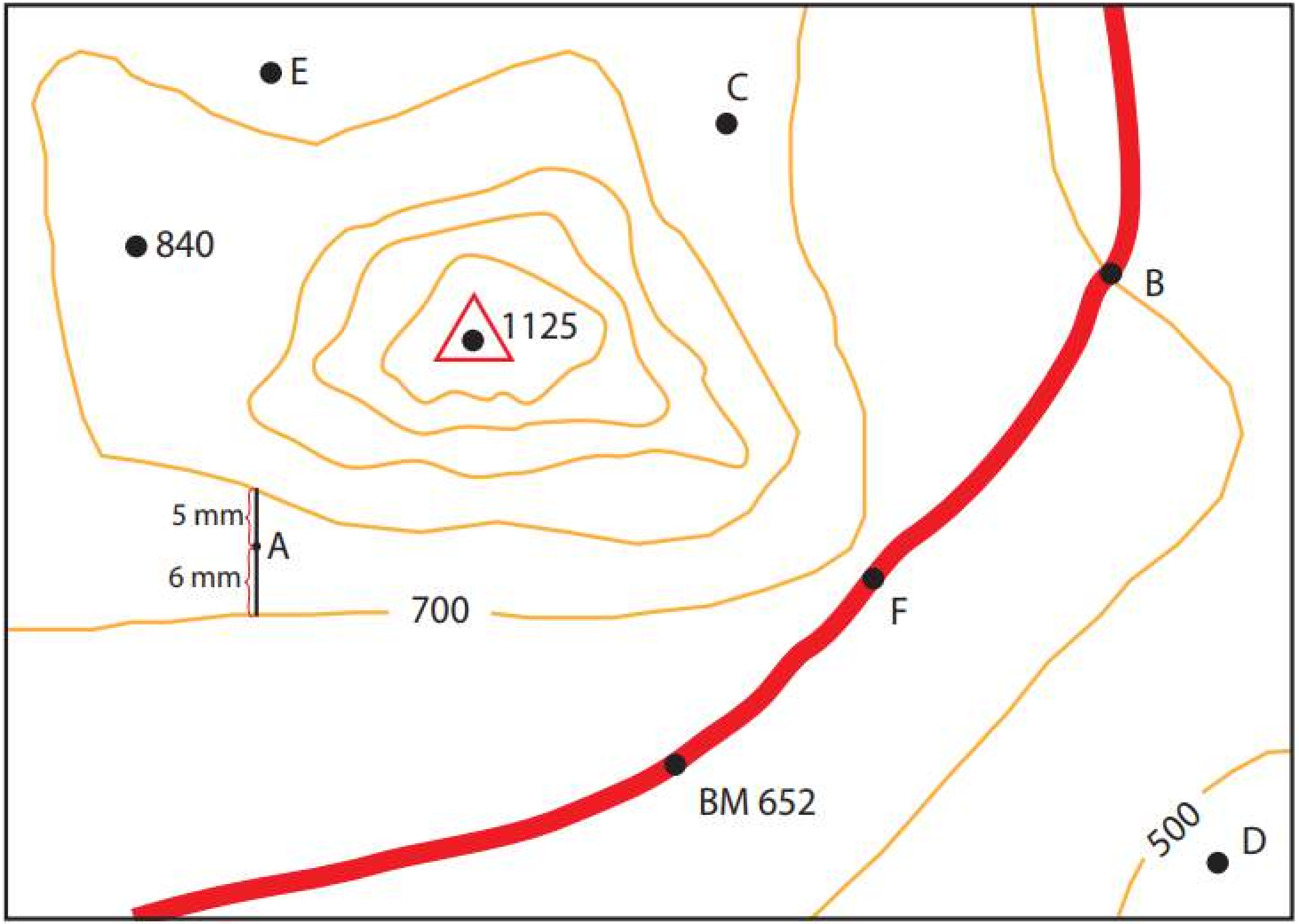
❖ Benchmarks: They indicate precise heights along highways or railways. Example: 

- **Calculating Altitude:** When the altitude of a point on a contour map is not shown by any of the above methods, it can be obtained by measurement and calculation, using the **interpolation method**.
- This can be done only if the given point is located between two contour lines

$$\text{Altitude}(A) = LC + \left(\frac{d_1 \times VI}{D}\right) \quad \text{or} \quad HC - \left(\frac{d_2 \times VI}{D}\right)$$

- **Where:** d1 is distance of point A from the lower contour,
  - ✓ d2 is distance of point A from the upper contour,
  - ✓ D is distance between the upper and lower contours,
  - ✓ VI is vertical interval,
  - ✓ LC is the lower contour and,
  - ✓ HC is the higher contour.

❖Find the altitude of point A in Figure 1.28



❖

Figure 1.28: **Altitudes shown on a contour map in different ways** Scale 1:50, 000

Procedures

- **Draw the shortest possible straight line that passes through point (A) and join the two contour lines adjacent to it.**
- **Measure the length of this line: = 11 mm.**
- **Measure the distance on the map between the lower and upper contours up to point (A). They are 6 mm and 5 mm respectively.**
- **Find the vertical interval between the two contour lines: = 100 m.**
- **Then determine the altitude of the point using the following formula:**

$$\text{Altitude(A)} = \text{LC} + \left(\frac{d1 \times VI}{D}\right) \text{ or HC} - \left(\frac{d2 \times VI}{D}\right)$$

$$= 700\text{m} + \left(\frac{6 \times 100}{11}\right) \text{ or } 800\text{m} - \left(\frac{5 \times 100}{11}\right)$$

$$= 700\text{m} + 54.54 \quad \text{or } 800\text{m} - 45.45$$

$$= 754.5\text{ m} \quad \text{or} \quad = 754.5\text{m}$$

Slopes and Gradients

A. Slopes on Contour Maps

- Slope is the upward or downward inclination of a natural or artificial surface. It is a deviation of the surface from the horizontal.
- On a map, steepness of a slope depends on:
  - ✓The distance between the contours drawn on the map. The closer the contours are, the steeper is the slope representation and vice versa .
  - ✓The vertical interval (V.I.) between two successive contours. The bigger the V.I, the steeper is the slope representation and vice versa.

Types of Slopes

➢ **There are different types of slopes, which include:**

❖ **Even slope: An even slope has a constant gradient from the bottom to the top. On a map of an even slope, the contour lines are evenly spaced throughout.**

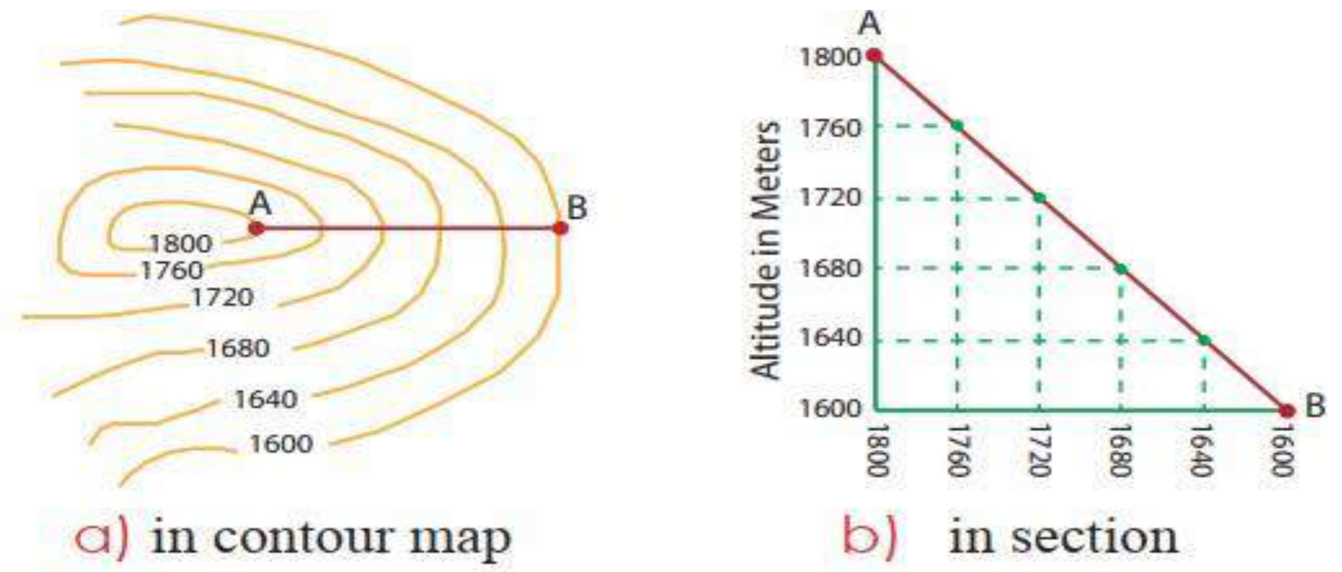


Figure 1.29: Even slope

❖ **Concave Slope: In a concave slope; the contour lines are widely spaced at the base and are close together at the top. In other words, a concave slope has a steep gradient at the top. The gradient becomes gentler towards the bottom.**

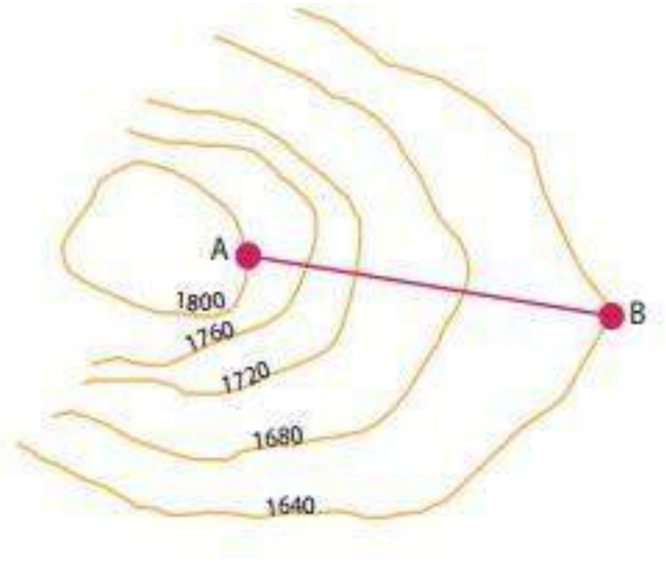
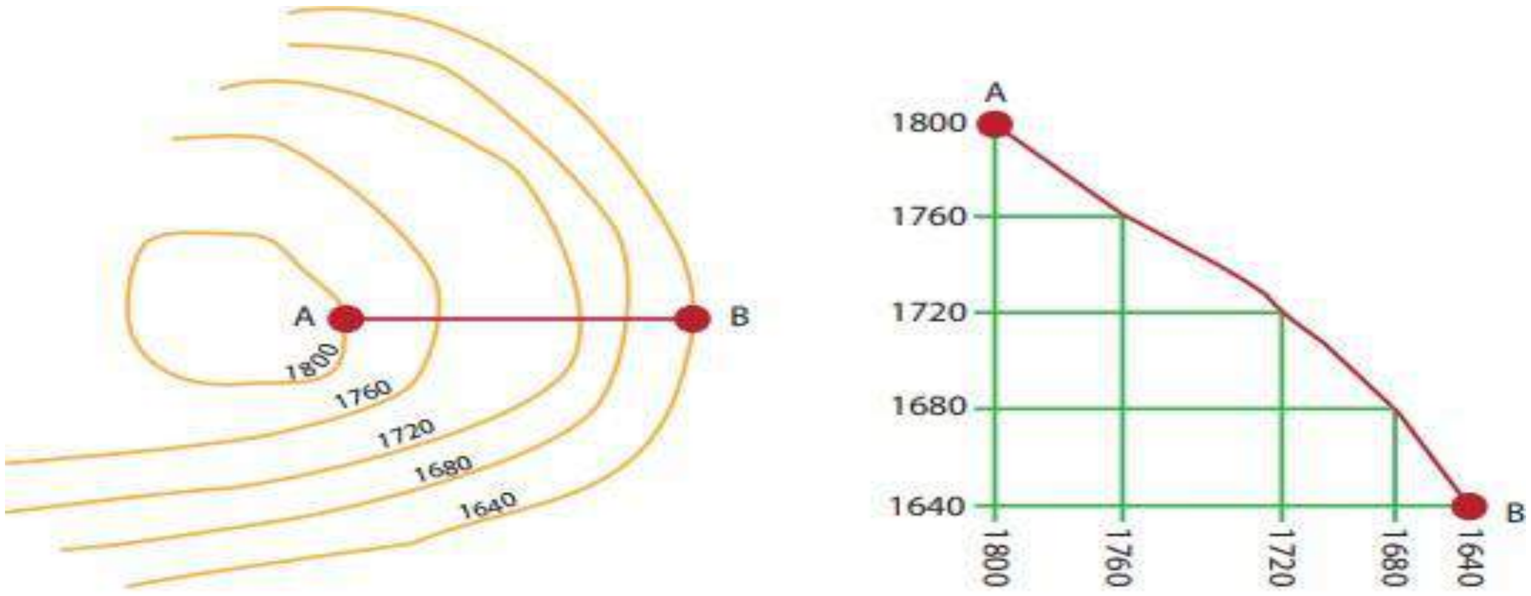


Figure 1.30: **Concave slope**

❖**Convex Slope**: **In a convex slope, the contour lines are close together at the base and widely spaced at the top. The slope has a steep gradient at the bottom that becomes gentler towards the top.**



a) in contour map

b) in section

Figure 1.31: **Convex slope**

❖ **Terraced or Stepped Slope: In a terraced or stepped slope, the contour lines are alternatively close together and far apart in a regular pattern. This means the gradient changes several times between the bottom and the top of the slope.**

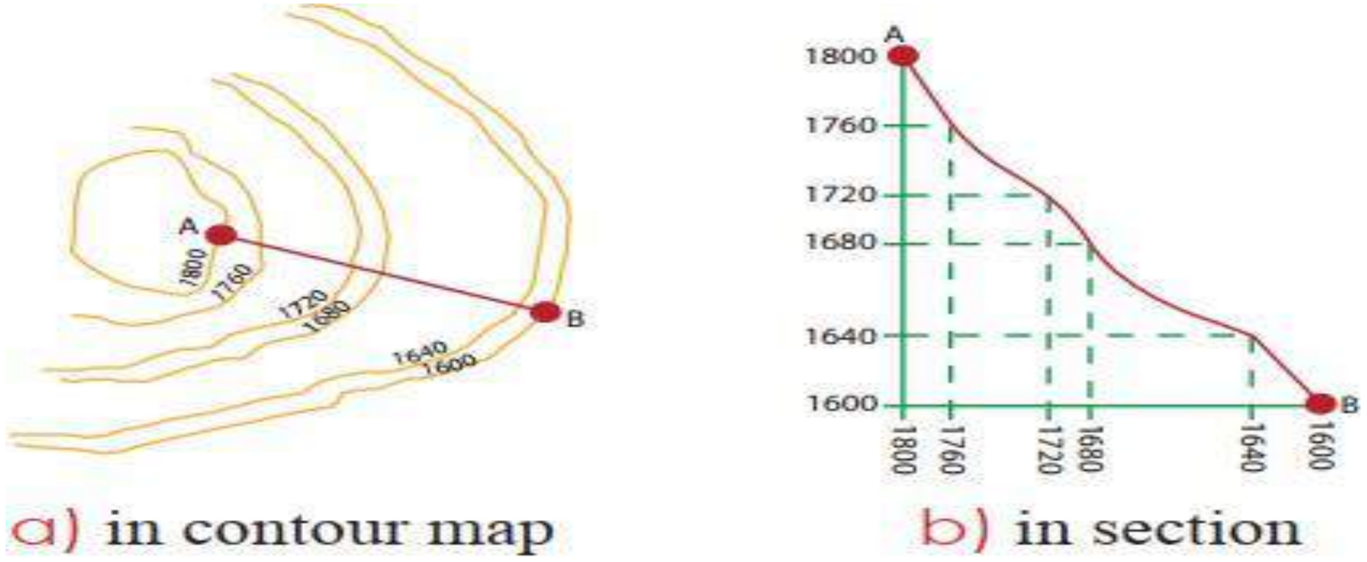


Figure 1.32: Terraced slope

❖**Escarpment: An escarpment is the steep slope of a plateau, especially one where the plateau ends and the lowland starts. The steep slope is called the scarp slope. The gentler slope is called the dip slope.**

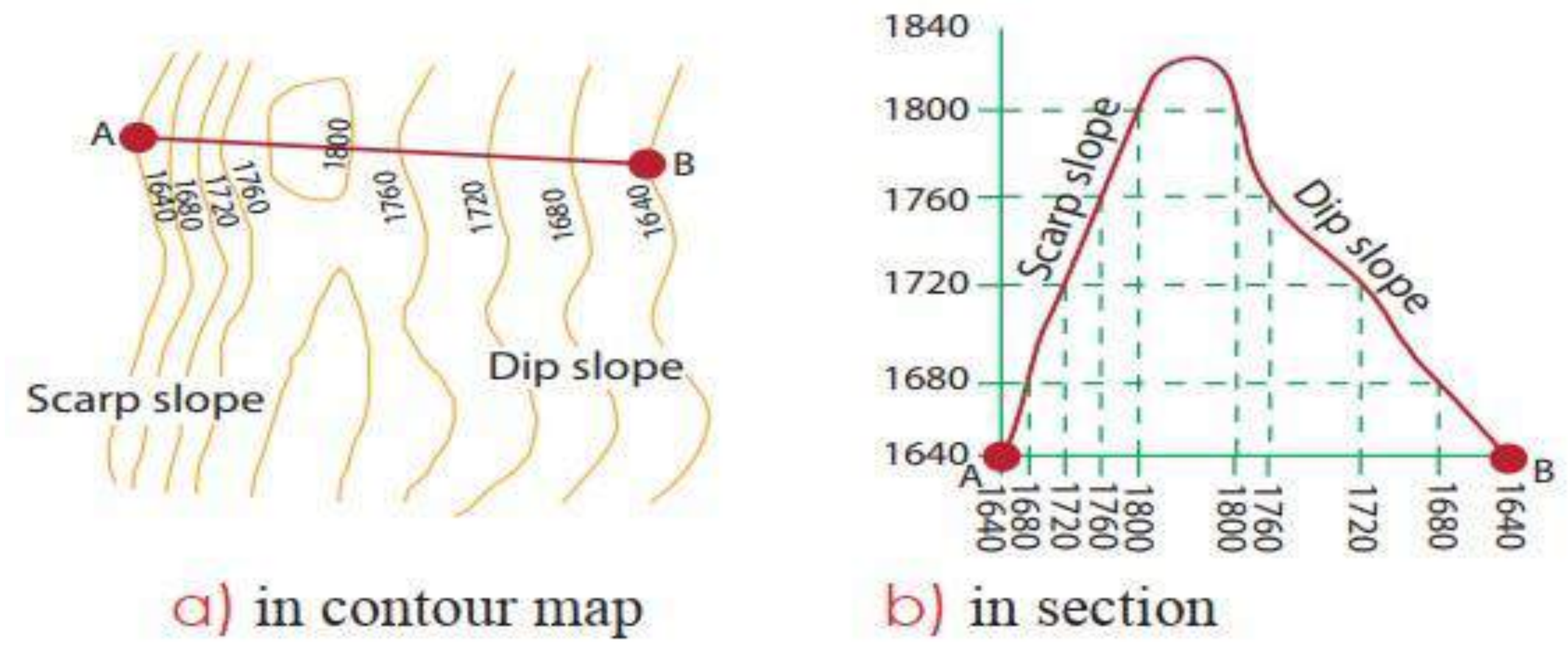


Figure 1.33: **Dip and scarp slopes**

B. Gradient on Contour Map

- **Gradient (GR) is the degree or rate of change of slope or elevation between two points.**
- **Gradient can be expressed in terms of ratio, percentage and degree. It is the rate at which one has travel horizontally in order to climb up a given height vertically.**
- **It is calculated using altitude difference (vertical distance) and map distance (horizontal distance) between two points.**

$$\text{Gradient in ratio} = \frac{\text{AD between the given points}}{\text{MD between the same points}}$$

$$\text{Gradient in percentage} = \frac{AD}{MD} \times 100$$

$$\text{Gradient in ratio} = \frac{\text{AD}}{\text{MD}} \times 60^0$$

- **Example: The distance on the map between Addis Ababa and Adama is about 10 cm with the scale of 1: 1,000,000 on a certain map of Ethiopia . The average elevations of the two are about 2400 and 1700 meters, respectively. Determine the gradient in ratio, in percent and in degree.**

procedures

- ✓ **Find the difference in altitude between Addis Ababa and Adama. i.e., 2400m – 1700m =** $700m \ or \ 0.7km$

- ✓ Convert the map distance between Addis Ababa and Adama in to ground distance with the help of the given map scale.

$$\text{Ground distance} = \frac{\text{MD} \times \text{Scale}}{100{,}000} = \frac{10 \times 1{,}000{,}000}{100{,}000} = 100\text{km}$$

- ✓ Calculate the gradient between Addis Ababa and Adama.

$$\text{Gr. In ratio} = \frac{AD}{MD} = \frac{0.7KM}{100KM} = \frac{1}{143} \text{ or } 1{:}143$$

- **Find the gradient between Aand F on the Figure 1.34.**

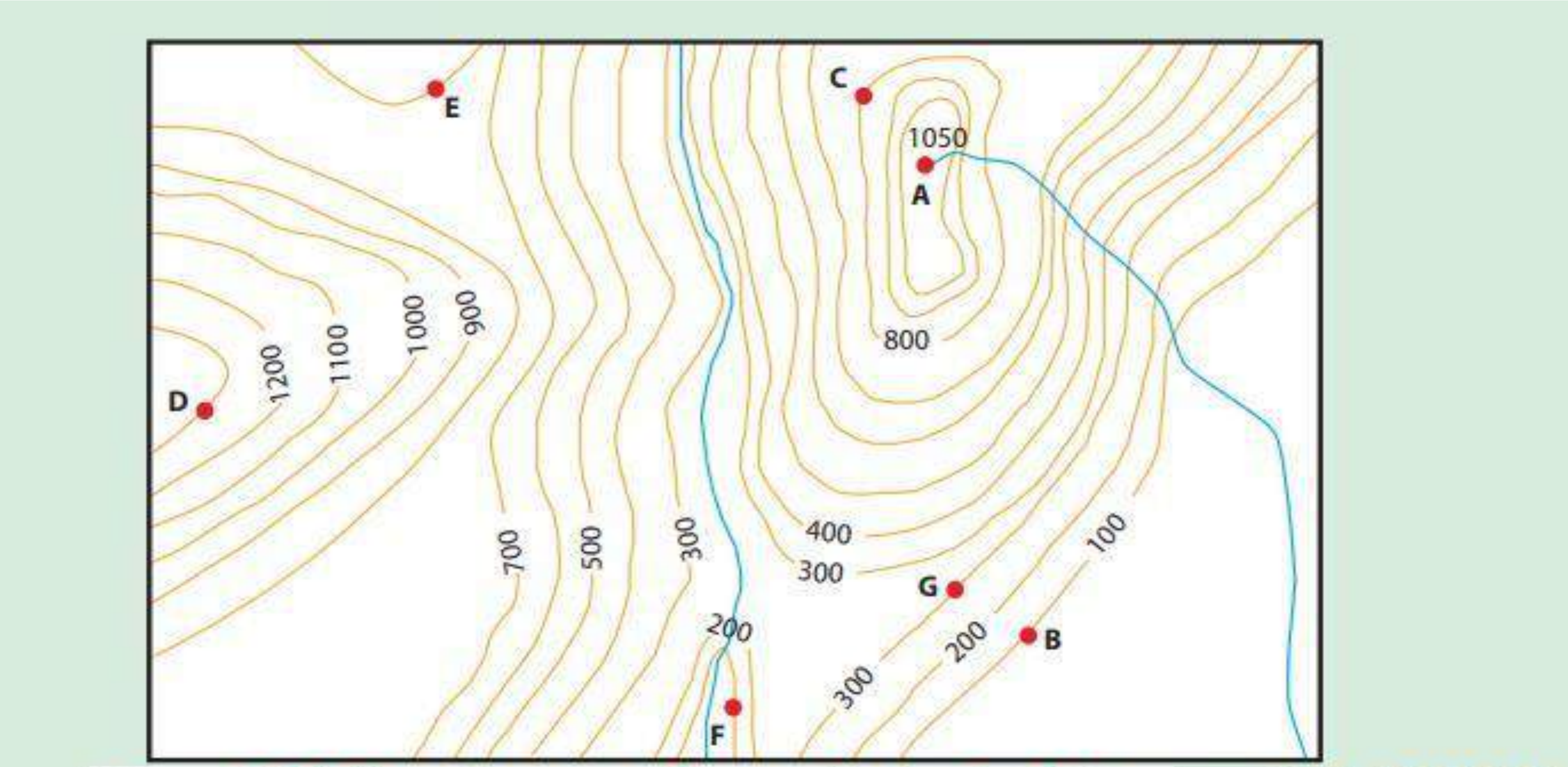


Figure 1.34: **A contour map for gradient calculation** Scale 1:50,000

Procedure

- ✓ **Find the difference in altitude between A and F.**

  1050m – 100m = 950m = 0.95km

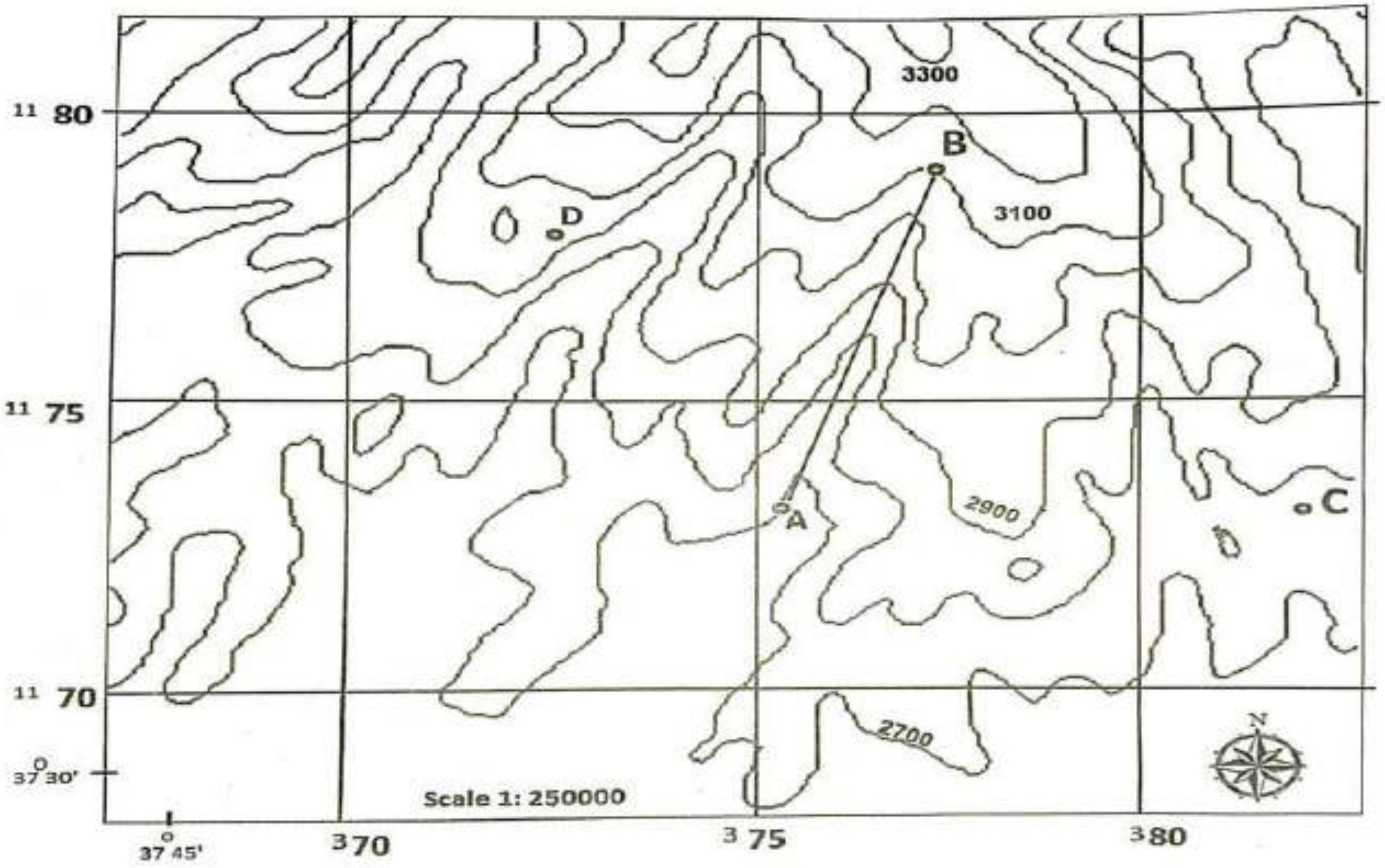
- ✓ **Measure the distance on the map between A and F by using ruler and convert map distance in to ground distance with the help of the given map scale. Assume MD= 5.5cm.**

$$\text{Ground distance} = \frac{MD \times Scale}{100{,}000} = \frac{5.5\ X\ 50{,}000}{100{,}000} = 2.75\text{km}$$

- ✓ **Calculate the gradient between A and F by using the following formula.**

$$\text{Gr. In ratio} = \frac{AD}{MD} = \frac{0.95km}{2.75} = \frac{1}{2.9} \text{ or } 1{:}\ 2.9$$

Based on the map given below answer the following questions



1. **What is the sex digit grid reference for point D on the map?**

   A. 755805 B. 755705 C. 805705 D. 705755

1. **The type of slope from point ‘A’ to point ‘B’ is**

   A. Even slope C. Concave slope

   B. Convex slope D. Straight slope

1. **The altitudinal difference between points ‘A’ and ‘B’ is**

   A. 300m B. 400m C. 100m D. 200m

1. **What is the correct statement scale of the map?**

   A. 1cm to 2.5km C. 1cm to 250km

   B. 1cm to 25km D. 1cm to 12.5km

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1. **What is the direction of point ‘A’ from point ‘C’?**

   A. 90^0E B. 180^0S C. 270^0E D. 90^0N

1. **The gradient between point ‘A’ and point ‘B’ is (if the MD between the two point is 5cm).**

   A. 1: 20 B. 1:31 C. 1: 41 D. 1:51

1. **If you want enlarge the above scale of the map two times, the new scale will be**

   A. 1:75,000 C. 1:500,000

   B. 1:125,000 D. 1:400,000