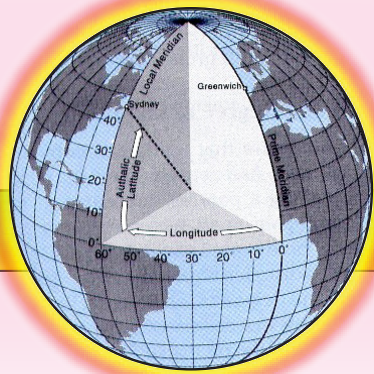
Unit 1



MAP READING

Unit Outcome

After completing this unit, you will be able to:

- Develop the skill of identifying direction;
- Measure distances on a map;
- Practice map enlargement and reduction;
- Acquire basic skills of locating places and objects on maps using different methods;
- Understand the different ways of representing relief on maps.

Main Contents

INTRODUCTION

Maps are graphical representations of the earth's surface. They give a bird's eye-view of features of the earth's surface. As you learned in Grade 9, they are used for many purposes, and are especially effective devices for recording and communicating information about our environment. This unit focuses on maps that present physical features of the world. You will learn how to read maps that

- *Show where places and things are located*
- *Indicate heights and depths of features on the earth*

What do we need to know in order to use maps?

To use maps effectively, you must be able to read them easily. In other words, you must be map-'literate.' This unit will teach you many skills you need to read maps.

For example, you will learn how to use the following information that maps present:

- *Location*
- *Distance and direction between locations*
- *Relief (elevation), which indicates the third dimension on a two-dimensional plane*

As you learn to read maps, you will also learn more about *scale*. As you learned in Grade 9, scale is the ratio between distance or area on a map and the corresponding measurements on the surface of the earth.

You will also learn how to reduce and enlarge maps accurately.

1.1 DIRECTION ON MAPS

At the end of this section, you will be able to:

- Acquire the skill of finding direction on a map;
- Show direction of a given place on a map by means of compass direction and bearings;
- Explain the use of magnetic compass;
- Practice, how to find direction and bearings of points on maps.

Key Terms

- Cardinal points
- Bearing
- True north
- Grid north
- Intermidate direction
- Land mark

1.1.1 Identification of Direction

How do we identify direction? Do you know places in your locality that got their names from winds? Do you know some local expressions related to direction?

The science of direction goes back to human's earliest observations of nature, especially stars and winds. For example, imagine an Ethiopian farmer of those days waiting for a wind to blow off the fine chaff of grains during harvesting. The farmer looked in the direction from which he or she hoped the wind would come. When the wind came, the farmer gratefully named it after its source, like 'ye Dega Nefas', 'ye Kola Nefas' etc.

Sometimes place names are associated with winds. For example the provincial capital city of Gayent in southern Gonder is known as 'Nefas Mewicha' or Source of Wind.

Landmarks are important aids to people who are travelling in a new environment. A landmark is an object that is easily seen from a distance. We use landmarks to help us remember where things are, and we try to remember their appearance and locations in order to avoid getting lost.

When we travel in familiar surroundings, we often relate to landmarks without being aware that we are doing so. But when we are in a new or not well- known area, we make a conscious effort to notice them. We might also use tools such as maps and compasses to help us find our way around.

Many of us are familiar with the four *cardinal* points of the compass–North, East, South and West. There are *thirty-two* points of the compass, but only sixteen are used to describe direction. The points midway between the cardinal points are known as North-East (NE), South-East (SE), etc. The others, North-North-East (NNE), East-North-East (ENE), etc. relate to further sub-divisions.

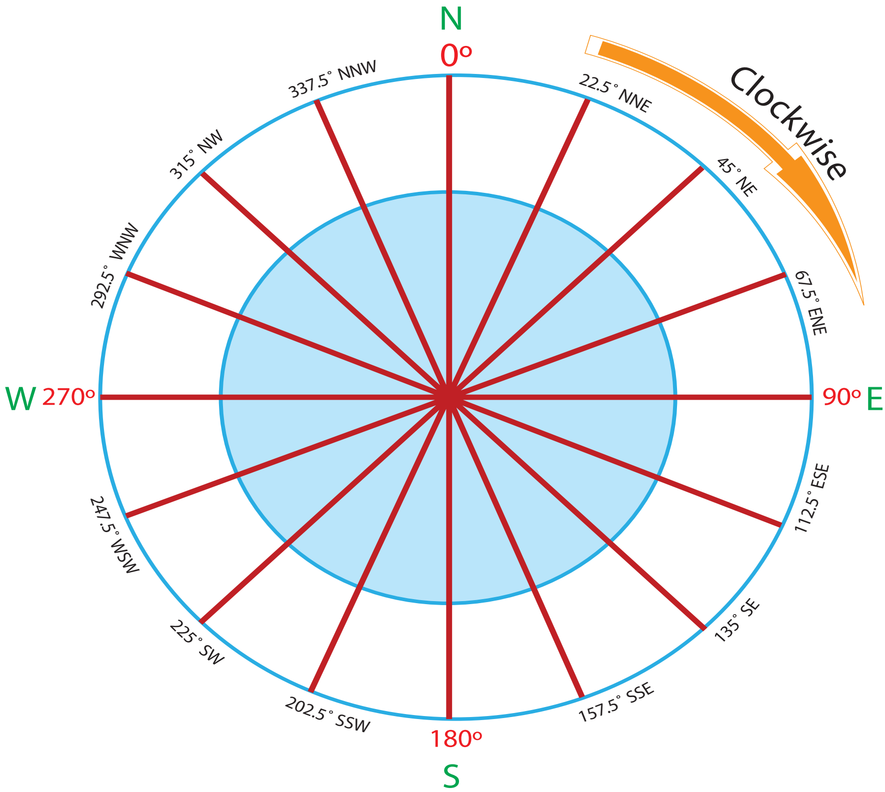


Figure 1.1: **Compass Points**

Compasses are marked with degrees as well as with the direction points we described earlier. As shown in Figure 1.1, the degrees start at the north from 0°, and increase in the clockwise direction. The direction points coincide with degree points. For example, 0° coincides with N, and 180° coincides with S. You can express direction more precisely in degrees than in direction points.

Activity 1.1

1. Draw a figure that shows comapss points and bearings respectively?
2. Identify the four cardinal points?
3. What is a landmark?
4. How many points do we have on a compass?
5. Which points of the compass coincide with 0°, 180°, 225° and 315°?

1.1.2 Measurement of Direction and Bearing

How do we measure direction and bearing?

In order to determine directions from one place to another out in the field or on a map, we must first select or identify one direction from which we can identify and measure other directions. This basic direction we call the cardinal direction.

The cardinal direction could be anyone but at present, internationally, we use North as the cardinal direction and measure all other bearings from this one.

When printing a map we usually arrange the cardinal direction so that it points to the top of the map. Before doing any measurements of directions, make sure that you know where true north is.

Directions from one point to another or the bearing of one point from another can be given using two different sets of units. The traditional system uses the cardinal compass points north, east, south, west and subdivisions of them. A modern, and more accurate, method gives the directions in degrees and fractions of degrees clockwise from north. The relationship between the two ways of giving directions is shown in Figure 1.1.

Figure 1.2 shows you how to determine directions and bearings on maps.

The procedure involves the following steps.

Example:

To find the direction from point A to point B on the map Figure 1.2.

1. Draw a line with a pencil joining points A and B on the map.
2. Through the point from which the bearing is required draw a pencil line parallel to true north as indicated by the meridians or the arrow indicating true north.
3. Using these two lines, set your protractor so that its centre is in point A and measure the angle between the true north line and the line A - B reading clock wise from north = 0^o.
4. State the bearing either in compass directions or degrees clockwise from north.

Answer:

i The direction from A to B is 135° or point B bears 135° from A.

ii Point B is roughly South East of A or point B bears South East from A.

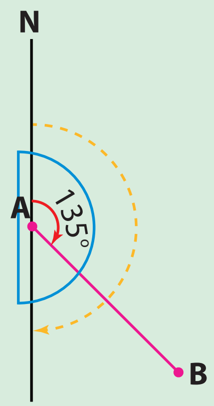


Figure 1.2: **The Measurement of directions**

The direction of a line from one point to another can be given in terms of compass direction. In Figure 1.3, for example, B lies north-east of A, and conversely A lies south-west of B.

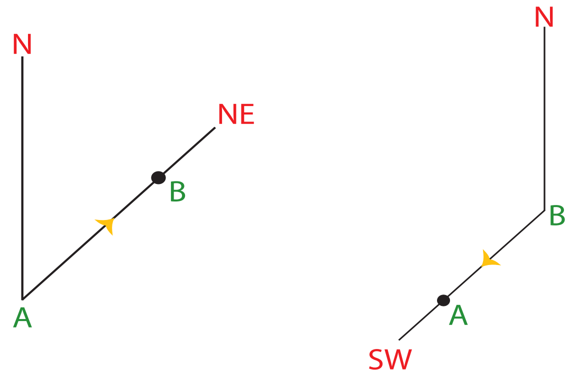


Figure 1.3: **Compass directions**

We may also describe wind direction in terms of compass direction. Look at Figure 1.4. B lies north-east of A. Therefore a wind blowing from B to A is called a north-east wind. Note carefully that wind direction is named after the direction from which the wind blows.

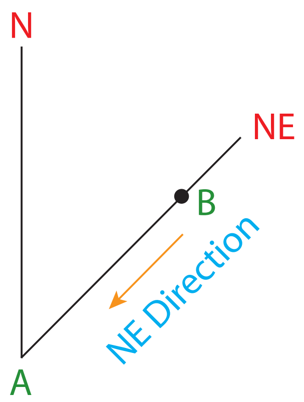


Figure 1.4: **Wind directions**

A direction indicated in degrees is called a **bearing**. The bearing of an object refers to its direction and a *clockwise* measurement in degrees from the zero line (0° or N), which is the north direction.

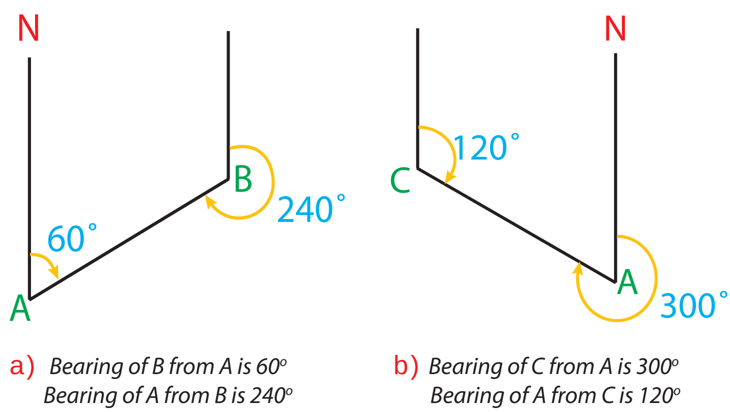


Figure 1.5: **Forward and back bearings**

In Figure 1.5, the bearing of B from A is 60°, which is angle NAB. The bearing of C from A is 300°, which is reflex angle NAC. Note that the bearing of C from A is not the smaller acute angle NAC, since bearings are always measured clockwise from north.

The directions of A from B and from C, respectively, are called back bearings. A back bearing is obtained by adding or subtracting 180° to or from a forward bearing.

Focus

1. If a forward bearing is less than 180°, add 180° to obtain the back bearing.
2. If a forward bearing is more than 180°, subtract 180° to obtain the back bearing.

Activity 1.2

Part I

Take an ordinary compass and try to obtain the bearing of an object in your school compound that is some distance away from you.

Hold the compass horizontally and face in the direction of the object. Turn the compass case gently until N (north) on the card lies under the north end of the needle. Now read the bearing of the object.

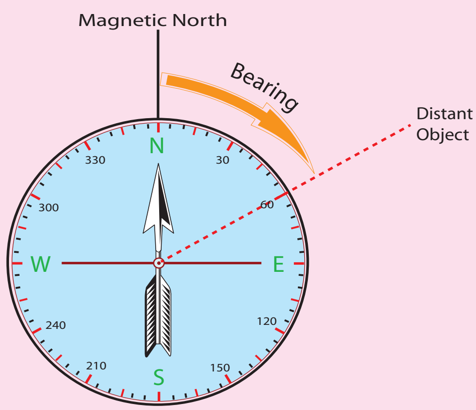


Figure 1.6: **Taking a bearing with an ordinary compass**

Part II

1. From where do we start measuring directions?
2. What would be the direction of wind blowing from A to B in Figure 1.3.
3. Which point of the compass is opposite in direction to each of the following?

   E NW SSW ESE

4. What compass points do these bearings indicate?

   a 135° d 67.5°

   b 315° e 292.5°

   c 112.5°

1.2 POSITION ON MAPS

At the end of this section, you will be able to:

- Define what the geographic grid system means;
- Demonstrate the position of a given place by means of geographic grid system;
- Define what the national grid system means;
- Show the position of places on maps by using national grid reference (four and six digit grid reference);
- Demonstrate the national grid origin of Ethiopia;
- Enlarge and reduce maps using a square or pantograph method;
- Compute the scale of enlarged or reduced map.

Key Terms

- Latitude
- Longitude
- Equator
- Meridians
- Parallels
- Grid origin
- Easting
- Northing
- Prime meridian
- Grid

How do we know the exact position of a place on the earth's surface?

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)*

1.2.1 Position by the Geographic Grid

Why do we prefer to use geographic grid system to locate the position of a place on a map?

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.

If you study a globe carefully you will find that two sets of lines form a network on the surface of it. One set of lines run from the North pole to the South pole. These lines are known as *Merdians*.

The other set of lines are running around the globe parallel to the equator. They are known as *parallels*.

Using this grid we can now give the accurate position of any place on the earth's surface. The parallels give the position in degrees, minutes and seconds north or south of the equator. This is the Latitude of the place. The other set of lines, the meridians, give the position of the point in degrees, minutes and seconds to the east or west of the zero degree meridian. This is the longitude of the place.

Focus

On the huge earth-globe, a net of lines only 1° apart would be far too open a mesh (the spaces of a certain size in a network) for particular use. Some spaces would be as large as 100 kilometers each way. And in navigation the position of an airplane must be precise to the fraction of kilometers.

For that reason the degree is divided by 60. Each of these 60^{th}s is a minute. (symbol:'). Not a clock-minute: "minute" also means "little". Even this little is not small enough for scientific locating. We must divide the degree a second time, and each of these divisions is a second. (Symbol:") A second is a 60^{th} of a minute. That makes a network of so small a mesh with which to cover the earth that no place can slip through.

Study the following diagram in Figure 1.7

Latitude: The latitude of point p on the surface of the earth is equal to the angle between the radius through the point and equatorial plane. (i.e., the plane limited by the equator.)

Longitude: The longitude of point p on the surface of the earth is equal to the angle between the radius through the point and the 0° and 180° plane. (i.e., the plane limited by the zero meridian and the 180° meridian.)

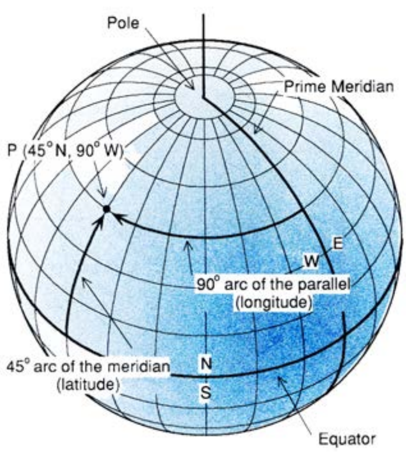


Figure 1.7: **The Complete Geographic Grid**

Therefore, the geographic grid of point P is 45°N, 90°W

Latitude and longitude sometimes are confused with two other terms: *parallel* and *Meridian*.

Parallel: an imaginary *line* joining all points with the same latitude.

Meridian: An imaginary *line* joining all points with the same longitude.

Note that the first set of terms (latitude and longitude) deal with angles the second set (Parallel and Meridians) with lines.

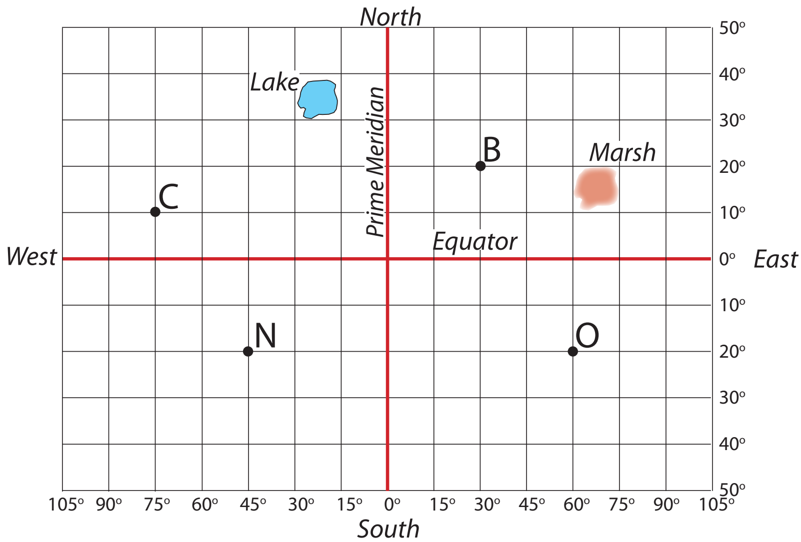


Figure 1.8: **Geographic Grid**

How do we locate the position of a place on a map?

Example 1:

Find the geographic grid of point B on Figure 1.8. Follow the following steps

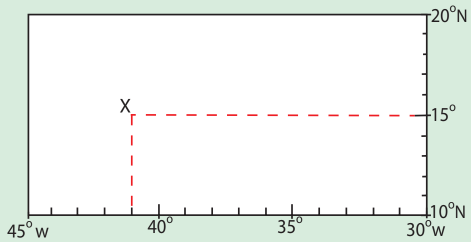
1. Identify whether point B is North or South of Equator.
2. Read the latitudes of B, North of the equator i.e., 20°N.
3. Read the longitude of B, East of the prime meridian i.e., 30°E.
4. The complete geographic grid of point B is 20°N 30°E.

Example 2:

Find the geographic grid of point X, A and Y on Figure 1.8. In order to find the locations of X, A and Y, you have to follow the following procedures:

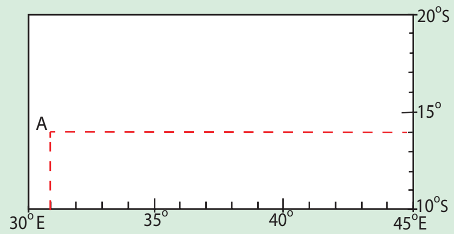
- *From Figure 1.8 identify the quadrants (boxes) where X, A and Y are found and divide the vertical and horizontal lines into 10 and 15 equal parts respectively with an interval of 1° (for X and Y points), and 1' for point Y.*
- *Identify whether X, A and Y are North or South of the equator.*
- *From point X, A and Y draw the perpendicular (using broken lines) to the two borders of the quadrants.*
- *Finally read the latitude and longitude from the vertical and horizontal borders accordingly.*

Points X (found North of the equator)



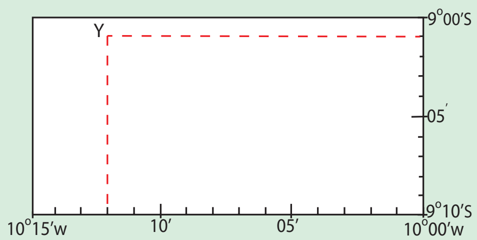
The location of point X is 15°N 41° W

Point A (found South of the equator)



The location of point A is 14°S 31° E

Point Y (found South of the equator)



The location of point Y is 9°01'S 10°12'W

Example 3:

Find the geographic grid of the Marsh area on Figure 1.8. Follow the following steps.

1. Identify whether the Marsh area is North or South of Equator.
2. Read the latitudinal extent of the Marsh area, North of the equator i.e. 10°N - 20°N.
3. Read the longitudinal extent of the Marsh area, East of the prime Meridian i.e., 60°E - 70°E.
4. The complete grid of the Marsh area is 10°N - 20°N and 60°E - 70°E.

Activity 1.3

1. Use a world map or atlas and identify places that are in the following positions:
   a. 9° 2'N 38°42'E
   b. 31° 47'N 35°10'E
   c. 40° 45'N 74°0'W
   d. 13° 15'N, 38°27'E
2. Based on Figure 1.9 find the geographic grid of the following points.
   a. O
   b. N
   c. C
   d. Lake

1.2.2 National Grid Reference System

What is a National Grid system? How can a national grid system help us to identify the position of a place on a map?

A National *grid* is a network of horizontal and vertical lines printed on the face of a map. The network of grid lines border squares. These squares may be divided into smaller and smaller squares.

The size of a map's grid squares depends on the scale of the map. For example, the sides of the squares on a large-scale or medium-scale national or regional topographic map might represent 100 km, 10 km or 1 km. Each line is given a number. This numbering begins at a particular point. This point is the south-western corner of the whole grid for the country and it is called the grid origin or the National grid origin.

- *The grid origin of Ethiopia lies in south-west most corner, is at the point in SW Kenya where the 34°30'E meridian crosses the equator (0°). (See Figure 1.9).*
- *Such a grid system provides the position of any point, in kilometers and fractions of kilometers east and north of the grid origin.*
- *From the origin, all vertical lines are numbered eastwards. They are called eastings.*
- *All horizontal lines are numbered northwards. They are called northings.*
- *In contrast to meridians, eastings (verticals) do not indicate true north.*

Focus

The grid origin of Ethiopia is located at a point where the 34°30'E meridian and the equator cross each other.

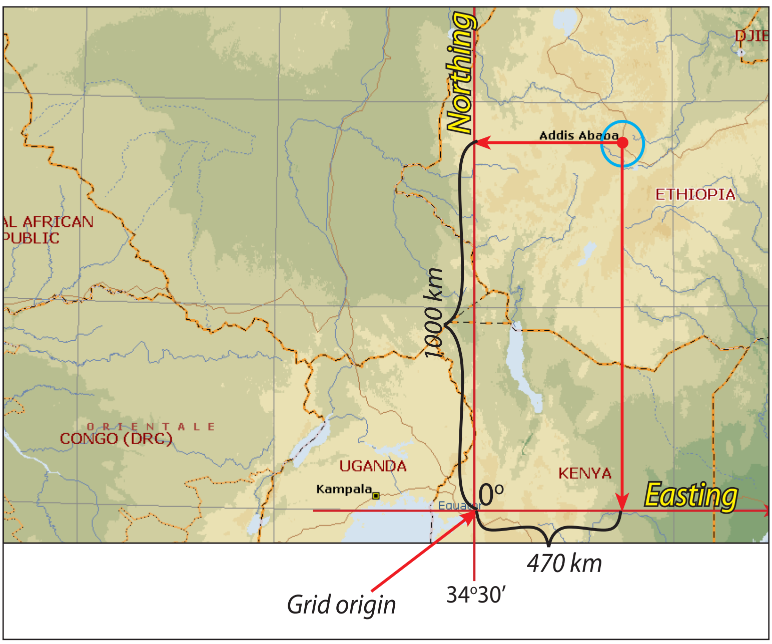


Figure 1.9: **The grid origin of Ethiopia**

The Four Digit Grid Reference

Find the four digit grid reference for point F using Figure 1.110.

Figure 1.11 shows part of Addis Ababa and its surroundings on a 1:250,000 topographic map.

	Proceedings	Easting (Vertical)	Northing (Horizontal)
1	Locate the vertical grid line to the left of the point F and read the large number.	5	
2	Divide the square into ten equal divisions and pick the tenth of the point.	5	
3	Locate the horizontal grid line below the point F and read the large number.		2
4	Again divide the square into ten equal divisions and pick the tenth.		5
	The grid references for point F:	55	25
	The 4-digit grid reference for point F: 5525		

Activity 1.4

Find the 4-digit grid references for the farmlands marked B and N on the map (Figure 1.10).

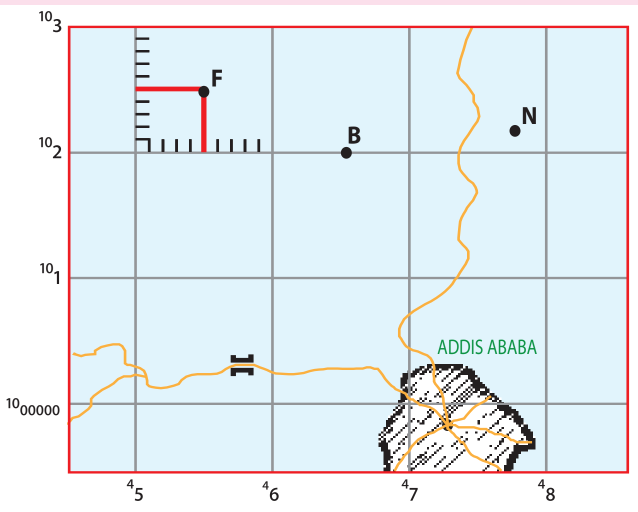


Figure 1.10: **4-Digit grid reference** Scale 1:250,000

The Six Digit Grid Reference

The six digit grid reference is appropriate on a map drawn in a larger scale so that a greater accuracy in position can be obtained.

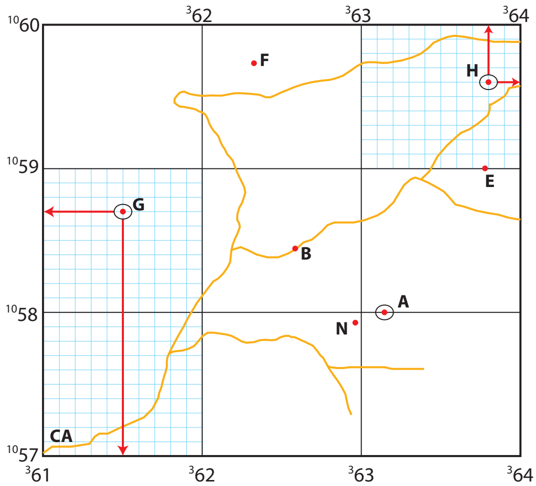


Figure 1.11: **6-Digit grid reference**

In Figure 1.11 the grid of a map drawn in the scale 1:20,000 is shown. Each square has a side of one kilometer.

Exercise: Find the national 6 digit grid reference for the points B, F and N on the map (Figure 1.11).

Procedure	Point B	Point F	Point N
1 All points are in the 100 km square marked CA.	CA	CA	CA
2 Locate vertical grid line nearest to the left of the point and write large digits only	62	62	62
3 Measure tenths from grid line to point	6	3	9
4 Locate horizontal grid line nearest below point and write large digits only	58	59	57
5 Measure tenths from grid line to point	5	8	9
6 Full National Grid Reference	CA 626584	CA 623598	CA 629579

Note that the three first digits in the grid reference always refer to the eastings and the three last digits to the northings. Find the eastings reference and the northings reference in the margin of the map. Then draw perpendiculars from these points as shown on Figure 1.11. Where the two lines cross one another you will have the point you are looking for.

The accuracy obtained with six figure grid reference as far as position is concerned is to the nearest 100 meters. This accuracy is made possible by the larger scale of the map. The actual difference between a four figure and six figure grid reference is therefore one of accuracy. Four figure grid reference should therefore be used only in connection with maps that have a scale so small that it is impossible to get a greater accuracy than to the nearest kilometer.

Remember always that a grid reference NEVER can be used to indicate an area. The reference always stands for a POINT, that is the intersection of two lines.

Activity 1.5

1 Mark the following grid references on the map Figure 1.12

a 615587 b 638596

Mark a with G and b with H.

2 Mark points E and A and find their grid references respectively

3 Mark the following grid references on map Figure 1.12

a 615577 c 630590

b 622594 d 611599

Mark a with T, b with K,

c with Z and d with L

N.B: Do not write or mark on the book. Trace the map on a separate sheet of paper and practice to find the position of point T, K, Z and C. Follow the procedure indicated in to the previous page.

1.3 MAP ENLARGEMENT AND REDUCTION

At the end of this section, you will be able to:

- develop the skill to enlarge and reduce a map using a square method and pantograph;
- compute the scale of an enlarged or reduced map;

- appreciate the need for map enlargement and reduction in certain circumstances.

Key Terms

- Enlargement
- Reduction
- Scale
- Square method
- Pantograph

Why do we enlarge a map?

We enlarge and reduce maps for different reasons.

Enlargement: We enlarge a map when we need to show more details (features) about the area it shows. Often, enlarged maps are produced in order to support detailed study of the area that the map presents.

We enlarge a map by enlarging its scale. The size of the paper on which the new map is printed increases in proportion to the new scale.

Example:

- *city maps are often enlarged maps.*
- *An enlarged map would be quite helpful for demonstrating the required area for a class room.*

Why do we reduce a map?

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.

When you enlarge or reduce a map, consider these principles: if a map is to be enlarged x times, the new map will be x times the scale of the old 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 1

If we enlarge a map with a scale 1:200,000 two times, what will be the scale of the new map?

Solution:

Previous scale = 1: 200,000 or 1/200,000

The scale of the new map = 1/200,000 × 2 = 1/100,000 or 1:100,000

The scale of the new map (1:100, 000) is two times larger than the scale of the old map, (1: 200,000)

Example 2

If we reduce a map with a scale 1:50,000 by half, what will be the scale of the new map?

Solution:

Previous scale = 1:50,000

The scale of the new map = 1/50,000 × 1/2 = 1/100,000 or 1:100,000

The scale of the new map (1:100,000) is half of the scale of the old map (1:50,000).

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

1 $$\text{Amount of enlargement} = \frac{\text{The denominator of the small scale}}{\text{The denominator of the large scale}}$$

Example 3

A map at 1: 200,000 is to be enlarged to a map at 1:100,000. By how many times is the scale increased?

Amount of increase = 200,000/100,000 = 2 times

2 $$\text{The amount of reduction} = \frac{\text{Denominator of large scale}}{\text{Denominator of small scale}}$$

Example 4

A map with a scale of 1: 50,000 is reduced to 1:1000,000. How many times is the scale reduced?

Amount of reduction = 50,000/100,000 = 1/2 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?

Methods of Map Enlargement and Reduction

How do we enlarge and reduce maps?

A Square method (free-hand)

B Pantograph method (uses an instrument)

Figure 1.13 is a map of a lake's area drawn to a scale of 1: 20,000,000.

How do we redraw this map to a scale of 1:10,000,000? In other words, how do we double the original scale?

A *Using Square Method*

On the basis of the given scale, you can enlarge or reduce the map by drawing as many squares as needed. The squares should cover the whole map.

For illustration refer to Figure 1.13.

Exercise: Increase the map scale 1:20,000,000 twice.

The steps involved are the following:

1 Find the size of the original map through measurement and make up your mind about how big you want your new map to be. This will give you the scale of the new map that you want to construct.

2 Draw the frame of your map to be in such a way that the sides are double as long as the sides of the original map.

3 Cover the original map with a grid of half centimetre by half centimetre squares.

4 Cover your map under construction with a similar grid now using one centimetre by one centimeter squares.

5 In order to cross check the squares on both maps, write numbers on the horizontal margin and alphabets on the vertical margin.

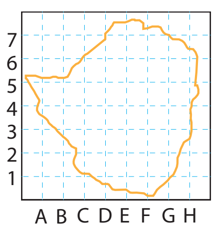
6 Using the grid as a guide, trace the major features that you want to show on your enlarged map carefully in pencil.

7 Finalize your map using color pencils for the different features that you wanted to show, then remove the grid lines from both maps.

This method of enlargement, or reduction, of scale can be used for any kind of drawing and the result is relatively accurate if your measurements and tracings are carefully done.

Note: that the scale for your map is arrived at multiplying the old scale with the number of times that you have increased the original scale or diving the original scale with the number of times that you have decreased that scale.

Note also that when you reduce the scale you usually have to leave out certain details present on the original map.



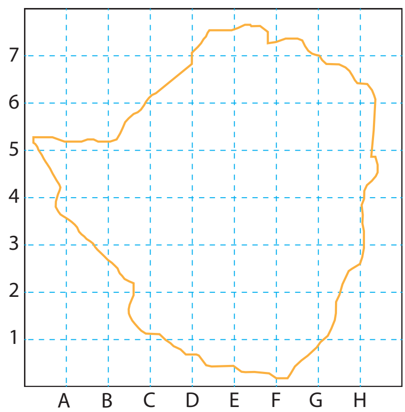


Figure 1.12: **Lake area**

Activity 1.7

1 Following the above method, enlarge the map of Ethiopia (Figure 1.13) Convert the current scale of 1: 20,000,000 into a new scale of 1:10,000,000 in order to create the new map.

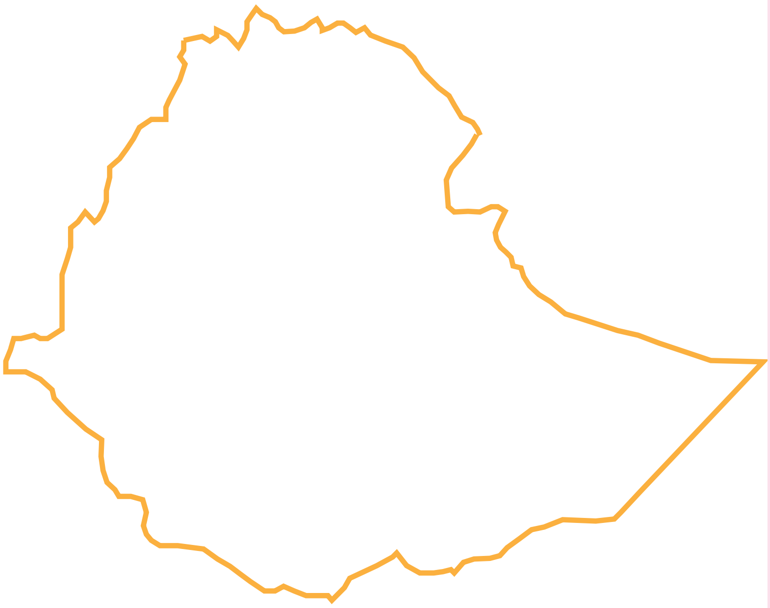


Figure 1.13: **Map of Ethiopia** Scale 1:20,000,000

2 Following the above procedure, reduce the map in Figure 1.13 by half of its size.

NB: Do not write or mark on the book. Trace the map on a separate sheet of paper.

B *Using the Pantograph Method*

A pantograph is a mechanical device used for reproducing maps, drawings etc. at the same or different scales. Maps that are enlarged or reduced using the pantograph are more accurate than ones done using the square method.

A pantograph is made of four pieces of wood, metal or plastic.

A pantograph has three operational points: the pivot, (noted as marked in red) the tracer and the pencil holder (marked in blue). The pivot is fixed on the table.

'Panto' means 'all' or 'every'. The device works in combination of all its parts.

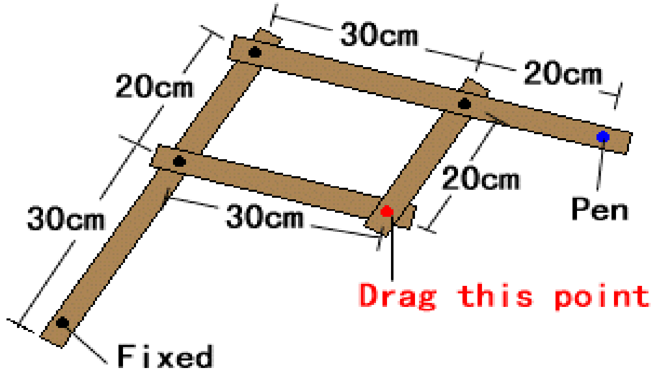


Figure 1.14: **Pantograph**
It is a drawing instrument to magnify figures. Tracing the original figure by moving the red point, we can automatically obtain the magnified figure with the pen at the blue point.

Procedure:

1. Arrange the pantograph either to do enlargement or reduction. the arrangement in Figure 1.14 is for enlargement.
2. Fix the map to be enlarged (original) at red point (traces). Fix a clean paper at the location of the "Pen".
3. Then, when you start tracing on the original map with a tracer at the red point, the pen starts drawing on the paper at the location of the "pen". The drawing will appear larger.
4. To do reduction you have to reverse the position of the tracer and the pen. The original map should be fixed at the position of the "Pen" and the new map to be drawn at the position of red point.

1.4 RELIEF ON MAPS

At the end of this section, you will be able to:

- describe methods of showing relief on maps;
- define the term contour lines;
- discuss the properties of contour lines;
- identify the different ways of showing specific height on a contour map;
- compute the altitude of points between contour lines;
- explain the term slope;
- demonstrate types of slope;
- compute gradients of slope;

- describe the term gradient of slope;
- express gradient in different ways;
- calculate field distance.

Key Terms

- Relief
- Hachures
- Physiographic diagram
- Hill shading
- Benchmark
- Trigonometric point
- Altitude
- Layer coloring
- Form lines
- Contours
- Spot heights
- Slope
- Gradient
- Field distance

What do you understand by the term relief?

What kinds of landforms are found in your locality?

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).

1.4.1 Methods of Showing Relief on a Map

How can we represent relief on maps?

In order to read relief features from maps, you should first know how map -makers represent the uneven surface of the earth on a plane sheet of paper, i.e., on a map.

There are different ways of showing relief on maps. These include:

- *Physiographic diagrams*
- *Hachures*
- *Layer coloring*
- *Hill shading*
- *Form lines*
- *Contour*

Traditional Methods

A *Physiographic Diagrams*

What is a physiographic diagram?

Early map makers used to represent relief features by diagrammatic pictures known as physiographic diagrams. They show three-dimensional pictures of landscapes as viewed from the side or oblique direction (see Figure 1.15).

This method of showing relief is simple and easy to understand. However, it has the following disadvantages:

- *It shows the side and oblique view of the landscape, unlike the modern relief map that gives you an overhead view of an area.*
- *Some geographic details of an area would be hidden from view behind the "backs" of the pictures of hills or mountains.*
- *Exact heights and slopes of the land forms are not indicated.*
- *It lacks accuracy because it is drawn without scale.*

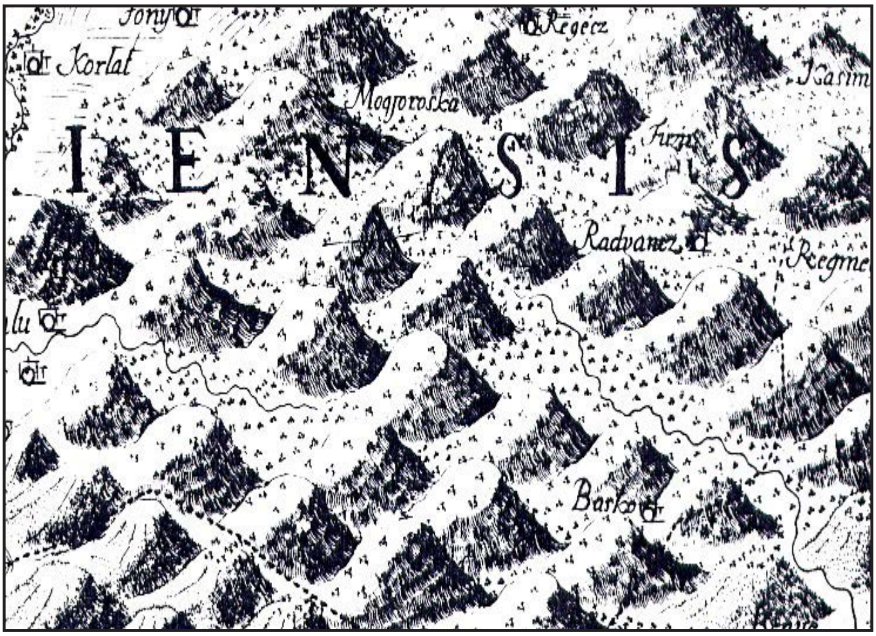


Figure 1.15: **Physiographic diagram**

Activity 1.8

1. Carefully look at the physiographic drawings on Figure 1.15.
   a. In which direction are the shadows of hills cast?
   b. What is the direction of illumination (sunshine)?
2. With the help of a physiographic diagram, draw a sketch map representing the major landforms of your locality and evaluate its shortcomings with your friends in the class.

B *Hachures*

What are hachures?

Hachures are short disconnected lines that represent slopes. For example, Figure 1.16. They are drawn in the direction in which water flows. Originally they were used to represent mountains and valleys on simple sketch maps.

Basically, hachures show the steepness of slopes. When slopes are steep, hachures are put close together. For gentle slopes, the hachures are spaced wide apart. In addition, hachures representing steep slopes are shorter than those representing gentle slopes.

Can you describe the major relief features represented in Figure 1.16?

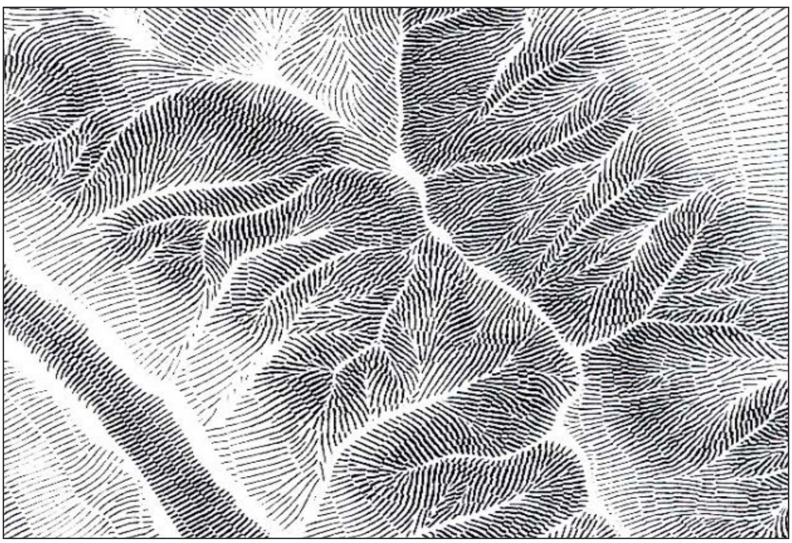


Figure 1.16: **Hachured map**

This approach has significant limitations, such as:

- *Flat areas are unshaded. Therefore, plateaus and plains can be confused.*
- *Hachures do not indicate height and exact gradients. They give only qualitative information.*
- *Hachures are laborious to draw and can be difficult to read and interpret.*

Nowadays, hachures are not used alone. Instead, they are used in combination with contour lines to show landforms like escarpments, depressions and craters. (contour lines are described in a later section of this unit).

Activity 1.9

Study Figure 1.16 and then briefly describe how hachures differ from and are superior to physiographic diagrams for representing relief.

C Hill shading

What is hill shading? What are some of the limitations of hill shading?

Hill shading is also known as oblique illumination. It is a method of showing relief on a map, assuming an oblique light that illuminates the landscape from the northwest corner of the map. Hence the northwest-facing slopes are shaded lighter than are the east-facing and south-facing slopes. The steeper the slope is, the darker it is shaded.

Hill shading offers a quick general impression of the land configuration that it represents. But still it has some limitations such as:

- *It does not give absolute altitude.*
- *It fails to indicate clearly whether the ground is sloping upward or downward.*
- *It fails to indicate whether the unshaded areas are low or high-level areas. Hence, plateaus and plains can be confused.*
- *Detailed map information can be obscured by shading.*

In general, hill shading is now used in combination with spot heights and contours to overcome some of its drawbacks.

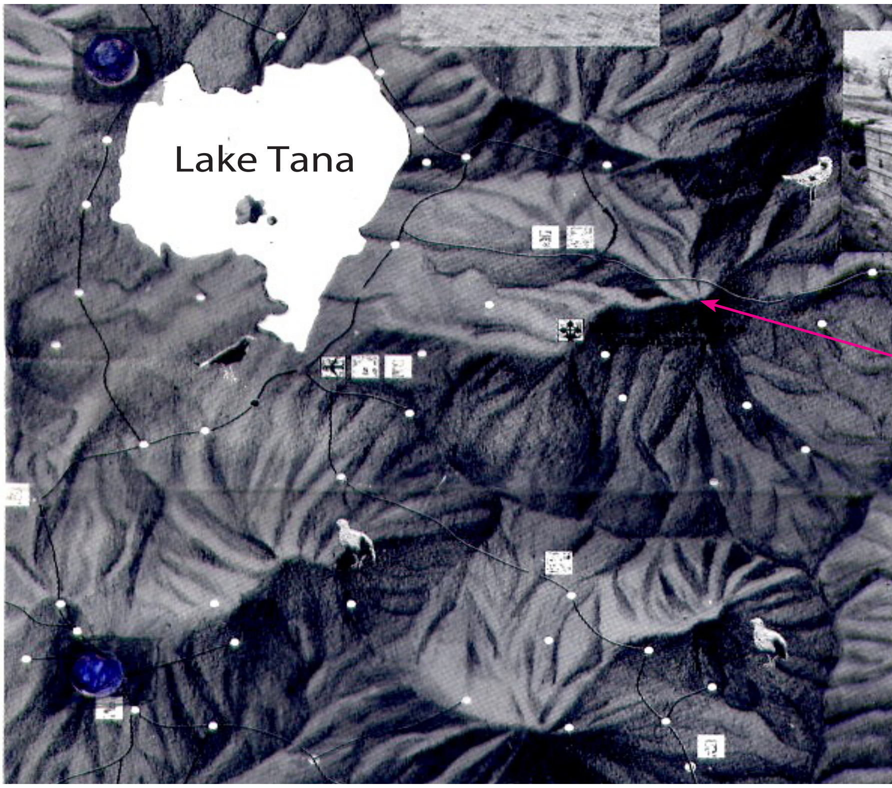


Figure 1.17: **Hill shading on a map of Northwestern Ethiopia**

Activity 1.10

Compare Figure 1.16 and Figure 1.17. What improvements do you see in Figure 1.17? Discuss your observations with your classmates or friends.

D *Layer Coloring (Layer Tinting)*

What is layer coloring?

It is a method of showing relief by using colors. The series of colors for showing different altitudes starts from sea level (see Figure 1.18).

Identify the types of colors used to represent the different elevation zones in Figure 1.18.

Elevation Zones	
(red)	Above 3000 m
(orange-brown)	2501 - 3000 m
(yellow)	1001 - 2500 m
(turquoise)	501 - 1000 m
(green)	0 - 500 m
(blue)	Water body

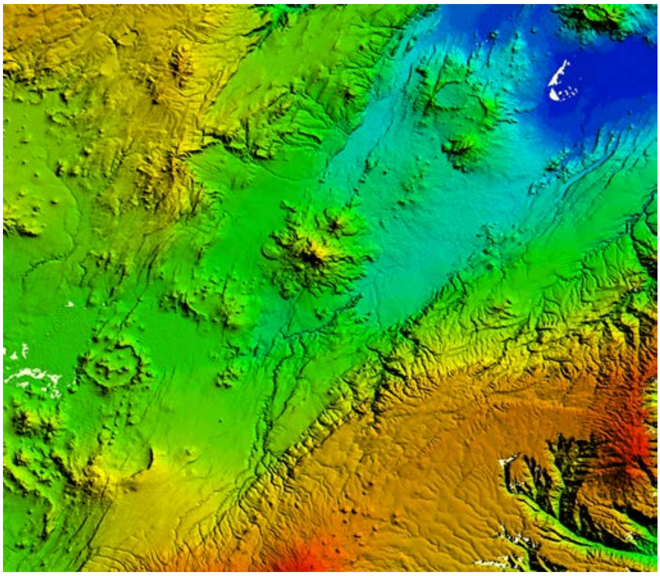


Figure 1.18: **Map with layer coloring**

Layer coloring has the following disadvantages:

- *Color shading does not indicate gradual changes in slopes.*
- *The edges of the areas of different colors can suggest nonexistent physical boundaries.*
- *Dark colors can obscure details in the areas that they overlie.*
- *Some colors can create false impressions in the map reader's mind. For example, green might suggest vegetation or a fertile area.*

Activity 1.11

By referring to the Ethiopian Atlas from your library, describe to the class how layer coloring is used to identify different altitudinal zones in Ethiopia. If possible try to cite some of the names of specific areas in each elevation zone.

E Formlines

What are 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.

What are the limitations of formlines?

Formlines have the following limitations:

- *They are not drawn on a map at a fixed interval of altitude.*
- *Although they represent the relief of an area, they provide little or no reference to sea level.*
- *In many cases they are unnumbered.*
- *They are usually drawn with broken lines.*

Activity 1.12

Discuss the following in your group and present the result of your discussion to the class.

1. Briefly describe some of the common problems of traditional methods of showing relief on maps.
2. Some of the traditional methods are still being used in combination with contour lines in order to show some landforms. Mention some of their current uses.

Modern Methods

F Contour Lines or Isohypses

What are contour lines? How do contour lines differ from traditional methods of showing relief on maps?

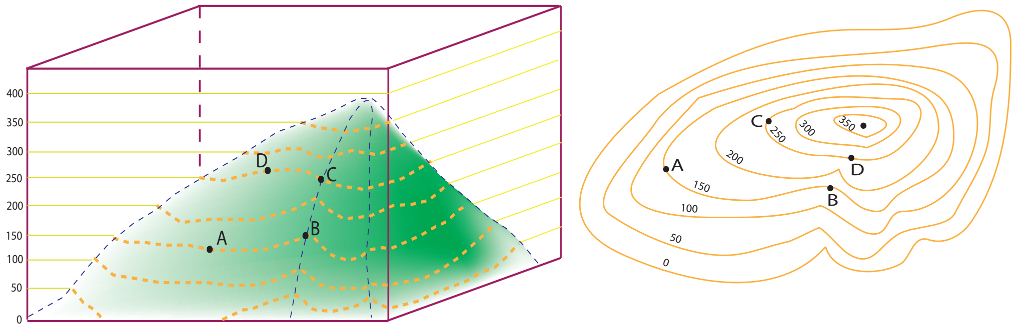
Contour lines are the most common and accurate way of showing relief on modern maps. A shoreline is a good example of a contour line.

Focus

Contour lines 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.

How are contour lines drawn?

The drawing of contour lines is illustrated in the diagram below. Study it carefully.



a) *Side view of a hill* b) *Top view of the same hill*

Figure 1.19: **Sketches of a hill with contour lines**

As indicated in Figure 1.19, a contour line joins all points on the hill that are at the same height. For example, contour line 150 m passes through points A and B, while contour line 250 m runs through points C and D. All of the points on contour line 150 m are 150 m high and those on the 250 m line are all 250 m high.

To give clearer impressions of the relief on contour maps, contour lines are sometimes used in combination with hachures, hill-shading, layer-coloring and spot heights.

Properties of Contour Lines

What are the main properties of contour lines? Why are contour lines more accurate than the traditional methods of showing relief on maps?

General properties of contour lines.

Here are some important points about contour lines:

i Contour lines are imaginary lines used on a map to represent relief. Unlike the lines that represent rivers, boundaries or coast lines, 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.

Focus

Mean sea level (m.s.l.) is the average level of the sea, as calculated from a large number of observations taken at equal intervals of time. It is the most common standard level from which all heights are measured.

ii A set of contour lines is drawn at a fixed height interval. For example in the Figure 1.19, contour lines are drawn at 50-meter intervals. The difference in altitude between two successive contour lines is known as vertical interval (V. I.) or contour interval (C. I.). The V. I. helps us to find out the heights of unnumbered contour lines.

iii 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. It rises from 100 meters to 150 meters.

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.

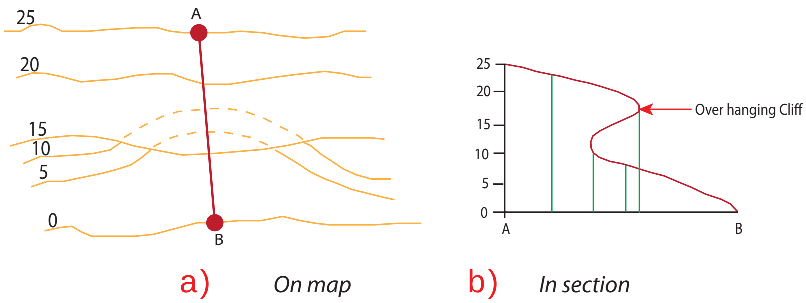


Figure 1.21: **An overhanging cliff**

iv Contour lines never branch. If you see branching lines on a map, they represent features such as rivers, roads, boundaries, etc.

v 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. The altitude of any point outside this line will be either greater or less than 250 meters (see Figure 1.22).

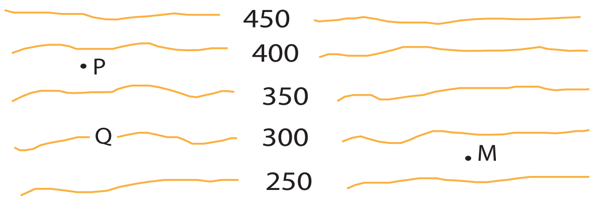


Figure 1.22: **Heights shown by contour lines**

What are the heights of points P, Q and M on the above figure?

vi 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).

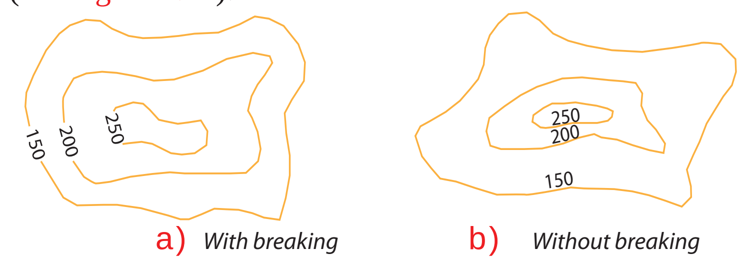


Figure 1.23: **Numbering of contours**

vii 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 (See Figure 1.24).

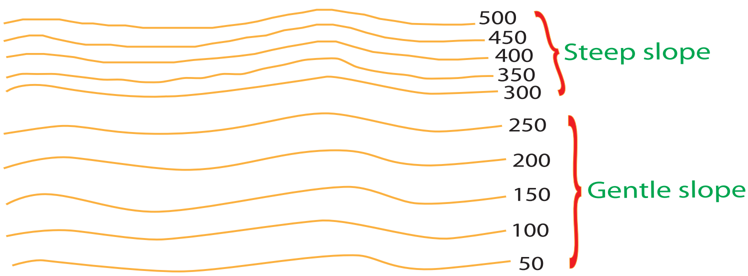


Figure 1.24: **Contour-line spacing indicating slope steepness**

viii Contour lines can be printed with different thicknesses on a map. This is especially helpful in mountainous areas where altitudes may vary considerably from summits to valley floors. 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.

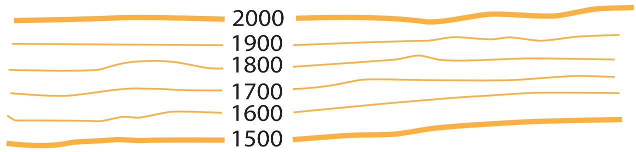


Figure 1.25: **Contour lines with a difference in thickness**

ix 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.

Figure 1.26 gives pairs of representations of various land forms. Each pair has a diagrammatic view and a contour view. Study it carefully.

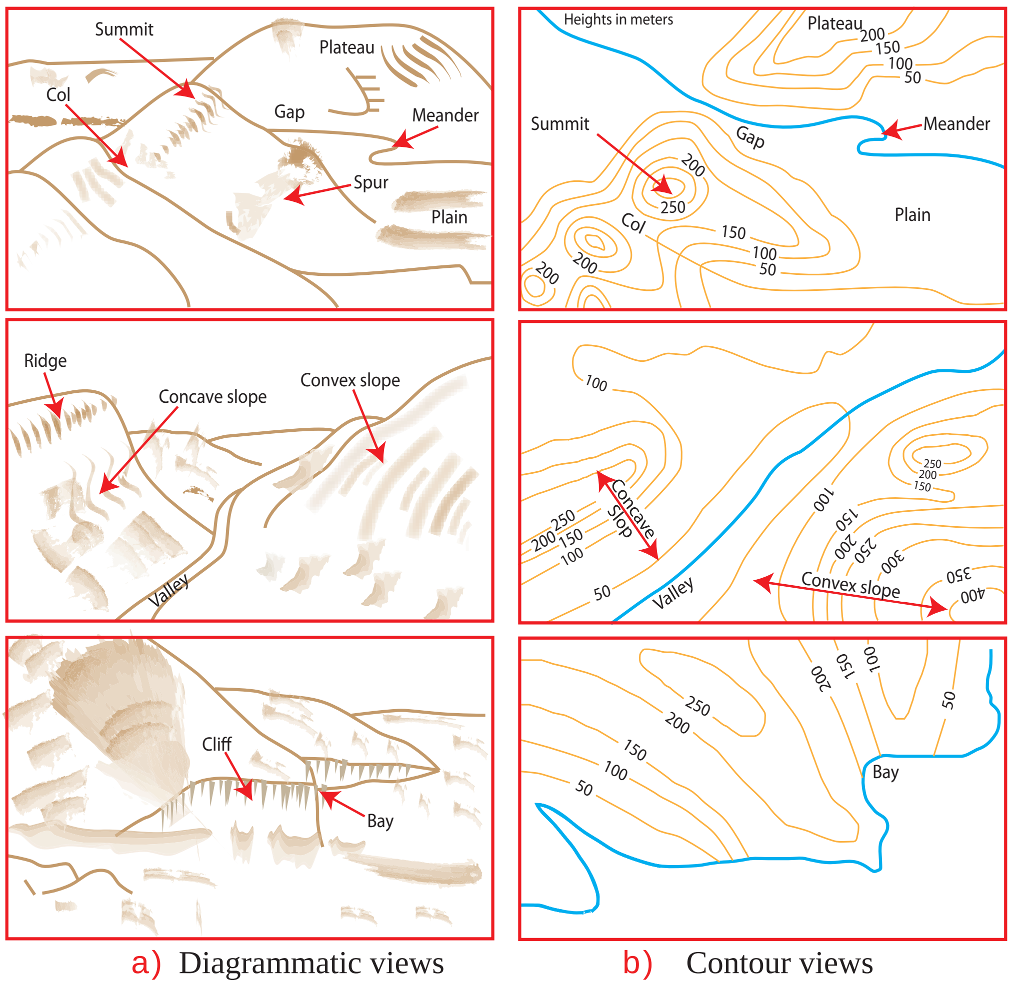


Figure 1.26: **Landforms represented both diagrammaticaly and by contour lines**

Activity 1.13

1. By referring to relevant source materials, attempt to define or explain the relief features shown in Figure 1.26.
2. Trace Figure 1.27 on a separate sheet of paper and then follow these instructions:
   - a Mark all roads using a red color.
   - b Color all rivers and the lake blue.
   - c Color areas below 1500 m green.
   - d Color all areas between 1500 m and 2100 m yellow.
   - e Color all areas between 2100 m and 2700 m light brown.
   - f Color areas above 2700 m dark brown.
   - g Find the V.I. of the map.
   - h Where is the lowest and highest point of the area shown on the map?
     - i How high is Debre Tabor?
     - ii What about altitude of Bahir Dar?

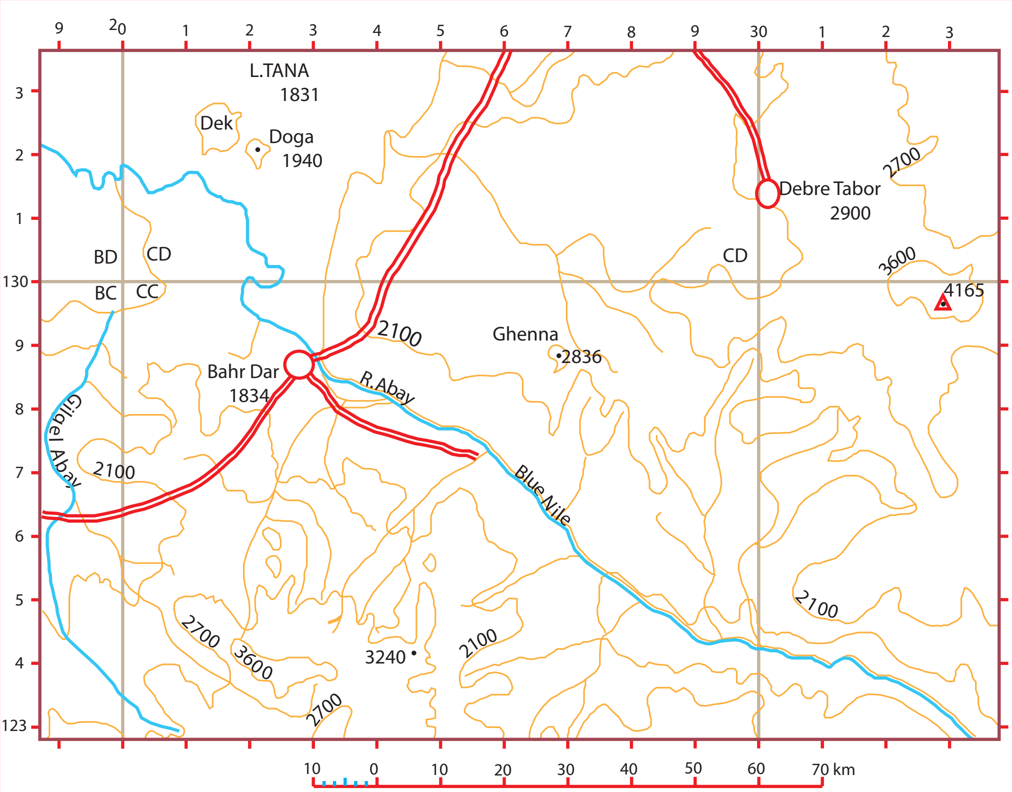


Figure 1.27: **Sample contour map**

G Different Methods of Showing Altitudes on Contour Maps

What are the shortcomings of contour lines?

How do you indicate the specific heights of hilltops, roads, railways, and towns?

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:

a Spot heights

- *They are marked on the map with a dot followed by an altitude number:*

Example:

- *• 1940 meter (see Figure 1.27).*

- *They provide accurate altitudes for individual points, such as those along a road, on a mountain top, or between contour lines.*
- *Unlike contour lines, spot heights do not give a good visual impression of the general relief.*
- *They exist only on maps.*

b Trigonometrical points

- *They exist both on maps and in the field.*
- *They mostly mark features such as hilltops and mountain peaks.*
  - *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 (see Figure 1.27).*

Example:

The top of Mt. Ras Dashen can be shown as ⊙△ 4620 meters on a topographic map. Mt. Gunna is ⊙△ 4165 meters (see Figure 1.27)

c Benchmarks

- *They indicate precise heights along highways or railways.*
- *They are shown on stones, bricks or bronze plates on walls of buildings and other convenient places.*

- *They are useful for road construction engineers and others who wish to know the precise altitude of a main transport network.*

Example:

[•] BM 1850 (where the point is marked on the ground, the height above mean sea level is 1850 meters).

d 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. In order to find the altitude of point A in Figure 1.28, follow the procedures given below.

i Draw the shortest possible straight line that passes through point (A) and join the two contour lines adjacent to it.

ii Measure the length of this line: = 11 mm.

iii Measure the distance on the map between the lower and upper contours up to point (A). They are 6 mm and 5 mm respectively.

iv Find the vertical interval between the two contour lines: = 100 m.

v Then determine the altitude of the point using the following formula:

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

Where: d_1 is distance of point A from the lower contour,

d_2 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.

$$\text{Altitude of point A} = 700 + \left(\frac{6 \times 100}{11}\right) = 754.55 \text{ meters or,}$$

$$\text{Altitude of point A} = 800 - \left(\frac{5 \times 100}{11}\right) = 754.55 \text{ meters}$$

Therefore, the altitude of point A is 754.55 meters.

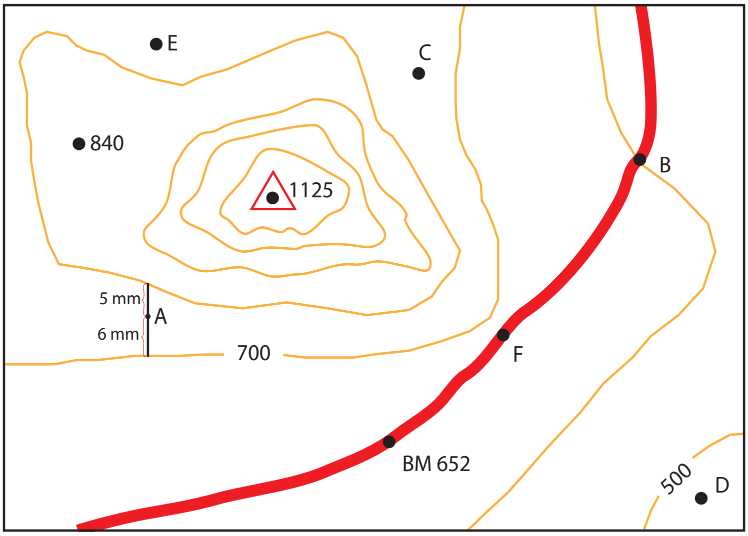


Figure 1.28: **Altitudes shown on a contour map in different ways** Scale 1:50, 000

Activity 1.14

Answer the following questions by referring Figure 1.28.

1 What are used to show altitudes on the map?
2 Calculate, using the interpolation method, the altitude of points F, B and C.
3 Where are the highest and lowest altitudes?
4 Measure the road distance between villages F and B.
5 Calculate the ground area of the map.
6 Draw a graphic scale for the map.

1.4.2 Slopes and Gradients

A *Slopes on Contour Maps*

What is slope? How can we determine the steepness of slopes on contour maps? What kind of relations exist between V.I. and slope?

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 (see Figure 1.24).*

➪ *The vertical interval (V.I.) between two successive contours. The bigger the V.I, the steeper is the slope representation and vice versa.*

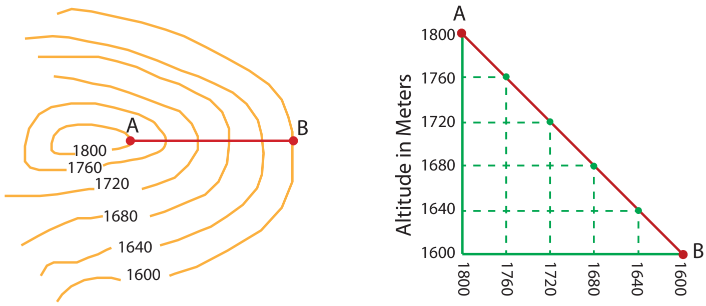
Types of Slopes

How many types of slope do you know? Mention some of them and describe how you can identify them from contour maps.

There are different types of slopes, which include:

i Even slope

An even slope has a constant gradient from the bottom to the top. Gradient is the degree or rate of a slope. You will learn more about gradient later in this unit. On a map of an even slope, the contour lines are evenly spaced throughout. For example, study the slope represented in Figure 1.29.

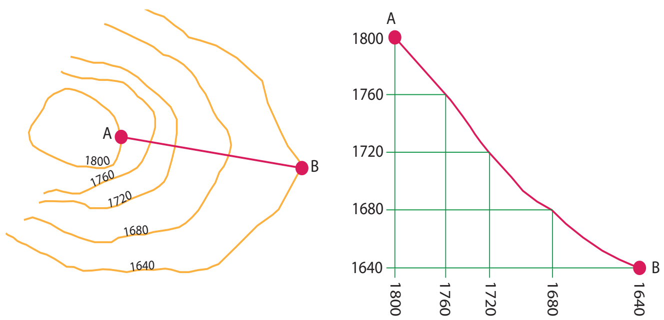


a) in contour map b) in section

Figure 1.29: **Even slope**

ii 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 (see Figure 1.30).



a) in contour map b) in section

Figure 1.30: **Concave slope**

iii 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. (See Figure 1.31).

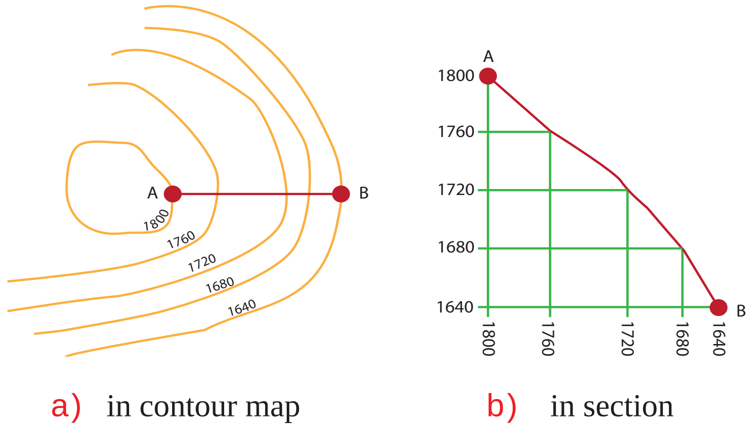


Figure 1.31: **Convex slope**

iv 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 (see Figure 1.32).

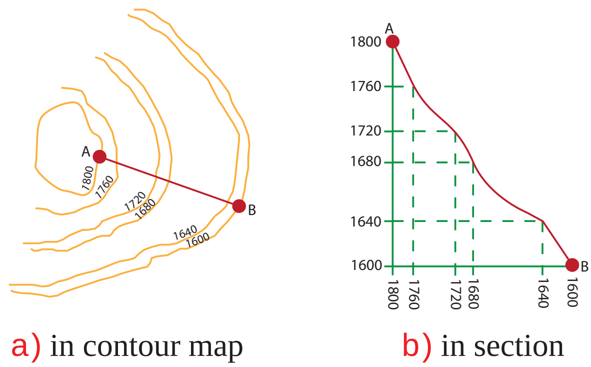
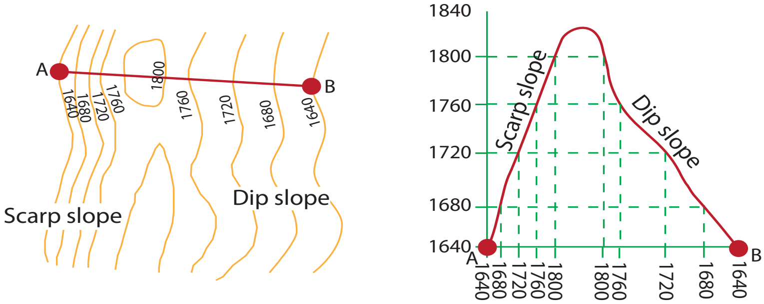


Figure 1.32: **Terraced slope**

v Escarpment

An escarpment is the steep slope of a plateau, especially one where the plateau ends and the lowland starts. You can also identify other two more slopes on either side of a mountain ridge. One slope is steep and the other is gentle. The steep slope is called the scarp slope. The gentler slope is called the dip slope (see Figure 1.33).



a) in contour map b) in section

Figure 1.33: **Dip and scarp slopes**

Activity 1.15

Perform the following activity.

1 Draw the following relief features, representing them with contour lines only:
- a Cliff
- b Convex slope
- c Concave slope
- d Even slope
- e Stepped slope

2 Refer to Figure 1.34, and describe the types of slope between:
- a D and E
- b A and G
- c D and F

B *Gradient on Contour Maps*

What is gradient? What are the three common ways of expressing gradient?

How do you determine the rate of change of slope between two points?

Gradient (GR) is the degree or rate of change of slope or elevation between two points.

It is calculated using altitude difference (vertical distance) and map distance (horizontal distance) between two points. Both AD and MD must be in the same unit of measurement.

It can be expressed in any of these three different ways:

1 As a simple ratio: $GR = \dfrac{AD}{MD}$

2 As a percent: $GR = \frac{AD}{MD} \times 100$

3 In degrees: $GR = \frac{AD}{MD} \times 60^{o}$

Where: GR = gradient, AD = altitude difference,

MD = map distance.

Usually we express gradient as a percentage. This expression is the simplest to use, and it is relatively easy to calculate.

Activity 1.16

Calculate the following:

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.

Here are some examples of the three methods:

a ***Ratio:*** This expression of gradient gives a relationship between the vertical and horizontal dimensions of the slope.

Example:

The gradient ratio 1:20 means there is 1 unit of rise of altitude for every 20 units of horizontal distance.

b ***Percent:*** We use the ratio expression of gradient to obtain the expression as a percent. Multiply the ratio by 100.

Example:

$^1/_{20} \times 100 = 5\%$. In other words, on average, there is a vertical rise of 5 units for every 100 units of horizontal distance.

c ***Degree:*** We also use the ratio expression to obtain the expression as a degree. Multiply the ratio by 60^{o}.

Example:

$\frac{1}{20} \times 60^{o} = 3^{o}$. In other words, on average, the slope between the two points is roughly 3^{o}.

Use the following Table 1.1 to see how individual gradients are given by the three different expressions:

Table 1.1: **Expressing gradients in three ways**

Type of expression			Type of gradient
Ratio	**Percent**	**Degree (Approximate)**	
1: 100	1%	0.6^{o}	Gentle
1:60	1.7%	1^{o}	Gentle
1:20	5%	3^{o}	Moderately steep
1:10	10%	6^{o}	Moderately steep
1:5	20%	12^{o}	steep
1:2	50%	30^{o}	Very steep

Example:

Find the gradient between A and F on the Figure 1.34.

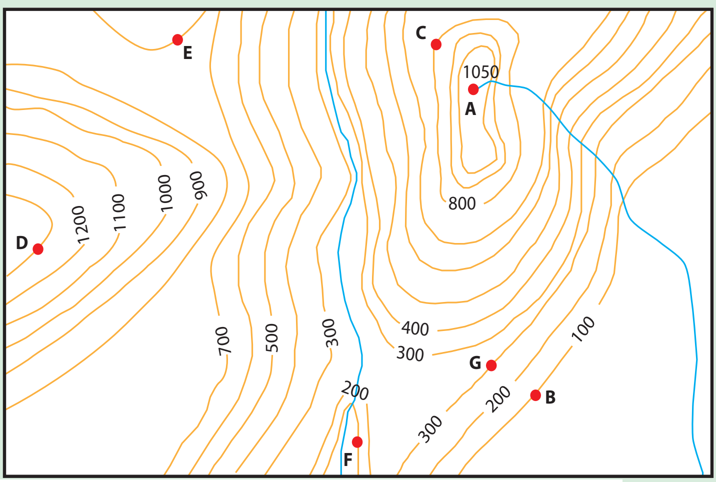


Figure 1.34: **A contour map for gradient calculation** Scale 1:50,000

Solution

Procedure:

i Find the difference in altitude between A and F.

That is, 1050 m – 100 m = 950 m = 0.95 km.

ii Measure the distance (on the map) between A and F with reference to the map scale.

Map scale = 1:50,000

The distance on the map from A to F = 5.5 cm which equal to

$$2.75 \text{ km} = \frac{5.5 \text{ cm} \times 50{,}000}{100{,}000}$$

iii Calculate the gradient between A and F.

$$\text{GR in ratio} = \frac{AD}{MD} = \frac{0.95 \text{ km}}{2.75 \text{ km}} = 1 : 2.9 \approx 1:3 \text{ approximately}$$

$$\text{GR in percent} = \frac{1}{3} \times 100 = 33.3\%$$

$$\text{GR in degree} = \frac{1}{3} \times 60^{\circ} = 20^{\circ}$$

Activity 1.17

1 Using the above map (Figure 1.34), calculate the gradient between A and D in ratio, in percent and in degree.

2 Change the following gradients given in ratios into percentages and degrees.

i 1:100 ii 1:25 iii 1:50

3 Change the following gradients given in percentages into ratios and degrees.

i 35% ii 75% iii 12%

1.4.3 Field Distances (FD)

Do you remember how to find or calculate the different types of distances on a map?

In any map exercise, you may need to find three different types of distances. Straight line distance, bending distance and field distance. Here we consider field distance.

What is field distance?

Field distance is the actual distance, which takes into account the effect of relief. It is the actual distance measured on the ground.

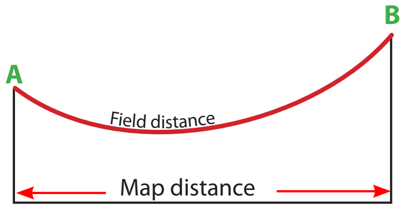


Figure 1.35: **Field distance and map distance**

To obtain field distance, a map user needs to know:

- *the map distance between the two points given*
- *the difference in altitude between the two points*
- *mathematically it can be expressed as:*

$$FD^2 = MD^2 + AD^2$$

The map distance between two points can be obtained from the map. However, the difference in altitudes between the same two points can be obtained from the contours on the map. The following example will illustrate this briefly.

Example:

a What is the actual distance in the field between point A and point B in the map shown below?

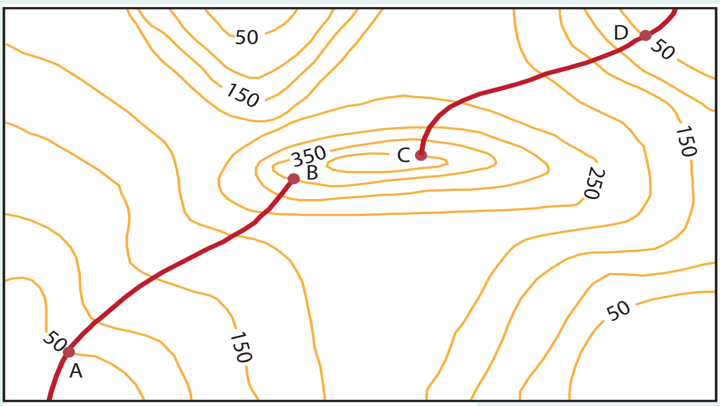


Figure 1.36: **Field distance between A and B on map**

Scale 1:25,000

Solution

Procedure:

- *Measure the distance on the map between the two points using a ruler. It is equal to 4 cm.*

⇨ *The scale of the map = 1:25,000.*

b If 1 cm on the map represents 25,000 cm on the ground, how much is 4 cm on the ground?

Solution:

$$\text{Scale} = \frac{\text{Distance on the Map}}{\text{Ground distance (GD)}} \Rightarrow \frac{1}{25{,}000} = \frac{4\text{ cm}}{\text{GD}}$$

GD = 25,000 × 4 cm = 100,000 cm

To convert the distance into kilometers

$$\Rightarrow \frac{100{,}000\text{ cm}}{100{,}000\text{ cm}} = 1\text{ km}$$

The difference in altitude between point A and point B can be obtained from the contour map.

The difference in altitude (AD) = (350 – 50) meters
= 300 meters = 0.3 kilometers

Then, FD can be calculated with the help of the Pythagorean theorem.

$$\therefore FD^2 = MD^2 + AD^2$$

$$\Rightarrow FD = \sqrt{(MD)^2 + (AD)^2} = \sqrt{(1km)^2 + (0.3km)^2} = \sqrt{1.09km^2} = 1.04km$$

Thus, the field distance = 1.04 km.

Activity 1.18

1 Find the field distance between C and D from the above map (Figure 1.36).

2 Compute the field distance for the pairs of places, based on the information given in the following table. Copy and complete the table.

Table 1.2:

Number	AD	Measured distance on the Map	Map scale	FD
1	6000 m	20 cm	1 cm to 1.5 km	?
2	1500 m	5 cm	1: 50,000	?

Unit Review

UNIT SUMMARY

- Direction is always measured clock wise starting from north. Direction can be expressed in compass points (N, E, S, W) or in degree (bearings)
- Position of a place can be described from maps by using latitude and longitude and national grid reference. The most accurate and international method used for locating places on maps is the geographic grid reference (latitude and longitude).
- Map enlargement and reduction can be done using a pantograph and graphic method. Patograph is an instrument which can be set-up for enlarging or reducing maps. Besides maps can be enlarged or reduced by using proportional grid squares. Note that whenever any map is enlarged or reduced, the scale of that map is also changed proportinally.
- Scale plays a significant role when we enlarge or reduce a map. We can perform these procedures accurately by using the grid-square method or the instrumental method.
- Relief refers to the ups and downs of the earth's surface. Since ancient times, map makers have used different methods to represent relief on maps. These days, the most common and accurate way of showing relief on modern maps is by contour lines.
- Contourlines are lines drawn on a map joining places of the same elevation above sea level. They give almost true altitude.
- Some of the properties of contour lines may include; they are imaginary lines and joining points of the same altitude on a map, they are drawn at a fixed V.I, they are never cross one another (except in the case of overhanging cliff), they are not branch, etc.
- Spot heights, trigonometrical points and benchmarks, are additinal methods, which are used to indicate specific heights that are found between consecutive contourlines, etc.
- Slope is a deviation of the land surface from the horizontal. The spacing between contour lines indicate the types of slopes (like even, concave, convex, terraced, etc) on contour maps.

- Gradient is the degree or rate of change of slope between two points. It can be expressed in the form of ratio, percent and degree.
- Field distance takes into account the ups and downs of the earth's surface. It can be obtained by combining the map distance (horizontal or straight line distance) between two points and the altitude difference between the same points.

REVIEW EXERCISE FOR UNIT 1

I ***True or False: Write True if the statement is correct and write False if it is incorrect.***

1 Grid North is the direction in which grid lines point towards the top of the map.

2 Usually direction is measured clockwise, starting from Magnetic North.

3 The grid-square method is the best method for enlarging or reducing a map without any errors.

4 The contour method uses pecked or broken lines to represent different types of landforms.

5 Field distance is usually calculated in reference to the formula for right-angle triangles.

II ***Matching: Match the items in column "A" with items in "B".***

	A		B
6	Magnetic variation	A	Position by geographic grid
7	Absolute location	B	Side and oblique view of the landscape
8	Four-digit grid reference	C	Magnetic declination
9	Physiographic diagram	D	Refers to the location of a point
10	Hill shading	E	Form line
		F	Oblique illumination

III *Multiple Choices: Choose the correct answer from the given options.*

11 A method of finding the position of a place in relation to directions and distances from well-known places is:

A Position by the use of bearing and distance.

B Position by the use of geographical grid.

C Position by the use of place names.

D Position by national grid reference.

12 If the angular bearing of point A to point B is 135°, then the cardinal direction will be:

A Northwest

B Southwest

C Northeast

D Southeast

13 Which of the following is not true about contour lines?

A They are drawn at a fixed-height interval

B They can merge or cross one another in the case of overhanging cliffs or waterfalls.

C They are continuous lines

D They are always numbered in the direction towards which altitude decreases.

14 The one that exist both on maps and in the field is _______.

A Spot heights

B Trigonometrical points

C Benchmarks

D B and C

15 In _______ slopes, the contour lines are widely spaced at the base and are close together at the top.

A Even

B Concave

C Convex

D Terraced

IV *Fill in the blank: Fill the following blanks with appropriate word(s).*

16 Direction can be expressed in either _______ or _______.

17 The steeper slope of an escarpment is known as _______.

18 An instrument used to enlarge or reduce a map is known as _______, _______.

19 A steep slope of a plateau which begins to descend gradually on the other side is _______.

V *Short Answers: Give short answers to the following questions.*

20 What is the basic difference between a contour line and a formline?

21 Indicate three shortcoming of hachures.

22 Define the term "cliff".

23 Explain briefly the difference between spot heights and trigonometrical stations or points.

VI *Things to Do: Answer the following questions by referring to Figure 1.37.*

24 Find the approximate R.F. of the map _______.

25 Measure the direction (bearing) of:

i A from B ii B from D iii D from A

26 Between points C and E, calculate

a The field distance

b The gradient in;

i ratio ii percent iii degree

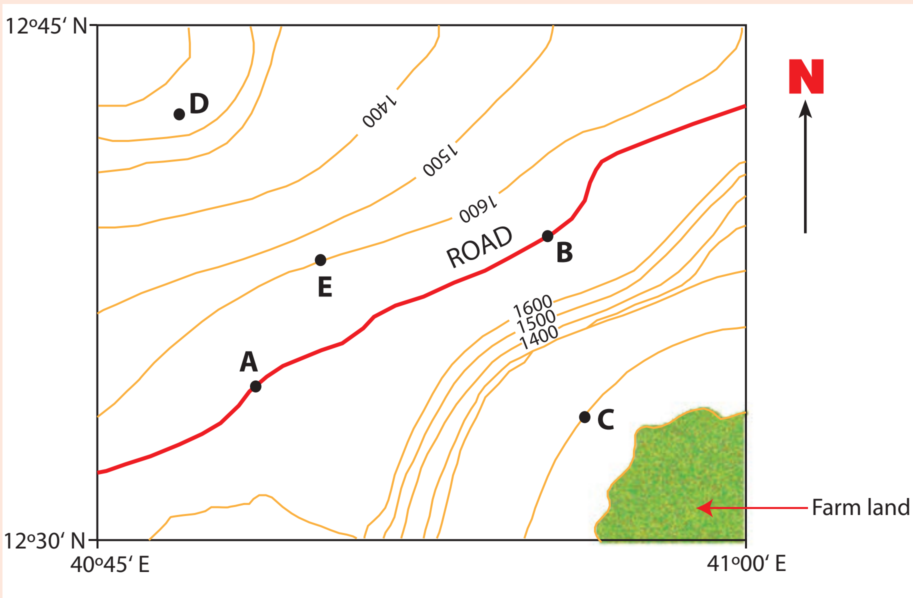


Figure 1.37: **Contour map of place 'x'**

27 Copy Figure 1.37 and then indicate a cliff, an escarpment, a convex slope, a terraced slope and an even slope.