

REMEDAL COURSE FOR GRADE 12 STUDENTS 2015/2023

Unit 1

1. THE SCIENCE OF GEOGRAPHY

1.1. Definition and concepts

❖ What is Geography?

⇒ Several definitions of geography proposed by different scholars.

❖ **Ancient Greeks** defined geography for the first time. **Eratosthenes** combined two words:

○ **Geo** – which means earth

○ **Graphic** – which means writing

⇒ Therefore, their definition of geography was **a description of the earth**.

❖ **Modern** some of the definitions were made by scholars of the **19th and 20th** century.

1. **Alexander von Humboldt, 1845- Geo is**

✓ A Synthesizing discipline to connect the **general with the particular**

✓ **Through measurement, mapping, and a regional emphasis."**

2. **E.A Acreman, 1953- Geog is**

✓ An understanding of the vast interacting system b/n the two.

3. **Richard Hartshorne, 1959- Geo is**

✓ « Provide accurate, orderly, and rational description & interpretation of the variable character of the earth's surface. »

4. **Yeates M., 1968- Geo is**

✓ The **rational development and testing of theories**

✓ Explain and predict the spatial distribution and location of various characteristics on the surface of the earth."

5. **Martin Kenzer, 1989- Geo is**

✓ "Concerned with the location or spatial variation in both physical and human phenomena at the earth's surface".

6. **Gregg Wassmansdorf, 1995- Geo is**

✓ "The study of the patterns and processes of human- built and env'tl (natural) landscapes, where the landscapes comprise real (objective) and perceived (subjective) space."

7. **Microsoft ® Encarta ® 2008- Geo is** "The study of the env't of the earth's surface and the r/s of humans to this env't.

⇒ the most **commonly acceptable definition** of geography can be defined as:

❖ **Geography is** "the study of the **spatial distribution** and the two-way interactions and interdependences of both physical and human-made things and phenomena on the earth's surface, their cause and effects."

⇒ Therefore, **Geography is the study of:**

- **The physical world**, its inhabitants, and the interaction between the two; The resultant patterns and systems of geographical phenomena;
- **Patterns and processes associated with causes;**
- **R/s b/n humans and their environment**, with emphasis on spatial perspectives at varying scales.

➤ Making spatial investigations, geographers ask five pertinent questions about the phenomena they study. These are:

✓ "WHERE are things located?" **descriptive in nature**

- ✓ “WHY are they located where they are?” what **factors determine**
- ✓ “WHEN did the things form?” explain **the time** of things and phenomena found.
- ✓ “WHAT things are found where?” explain **the type and the nature** of the things.
- ✓ “HOW are they arranged?” primarily **analytical**

1.2. Branches of Geography

1. **Physical Geography:** is studies the distribution of the natural features of the world, such as climate, landforms, soils, vegetation, and drainage systems.

➤ Physical geography includes the following specialized fields of study:

- 1.1. **Climatology:** studies factors that create climate and examines the variation and distribution of climate and related causes and effects.
- 1.2. **Geomorphology:** studies the distribution of landforms (such as mountains and plains) and the forces that change them.
- 1.3. **Soil geography:** studies the distribution of soils and their characteristics.
- 1.4. **Biogeography:** studies the distribution of plants and animals in relation to the environments that they inhabit.
- 1.5. **Oceanography:** studies the location, causes and effects of ocean currents, waves and tides.

2. Human geography

❖ **Human Geography:** is studies all the human aspects of our world, including cultures, population settlement, economic activities and political systems.

➤ **Human geography includes these specialized fields of study:**

- 2.1. **Cultural geography:** studies the distribution and interactions of cultures, including peoples’ beliefs and customs.
- 2.2. **Population geography:** studies the distribution, growth and structure of population demography.
- 2.3. **Economic geography:** studies production, consumption and exchange and the spatial distribution of goods and services and factors affecting them.
- 2.4. **Political geography:** studies the distribution of political systems and the ways people use them to exercise power and make decisions.
- 2.5. **Urban geography:** studies the development and characteristics of towns, cities and other urban centers.
- 2.6. **Historical geography:** is the study of the geography of the past and how places or regions change over time
- 2.7. **Transportation Geography:** deals with the History of transport, modes, networks and models of transportation, cost of transport and accessibility and connectivity.
- 2.8. **Medical Geography:** Medical geographers study the geographic distribution of disease (including epidemics and pandemics), illness, death and health care.
- 2.9. **Recreation, Tourism, and Sport Geography:** The study of leisure-time activities and their impact on local environments, among others.

1.3. THE SCOPE OF GEOGRAPHY

- **Scope** refers to the extent of interest or focus in a certain subject.
- Scope means the range and variety of contents which are included in a subject or field of study.

- Geography's scope is very **wide and dynamic**, it changes often as new discoveries and ideas enter the field.
- It also refers to the capacity and limits that an academic discipline treats.
- Generally, the **geo-sphere** considered as geography's **scope**.

⇒ The **geo-sphere** itself is made up of **five sub spheres**, namely:-

1. **Lithosphere**- The solid part of the earth sphere- related to **Geomorphology, Soil geography**.
2. **Hydrosphere**- The water surface – oceans, seas, lakes - **Ocean geography**.
3. **Troposphere**-The lower part of Atmosphere- weather changes- related to **Climatology**.
4. **Biosphere**- Supports all sorts of life- related to **Biogeography**.
5. **Anthropos here**– the Cultural landscape- related to **Cultural** and **population** geography.
 - **Geography's area** of study is very wide and diverse in its nature.

⇒ **The major areas that geography focuses on are:**

- The **position of the Earth** in the universe and **its movements**;
- The **different physical features** that constitute the earth's surface,
- The **forces that cause their spatial variations** and their changes over time;
- The **two-way r/s** between human beings and their natural environment.
- The **interdependence and the impact** of the two-way relationships;
- The **conditions of the lower part of the atmosphere** and the subsequent **weather** and **climatic conditions**, with their spatial distribution and variation.
- The **materials that make up the earth** and its diverse land forms.
- The **major economic activities** of humans and the impacts on the environment.

1.4. **THEMES AND APPROACHES IN GEOGRAPHY**

A. THEMES OF GEOGRAPHY

- Geography has five basic themes namely

1. Location 2. Place 3. Movement 4. Region, 5.human-environment interaction.

1. **Location**: - is defined as a particular place or position.

2. **Place**

- Place refers to the physical and human aspects of a location.
- Place is associated with:-
 - ✓ **Toponym** (the name of a place),
 - ✓ **Site** (the description of the features of the place), and
 - ✓ **Situation** (the environmental conditions of the place).

3. **Human-Environment Interaction**

- Human-environment interaction involves three distinct aspects: dependency, adaptation, and modification.
 - ✓ **Dependency** refers to the ways in which humans are dependent on nature for a living.
 - ✓ **Adaptation** relates to how humans modify themselves, their lifestyles and their behavior to live in a new environment with new challenges.
 - ✓ **Modification** allowed humans to “conquer” the world for their comfortable living.

4. **Movement**

- Movement entails to the translocation of human beings, their goods, and their ideas from one end of the planet to another.
- So, the three dimensions of movement include:
 - ✓ physical movement of people;
 - ✓ the transport of goods and
 - ✓ the flow of ideas

5. **Region**

- A **region** is a geographic area having distinctive characteristics that distinguishes itself from adjacent unit(s) of space. Region could be:-
 - ✓ A **formal region (natural regions)** that is characterized by homogeneity in terms of a certain phenomenon like soil, temperature, rainfall, physical conditions, etc.
 - ✓ A **functional region or nodal region** characterized by functional interrelationships in a spatial system. Ex: Town-region which is interdependent with surrounding rural areas

B. APPROACHES IN GEOGRAPHY

⇒ Like other social scientists, Geographers have their own approaches to their subject.

⇒ **The most frequently adopted approaches are:**

A. Topical or systematic approach

B. Regional approach

A. Topical or systematic approach

- It studies one issue and looks at its spatial variations in all parts of the globe.
- It gives emphasis on a **real differences** of specific elements over the whole earth or major parts of it.

❖ Example:

- ✓ The geography of hunger, climate, agriculture, population,
- ✓ The distribution of rainfall
- ✓ The distribution of rice cultivation, etc.

B. Regional approach

- It focuses on a region – a defined geographic unit or locality.
- It examines a **variety** of geographic features.
- It divides the **world into regions** with each having its **own distinct features** that make it different from others.
- The region studied could be countries that **share a common geographic** factor/elements.

❖ Example:

- o The geography of Africa, Asia, or Oceania, sub-Sahara, the Middle East, the Balkans.
- o The study of climate, natural vegetation, agriculture, etc. of each regions.

- A **region** is an area or spatial unit consisting of **similar** or **homogeneous** geographical features.
- **Regions are** vary in **area**; the size of a region is a function of the study's purpose.

⇒ Although geographers use these **two** basic approaches, are **interconnected and overlapping**.

⇒ The similarity could be, either **physical** or **cultural**.

1.5. MAJOR SCHOOL OF THOUGHT IN GEOGRAPHY

- Geography is a **dynamic** subject; it has gone through a series of **changes** and developments in scope.
- The 1930's, **witnessed/evidence/** shows major radical changes in the discipline, and were turning points in the history of geography.

➤ **The most prominent of these scholars were:**

1. Environmental Determinism

- It was the dominant idea up to WW. I.
- It is based on largely up on the teaching of **Friedrich Ratzel**.
- The physical env't is determining the day-to-day activity of people.
- This idea was laid down by **Greek** and **Roman** scholars.

🌈 EXAMPLE:

- **Darwin-1859**, "the origin of species" explain **extinction/destroy/** and the **distribution** of d/t species

- **Demolish** (1901 and 1903) - “**the flourishing of society is based on the environment.**”
- It consider human beings as **passive agents** where the **physical factors** determine their **attitude** and **process** of decision making.
- The prominent scholars who supported the school of determinism were:
 - ✓ Charles Darwin
 - ✓ Demolins,
 - ✓ Friedrich Rutzel, etc.

2. Environmental Possibilism

- It was postulated by **Fevre**.
- Human beings are **Masters of the environment** and they can judge their benefits.
- **Example: Deserts** can be turned into agriculturally productive areas through irrigation supports.
- They argued that there are **no necessities** but **only possibilities**.
- They emphasize that **two-way relationships** exist.
- They state that **people can influence** the env't to enhance their way of life.
- They agree that the env't can potentially affect people's activities, but they believe that we can **use our knowledge** and **skills** to regulate these effects.
- The possibilism believes that human societies cannot **fully tame** nature and is not always victories. Hence it replaces more:
 - ✓ **Deterministic terms** ‘*control*’ by ‘*influence*’ and ‘*influence*’
 - ✓ **Possibilities terms**, more **moderate terms** like ‘*response*’ or ‘*adjustment*’.

3. The Quantitative Revolution

- It is **inquiry** methods began to employ statistical techniques.
- Its roots in the 1950's and flourished during the 1960's helped geography to follow **quantitative data analyses**.
- It evolved a more abstract, theoretical approach to geographical research has emerged, and the analytical method.
- It was driven by the development of the **computer** and its ability to rapidly process data.
- **Quantitative geographers** “went radical” and applied computers, statistics, and mathematical models to the study of geographers.
- The subject focused mainly on the “**where**” of geographic features.
- The revolution was founded by geographers and statisticians in **Europe** and the **United States**.
- **The contribution of the revolution to the development of geography:**
 1. Bringing ‘scientific thinking’ to geography.
 2. Emphasized multivariable analysis.
 3. Response to the crisis in the 1950's.

⇒ Geography faced **challenges** during late 1940's & early 1950's.

✓ **Some of the major challenges were:**

1. The **shutting down** of many geography departments and courses.
 - o **For example**, Harvard University was abolished in 1948.
2. The **division between** Human and Physical geography.
3. Geography was seen as **solely descriptive** and **unscientific**.
4. Geography was **not useful** for solving problems.
5. Questions regarding the **nature of geography persisted**.
 - o **For example**, is geography was a science, or an art,

6. **Disagreement between scholars** who supported **quantitative methods** and those who favored the **descriptive approach** arose **Solution:**

1. Introduced a rapid change in the methodologies used in geographical research.
2. The change led to a shift from *descriptive geography* to *empirical law-making geography*.

⇒ **Some of the techniques that became central to geography during the quantitative revolution were:**

- ✚ Descriptive statistics
- ✚ Inferential statistics
- ✚ Basic mathematical equations and models, such as **gravity models**
- ✚ Deterministic models e.g., **Von Thune's and Weber's** location models
- ✚ Statistical models, using concepts of probability.

4. The Emergence of Applied Geography

- ❖ **Applied geography** is the applicability of geographic knowledge and skills to the solution of **economic and social problems** and **learns of planning**.
- The emergence of scientific research has helped the emergence of applied geography; which has **paved the way** for solving problems that restrict human progress.
- This development has become a science that we can solve socio-economic and political problems and aids in decision making.
- It is the use of geographic analysis in **private business, government, non-profit organizations**. Etc.

1.6. The Relationship b/n Geography and other Disciplines

- Geography is an interdisciplinary subject.
- It has strong relationships with various disciplines in both the **natural and the social sciences**.
- Knowledge and information in geography and the other sciences are interchangeable and interdependent.
- Geography shares facts with them and explains certain aspects of those sciences.
- ❖ **Examples:** how geography relates to these other sciences:

1. **Biology- related to** biogeography- is the study of plant and animal distribution, classification.
2. **Meteorology- related to** climatology.is the study of the earth's atmosphere.
3. **Geology- related to** Geomorphology and soil geography is the study of the internal composition of the earth.
4. **Astronomy: related to geo-astronomy**-is the study of the solar-system, the universe, the motions, positions, sizes, composition, and behavior of astronomical objects.
5. **Economics: related to- economic geography** is the study of the production, distribution, and consumption of goods and services.
6. **Political Science: related to political geography** is the study of political organizations and institutions, especially governments.
7. **History: linked to historical geography** is study of the past socio-economic and political processes of human society.

8. **Demography: related to population geography** is the study of human populations, trends, distribution, and statistics regarding birth, marriage, disease, and death.
9. **Physics: related to geophysics** is the study of matter and energy and the effects.
10. **Sociology: related to cultural geography** is the study of the origin, development, and structure of human societies and the behavior of individual people and groups in society.
11. **Mathematics: related to mathematical geog.** is the study of the relationships among numbers, shapes, and quantities.

UNIT TWO

2. MAP-READING AND INTERPRETATION

2.1. Definition and Concepts

- What is a map?
 - The art, science and technology of map-making is called **cartography**.
 - In the 17th century, Europeans developed the mathematical method of map making.
 - They developed the concepts of parallels and meridians lines covering the whole globe.
 - In recent years, remote sensing technique applied for:
 - ✓ Making accurate maps,
 - ✓ Monitoring the environment and
 - ✓ Conducting surveys.
 - ❖ **A map** is a simplified, diminished, plain representation of all or part of the earth's surface as viewed from vertically above in reduced scale.
 - ❖ Maps are graphical representation of the earth's surface.
- **Here are the main features or characteristics of maps:**
 - ✓ A map represents all or part of the earth's surface.
 - ✓ A map is a two-dimensional (plane) representation.
 - ✓ Maps show the earth's surface as if it were seen from directly above. This view is called a **bird's-eye view**.
 - ✓ All maps are smaller than the area they represent.
 - ✓ Maps are drawn to scale
 - ✓ Maps are simplified representations.
 - ✓ Most maps use generally accepted symbols to represent natural, artificial or cultural features of the area they represent.
 - ✓ All maps have marginal information to provide back ground of the map, such as the map's title, date and scale.

2.2. Uses of Maps

- Maps are basically used for identifying **locations, distance, area and direction.**

1. Location:

- ✓ Locate places by referring to absolute and relative location.

1.1. **Absolute location:** locate places using latitudes and longitude lines

- ✚ **Example**, the absolute location of Ethiopia is
 - o 3° N-15° N latitude and 33° E-48° E longitude

1.2. **Relative location**

- ✓ Locate a place with reference to neighboring countries, external land masses and water bodies.

- ✚ **Example-** Ethiopia's location can be expressed in terms of its
 - o Neighboring countries, such as; north of Kenya, east of Sudan & S. Sudan, west of Somalia, south of Eritrea.

2. Distance

- ✓ It is possible to calculate the extents between two or more places on a map.
- ✓ This is done by using the scale of the map.

3. Area

- ✓ The area of a place, a country, a region, a continent, a sub-continent or the whole world can be calculated from a map.
- ✓ Measuring the length and the width of the given place on the map and by converting them to ground distances with the help of the **scale of the map.**

4. Direction-

- ✓ Identify the direction and bearing of any place on the map by referring to another place.

2.3. Classification of maps

- **Maps are classified based on the purpose and scale variation**

➤ **Based on their purposes distribution maps are group into different classes**

1. Reference or General-purpose maps (Topographic maps)
2. Special-purpose maps (Thematic maps).
3. Charts

1. **General Purpose Maps** (Topographic map)

- These maps are topographic maps that **portray** different features at the same time.
- They are made at a **larger scale** covering smaller areas to show details information.
- They show both natural and human-made features. Because of this, they are used as **inferences.**

2. **Special-Purpose Maps** (Thematic Maps)

- Are the distribution that emphasize a **single geographical** element or character.

✚ **Example:** *rainfall map, Population map, soil map, etc.*

➤ **Thematic maps are reclassified into two subgroups:**

2.3.1. **The Study of Distribution Maps**

- A. Qualitative *Distribution Maps*
- B. Quantitative *Distribution Maps*

A. Qualitative Distribution Maps

- Show non-quantitative attributes.
- They are reclassified into two subgroups:

I. Chorochromatic Maps:

- ✓ Show the spatial distribution of geographic elements, using **color tint**, shading, symbols, dots, or line **without attaching any numerical values**.

II. Choro schematic Maps:

- ✓ Are use pictures and letters.
- ✓ The pictures often symbolized are pictures of the real element.
- ✓ They are relatively simple to understand.

B. Quantitative Distribution Maps (They display quantifiable features)

- ✓ Display spatial distributions of geographical elements by representing numerical values.
- ✓ Maps use graphs, dots, and proportional figures to show distributions.

➤ The most commonly used quantitative distribution maps are:

I. Dot maps

II. Choropleth maps

III. Isopleth maps

IV. Graphs and diagrammatic maps

I. Dot maps: In dot quantitative maps, each dot represents a given quantity or value.

➤ To create an accurate dot map, you must

- ✓ *place the dots accurately*
- ✓ *be sure there is enough space between the dots to distinguish them*
- ✓ *be sure all dots on the map are of the same size*

II. Choropleth maps: they are also called *shaded maps*.

- ✓ Display quantifiable features
- ✓ Used to show the distribution of **average values** such as population density.
- ✓ The type or intensity of the shading reflects variation in quantity.

III. Isopleth maps:

- ✓ Isopleths are lines of equal value or magnitude.
- ✓ Use lines that pass through points of equal value.
- ✓ They are most commonly used for representing **climatic elements, transportation costs, etc.**

✚ **Example of isopleth maps**

- ✓ **Isotherm maps** - are show equal temperature points.
- ✓ **Isobar maps**- are show equal pressure distribution.
- ✓ **Isodapane maps** -are show equal transportation-cost distribution.
- ✓ **Isohyet maps** -are show equal rainfall distribution.
- ✓ **Isoneph maps** -are show equal cloud cover distribution.

IV. Graphs and Diagrammatic Maps:

- ✓ Used to show quantifiable distributions data.
- ✓ They can be used for comparative studies of d/t geographical aspects.
- ✓ Such as Economic data, Population data

a. Graphic maps:

- ✓ Used to show the r/p b/n two geographic variables in **time** and **space** series.

- ✓ The simplest and most widely used graphs are line graphs and bar graphs.
- ✓ Both line graphs and bar graphs can use a single or double format.

b. Diagrammatic maps:

- ✓ Are more explanatory than graphic maps since they are two-dimensional model.
- ✓ These maps employ figures such as squares, circles, arrows, spheres, etc.
- ✓ The sizes and area of the figures are proportional.
- ✓ Proportional figures are used for making comparisons.
- ✓ These are:
 - o **Proportional Squares:** the resulting d/t sized squares represent the d/t Potentials values.
 - o **Proportional circles:** to show the proportional share of individual components (pie chart).
 - o **Proportional arrows:** used to show different magnitudes or flows.
- ✓ Used to portray the degree or volume of movements of goods, traffic flow, migration of people, direction of exports and imports, etc.

➤ **Map based on Scale variation:**

- ❖ **Scale** is a ratio that shows the degree to which the area that is mapped has been reduced.
- 1. Large-scale maps
- 2. Medium-scale maps
- 3. Small-scale maps

A. Large-scale maps

- Expressed with a scale of $\geq 1:50,000$.
- It presents small areas in detail with great accuracy.
- Show detailed information of small areas

✚ **Example;** cities or towns map, villages map, the bends/corves in highways. etc.

B. Medium-scale maps

- prepared with a scale b/n $1:50,000 - 1:250,000$
- Cover wider areas than large scale maps,
- But cover smaller areas than small-scale maps.
- Contain moderately detailed information

✚ **Example;** cities or towns map, villages map.

C. Small-scale maps

- prepared with a Scale: $\leq 1:250,000$
- Cover large areas
- Contain less-detailed information

✚ **Example;** used to drawing country, continents, or world as a whole.

2.4. Map Scale

- ❖ What is map scale? Why do we need map scales?
 - The scale of a map is the ratio between the measurement of distance on the map and the corresponding measurement on the earth's surface or ground.
- **Ways of Map Scale Expression**

a. Scale Statement

- ✓ It is a technique by which scale can be expressed in words.
- ✓ Example: One centimeter to one kilometer (1cm to 1km).

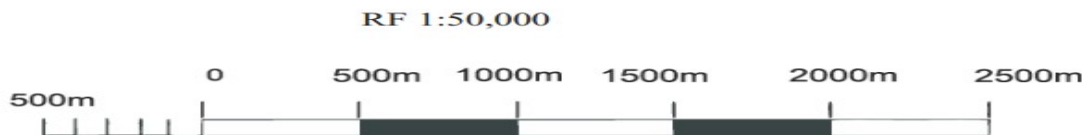
b. Representative Fraction

- ✓ Map scale is expressed as a ratio or fraction.
- ✓ However, Representative fraction is commonly expressed in a ratio

Example: 1:400,000 (ratio) or $\frac{1}{400,000}$ (Fraction)

c. Graphic Scale/Linear Scale

- ✓ It is called bar, linear or line scale
- ✓ Graphic scale is a line drawn on a map and it is subdivided into units appropriate to the scale of the map
- ✓ Graphic scale is drawn with primary divisions towards the right of zero where one division with secondary divisions marked on the left of zero



➤ **There are two types of scales Linear and Areal Scale**

1. Linear Scale

❖ What is linear scale?

- Linear scale is measure distance.
- Linear scale expresses the ratio of map distance to ground distance.
- It is the most common scale type.
- It expresses by statement scale. Example- 1cm to 2km, 1cm to 0.5km, etc.

2. Areal scale

❖ What is Areal scale?

- Areal scale shows the relationship between map area and ground area
- Areal scale is the square of linear scale.
- For example, if a map has a linear scale of 1 cm to 6 km, then
- The areal scale of the map is $(1 \text{ cm})^2$ to $(6 \text{ km})^2$, which means 1 cm² to 36 km².

$$\text{Areal Scale} = (\text{Linear Scale})^2 = \left(\frac{\text{Distance on the map}}{\text{Distance on the Ground}} \right)^2$$

3. Convert one form of scale into another form of scale

- To calculate linear scale from areal scale, you put the areal scale into a square root.
- For instance, if the areal scale of a map is 1 cm² to 36 km², then
- The linear scale of the map is the square root of the given areal scale, as shown below.

$$\begin{aligned}\text{Linear Scale} &= \sqrt{\text{Areal scale}} = \sqrt{\frac{\text{Map Area}}{\text{Ground Area}}} \\ &= \sqrt{\frac{1 \text{ cm}^2}{36 \text{ km}^2}} = 1 \text{ cm to } 6 \text{ km}\end{aligned}$$

- If a certain linear scale is doubled, then its areal scale equivalent would be four times larger than its original scale.

Activity 1.8

➤ **Perform the following tasks.**

1. Find the areal scale for the following:
 - a. 1 cm to 2 km
 - b. 1 : 100,000
 - c. 5 cm to 25 km
 - d. 3 cm to 9 km
2. Find the linear scale for the following:
 - a. 4 cm² to 400 km²
 - b. 4 cm² to 16 km²
 - c. 5 cm² to 500 m²
 - d. 1 cm² to 4 km²

➤ **How to Find the Scale of a Map**

- In principle, every map should show the scale to which it has been drawn.
- If the scale is not shown, we can calculate it.

➤ **There are two ways of finding a map scale, if it is not given:**

A. **By using the known distance between two points on the map**

- This method is used if the ground distance between two points or places shown on the map is given.
- Then use the following procedure to obtain the scale:
 - i. Measure the distance between the two points on the map in centimeters.
 - ii. Divide the obtained distance on the map by the ground distance to obtain the ratio between the two. This gives you the scale of the map.
- To understand this better see the following example.
- Let us say, if the straight-line distance between Addis Ababa and Mekele is 555 km.
- What is the scale of the map?

➤ **Using the distance between Addis Ababa and Mekele:**

- iii. Measure the distance between Addis Ababa and Mekele by using a ruler approximately 3 cm.
 - o The given air distance between the two places is 555 km.

iv. Find the ratio between the distance on map and the actual distance.

- This is the scale.

$$\text{Scale} = \text{Md/gd}$$

$$3 \text{ cm to } 555 \text{ km} = 1 \text{ cm to } 185 \text{ km} = 1: 18,500,000.$$

B. By using latitudes

- In this method, the scale of the map can be obtained by using the values of latitudes.

✚ For example,

- Let us calculate the scale of Figure 1.7 by using the 5° and 10° N latitude lines:
 1. The degree difference between the two latitudes is 5° (10° – 5°).
 2. The distance that 5° represents is 555 km (111 km × 5).
 3. The distance between the two latitudes on the map is approximately 3 cm.
 4. The scale of the map is, therefore:

$$\text{Scale} = \frac{\text{Distance on the Map}}{\text{Ground Distance}} = \frac{3 \text{ cm}}{555 \text{ km}} = 1 \text{ cm to } 185 \text{ km}$$

$$1: 18,500,000$$

➤ **Focus**

- 1° latitude is about 111 km,
- This relationship is derived from the circumference of the earth – 40,000 km.
- If 360° = 40,000 km
1° = ?

$$\frac{1^\circ \times 40,000 \text{ kms}}{360^\circ} = 111 \text{ km}$$

$$1^\circ = 111 \text{ km}$$

➤ Answer the following questions in your group.

1. The ground distance between two places is 100 km. If this distance is represented by 5 cm on a map, what is the scale of the map?
2. If two places on the ground that are located 5° north and 10° north are shown 10 cm apart on a given map, what is the scale of the map?

➤ **The Measurement of Regular and Irregular Shaped Areas**

- Some areas have regular or geometric shapes,
- Such as rectangles, triangles, circles and squares.
- Others have irregular or non-geometric shapes.
- Such as farm land, lakes, stone, swamps, etc.

➤ This procedure is important for measuring areas on maps:

1. Measure the area of the feature on the map;
2. If the map scale is linear, convert it to areal;
3. Using the areal scale, convert the area on the map to actual ground area by using cross multiplication.

A. Measuring Regular-Shaped Areas

- A regular shape is a geometrical shape such as a circle, triangle or square.
- Calculate the ground area by using the map's areal scale.
- The following table gives you some of geometric formulae for calculating the areas of regular shapes.

Table 8.1: Geometric Formula

Regular Shaped Areas	Mathematical Formula
Square	$A = S^2$; where A = area, and S = side
Rectangle	$A = l \times w$; where A = area, l = length, and w = width
Right Angle Triangle	$A = \frac{1}{2} bh$; where A = area, b = base, and h = height
Circle	$A = \pi r^2$; where A = area, and r = radius. ($\pi = 3.14$)

➤ **Calculate the Following**

$$L = \frac{2 \text{ cm} \times 2 \text{ km}}{1 \text{ cm}} = 4 \text{ km} \quad \text{and} \quad W = \frac{4 \text{ cm} \times 2 \text{ km}}{1 \text{ cm}} = 8 \text{ km}$$

$$\text{Area} = L \times W$$

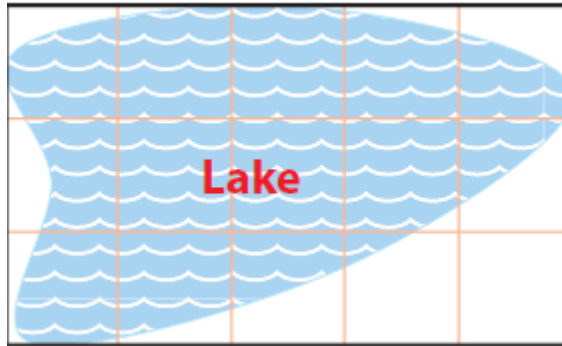
$$\begin{aligned} \text{Area} &= 4 \text{ km} \times 8 \text{ km} \\ &= 32 \text{ km}^2 \end{aligned}$$

Therefore, the area of the farm land is 32 km².

B. Measuring Irregular-Shaped Areas

- Its area cannot be directly calculated by using mathematical formulae.
- In such cases, we can use the grid square method to measure the area of the lake on the map.
- land such as islands, farmlands, parks, etc. cannot be obtained accurately by simple methods as the regular shapes
- Such areas can be obtained by devices like plan meter and other methods such as the grid square method
- **Plan meter:** is an instrument used to get accurate areas of both regular and irregular shaped features from maps.

Grid Square method: it deals with the area of purely irregular shape. It is manual and involves tremendous labor



➤ We follow the following steps:

1. Copy the boundary of the lake.
2. Draw grid lines at a uniform interval (for example, 1 cm apart) over the lake.
3. Count the number of grid squares within the lake:

✓ number of full squares = -----

✓ Number of $\frac{3}{4}$ squares = -----

✓ Number of $\frac{1}{2}$ squares = -----

✓ Number of $\frac{1}{4}$ squares = -----

✓ Thus, total number of squares = $4 + 5 \times \frac{3}{4} + 4 \times \frac{1}{2} + 1 \times \frac{1}{4} = 10$

✓ Calculate the approximate area of the lake.

d. First, find the area of one square by using the scale. area = $S^2 = 1 \text{ cm} \times 1 \text{ cm} = 1 \text{ cm}^2$ or $2 \text{ km} \times 2 \text{ km} = 4 \text{ km}^2$

e. Then, calculate the total area of the lake.

✓ If one square = 4 km^2

$10 \text{ cm}^2 = \text{----?}$ The approximate area of the lake is **40 km square**

2.5. Marginal Information of Maps

➤ What is a map's margin?

➤ What are the most common types of information that are found in the margin of a map?

- Maps are used to convey information.
- To read maps effectively, map users need information about the map. Such information is presented in the map's margins and is known as marginal information.

➤ Marginal information includes:

1. **Title of the map:** Gives the map's name. For example, "Soil Map" explains that the map presents information about soil.
2. **Year of publication:** identifies the year in which the map was published. Because this information tells you how old the map is, you might be able to judge whether the map's contents are current or might be out of date.
3. **Author:** identifies the copyright owner of the map and indicates who (or what organization) has prepared the map.

4. **Place of publication and publisher:** tells where the map was published and identifies the organization that published the map.
5. **Scale:** This information indicates the extent to which the area that is represented in the map has been reduced.
6. **Legend/Key:** explains the meaning of the signs and symbols used in the map.
7. **Type of projection:** tells the kind of projection used in making the map.
8. **Direction or orientation** (North) arrow: Shows the north direction on the map.
9. **The magnetic declination** (variation): is the difference between Magnetic North and True North. This will be explained later in this unit

2.6. Conventional Signs and Symbols

- Conventional signs and symbols are those signs and symbols that are used on maps through the agreement of all map-makers of the world.
 - They are used to represent the same detail on a map in all the countries of the world.
 - Signs and symbols help the map reader to understand maps. Therefore, the map reader has to look first at the **key or legend** of the map.
- When you create a map, the symbols you select should satisfy the following requirements.
1. They should be uniform throughout the map.
 2. They should be easy to read and understand.
 3. The space occupation, orientation and size of the symbols should be constant.
- Here are some of the symbols and conventional signs that are widely used and understood worldwide:
1. Cities and towns are indicated by dots or patches of shading;
 2. Streams and bodies of water are often printed in blue; and
 3. Political boundaries are shown by dot lines/solid lines.

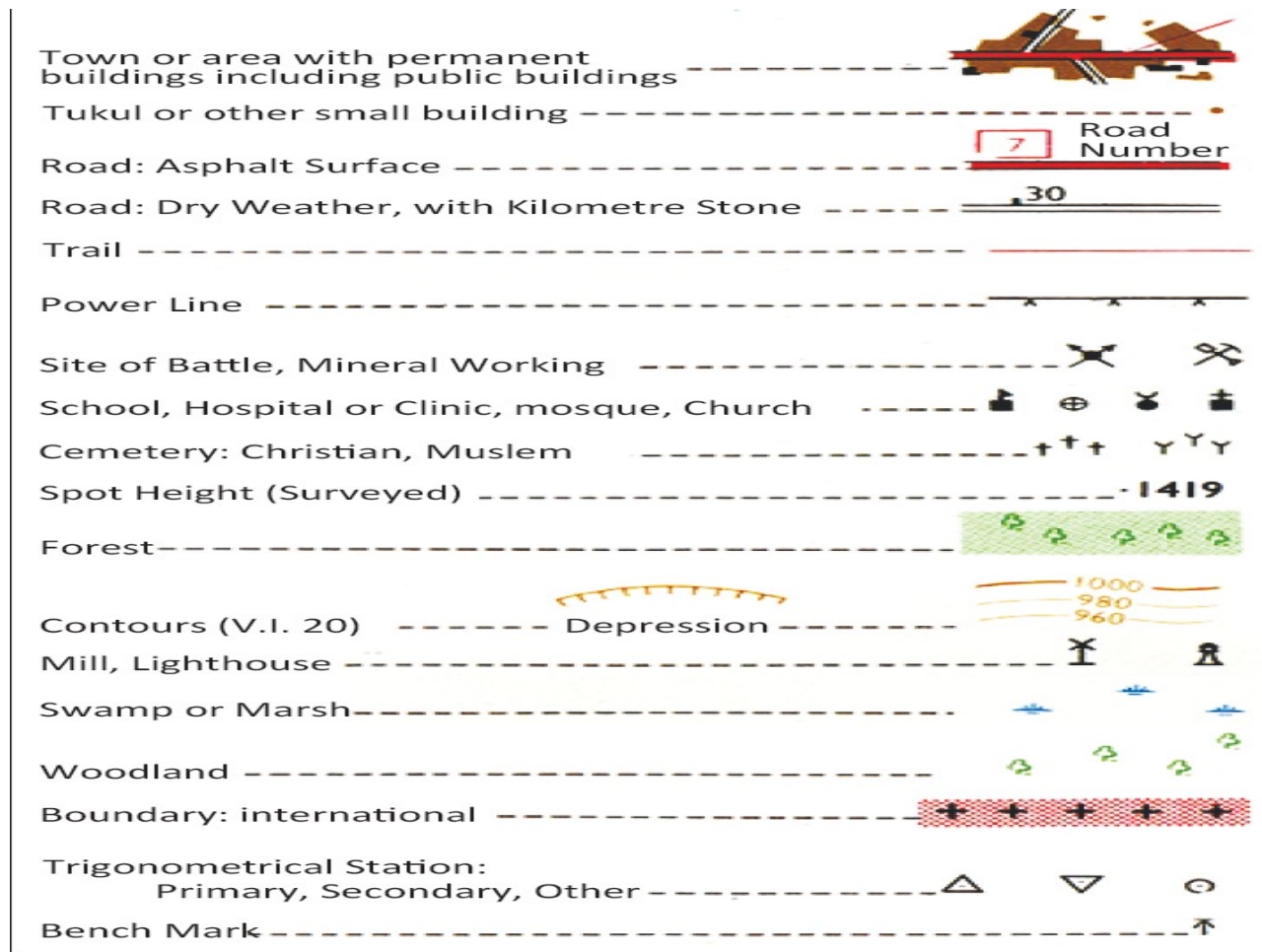


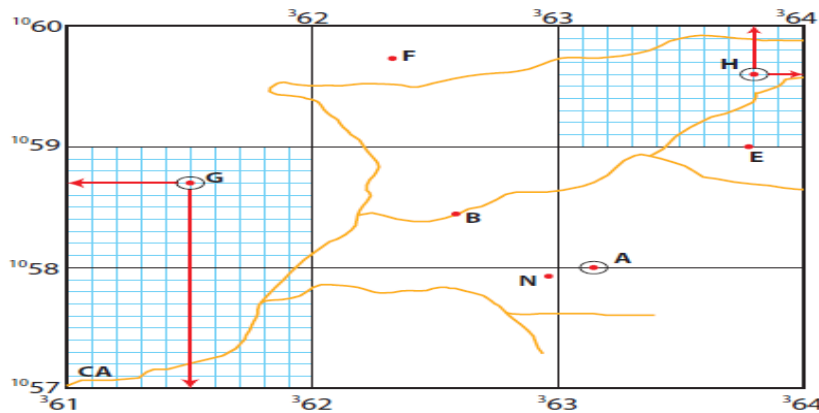
Figure 2.3: Conventional symbols used in the topographic map of Ethiopia

Symbol	Description
	All-weather road
	Bridge
	Permanent lake
	Plantation
	Mine

2.7. Grid References

- A map grid is a set of imaginary lines that divides the earth's surface into regular grids.
- There are two major map grid systems:
 1. International (Geographic) Grid System
 2. National Grid System

1. **The International (Geographic) Grid System** shows the absolute locations of places on the surface of the earth.
 - Its references are made up of:
- 1.1. **Parallels or lines of latitude** – define locations north and south of the equator.
 - They are horizontal lines of the grid.
 - They have equal distant from each other.
 - Degrees of latitude are numbered from 0° to 90° north and south of equator.
 - Each degree of latitude is approximately 111 km apart.
 - Zero degree is the equator, the imaginary line which divides our planet into the northern and southern hemispheres.
 - 90° north is the North Pole and 90° south is the South Pole.
 - Latitudes are angular distances measured to the north and south of the equator in degrees, minutes and seconds.
- 1.2. **Meridians or lines of longitude** – define locations east and west of an imaginary north-south map line called the **Prime Meridian**.
 - They are vertical lines of the grid.
 - They converge at the poles and are widest at the equator (about 111 km apart).
 - Zero degrees longitude is located at Greenwich (0°).
 - The degrees continue 180° east and 180° west where they meet and form the International Date Line in the Pacific Ocean.
 - Longitudes are also angular distances, but they are measured to the east and west of the Greenwich meridian.
 - Try to explore how lines of latitudes and longitudes create a grid network on the following map.
2. **The National Grid Systems:**
 - Used on maps of individual countries and regions within them.
 - The National Grid System uses eastings and northings.
 - ✓ **Eastings** are lines that are drawn from north to south.
 - ✓ **Northings** are lines that are drawn from east to west.
 - Eastings and northings in the National Grid System originate from the “False Grid Origin” that lies at the southwestern corner of the place they cover.
 - While the values of eastings increase eastwards, the values of northings increase northwards.
 - Eastings and northings are measured in kilometers.
 - In Ethiopia, there are two ways of giving national grid reference.
- **They are four digit and six-digit grid reference.**



Find the four and Six digit grid reference F, H, A, N, B, G.

2.8. Measurement of Direction and Bearing

- **Directions** from one point to another or the bearing of one point from another can be given using two different sets of units
- A modern, and more accurate, method gives the directions in degrees and fractions of degrees clockwise from north.
- 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.

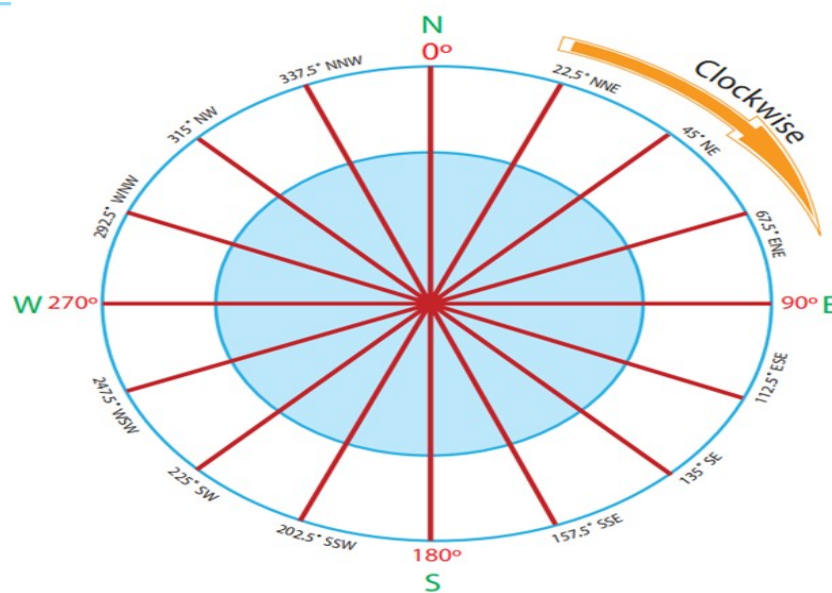
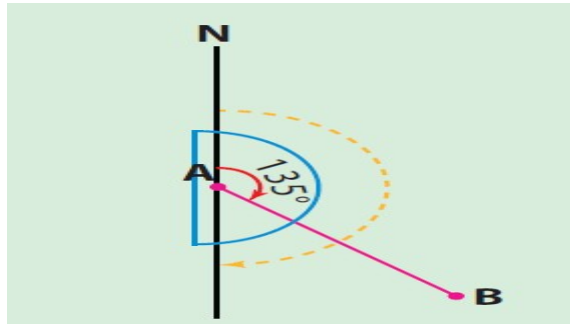


Figure 1.1: Compass Points

- ✓ To determine directions we need to have Cardinal Direction
- ✓ Cardinal Direction is - direction from which we can identify and measure other directions.
- ✓ We use North as the cardinal direction and measure all other bearings from this one
- ✓ Before doing any measurements of directions, make sure that you know where true north is
- ✓ Directions from one point to another can be given using two different sets:
- ✓ **Traditional system** -uses the cardinal compass points North, East, South, West and subdivisions of them.

- ✓ Modern method -gives the directions in degrees and fractions of degrees clockwise from north.



- ✓ 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.

2.9. GLOBE AND MAP

➤ The properties of globes and maps.

- Maps and globes are very important tools that use in order to show geographic facts.
- They differ from each other in what they can portray and how they portray this information.

➤ The particular Properties of a map

- ✓ Maps are two-dimensional plane representation of the surface of the earth printed on a piece of paper.

➤ The particular Properties of a Globe

- ✓ Globes are the most appropriate models for representing the surface of the earth because they are spherical shape.
- ✓ The scale on the surface of a globe is identical over all of its surface.
- ✓ All meridians and parallels on a globe intersect at right angles.
- ✓ All meridians converge at the poles.
- ✓ All parallels are parallel to the equator and to each other.
- ✓ Parallels decrease in length as they approach the poles.

➤ The advantages of a map over a globe:

- Maps are used more frequently than globes, particularly in the classroom and in fieldwork.
- If a globe is a more accurate representation of the earth than a map, why do we often prefer maps?
The answer is that:
 - ✓ Globes are expensive to reproduce and update, but maps are not.
 - ✓ Globes are not easy to fold and handle, but maps are.
 - ✓ Globes must be rotated to show the entire surface of the earth, and
 - ✓ Globes are not convenient for showing locations and distributions over very large areas. With a map, you can see the whole of any area shown on map immediately.
 - ✓ Most globes are less than one meter in diameter and therefore are too small to provide detailed information
- ❖ Cartographers developed map projection to solve the problems that globes presented.
- ❖ The end result of their efforts was to produce an alternative tool – the map.

2.10. MAP PROJECTION

2.10.1. Meaning and Significance of Map Projection

- **Map projection** is a technique that cartographers use to transfer information from a **globe** to a flat surface in order to create a **map**.
- ❖ The process of transferring information from globe (a three-dimensional model) to a flat (two-dimensional model) in order to create a map.
- ❖ **Map projection** Transferring information from a spherical shape surface of the earth to a flat map, we use a remedial device is called **map projection**.

2.10.2. Properties of Map Projection

- No type of map projection is free from distortion.
 - This is because there is no way to cut up the spherical surface of a globe to lie on a flat piece of paper.
 - The task of representing a spherical surface on a perfectly flat plane surface is complicated.
 - Therefore, transferring the globe to a flat surface always results in distortion.
 - Distortions is always occur in the following properties:
 - ✓ *Area, Distance, Shape and Direction (angle)*
 - Therefore, there is **no projection** type that provides an absolutely perfect representation of the earth on a flat surface.
- Here are some commonly used types of projections. Each maintains accuracy in one of the features by sacrificing in others.
- ❖ **Homolographic projections** maintain accuracy of **shape**.
 - ❖ **Orthomorphic projections** maintain accuracy of **size**.
 - ❖ **Azimuthal projections** maintain accuracy of **direction**

2.10.3. Geometrical Map Projection (Base on geometrical surfaces, geometrical figures)

- There are some geometrical surfaces that can cover the globe partially.
 - By covering a globe of glass (that illuminates from inside) the shadows of parallels and meridians can be traced on the paper and then open into a plane surface.
 - Here are some commonly used map projections that are based on the shape of the **developable surface. Some of them have sub-categories**.
 1. Cylindrical
 2. Conic (cone)
 3. Planar (plane) – also known as azimuthal
1. **Cylindrical map Projections: (Keeping of the globe in to a cylinder)**
- Cylindrical projection are obtained with the help of a cylindrical developable surface.
 - The cylinder is tall enough to parallel **both sides of the equator**.
 - After the data have been captured, the cylinder is removed from the globe and cut open and flattened to create a rectangular plane surface.
- **Characteristics of Cylindrical Projection** In such projections:
- ✓ Parallels and meridians in such a projection are straight lines intersecting at **right angles**.
 - ✓ The lines tangent to the developable surface are **true to scale**.
 - ✓ All parallels are equal in length to the equator.
 - ✓ Distortions increase pole wards from the equator.

- ✓ Cylindrical projections are best suited for the projection of **tropical regions** since deformities increase pole wards.

2. Conic map Projection

- **It means** covering the globe with a cone-shaped developable surface.
- The cone is placed tangent to the globe located above a pole.
- **Characteristics of Conic Projection** In such projections:
 - ✓ Parallels make arcs of concentric circles.
 - ✓ Meridians are straight lines radiating from the pole.
 - ✓ The parallel tangent to the cone is true to scale. It is known as the standard parallel.
 - ✓ Distortions increase as parallels move away from the standard parallel.
 - ✓ Conic projection cannot be used to show worldwide distributions.
 - ✓ Conic projections are mostly restricted to **show maps of mid-latitude regions** so that does not extend very far to the north or to the south.
 - ✓ Linear features, such as transcontinental railways and forests, for example, coniferous forest regions, can be depicted accurately.

3. Zenithal Projection: *planar (plane)* –

- It refers to overhead position that is perpendicular.
- This projection is also known as **azimuthal projection**.
- True distances and directions in such projection are retained by placing a developable surface at one of the poles.
- **Characteristics of Zenithal /Azimuthal Projections** In such projections:
 - ✓ Parallels are concentric circles.
 - ✓ Meridians are straight lines radiating from the poles.
 - ✓ Planar projections produce circular maps.
 - ✓ Planar projections are very much suited **to maps of polar landmasses (high latitude regions)**.

2.11. Relief representation on maps

- Methods of Showing Relief on a Map
- Two methods (Traditional and Modern)
- A. **Physiographic Diagrams** relief features were represented by diagrammatic pictures show three-dimensional pictures of landscapes is simple and easy to understand
- **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.

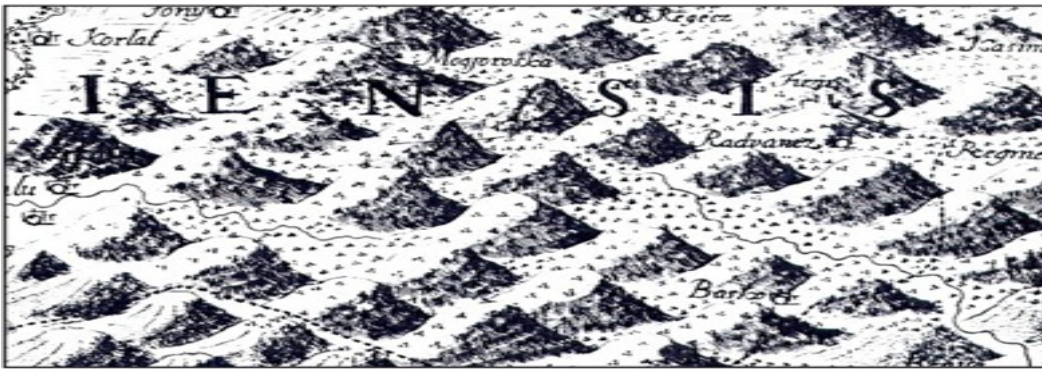


Figure 1.15: Physiographic diagram

B. Hachures

- ✓ Hachures are short disconnected lines that represent slopes.
- ✓ Show the steepness of slopes.
- ✓ For steep slope, hachures are put close together.
- ✓ For gentle slopes, the hachures are spaced wide apart.

➤ Disadvantages

- ✓ 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.

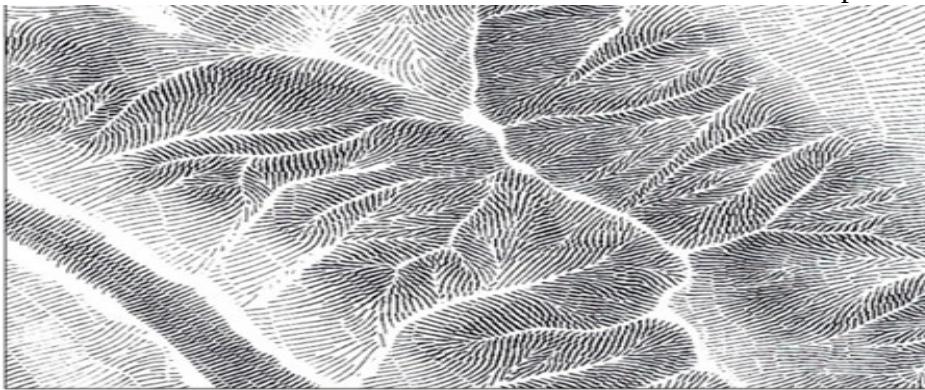


Figure 1.16: Hachured map

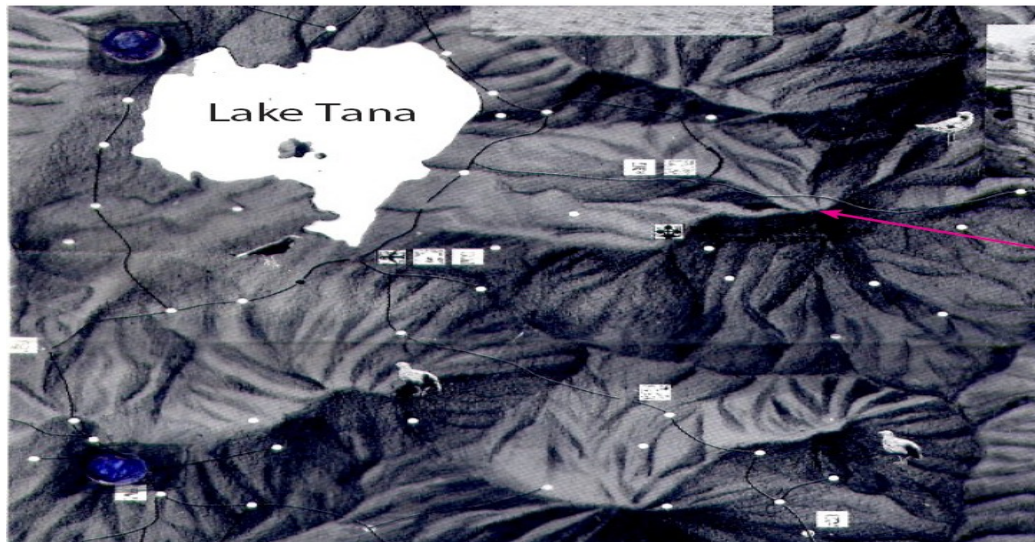
C. Hill shading

- ✓ known as oblique illumination
- ✓ method of showing relief on a map, assuming an oblique light that illuminates the landscape from the northwest corner of the map
- ✓ The steeper the slope is, the darker it is shaded.

➤ Disadvantage

- 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



D. Layer Coloring (Layer Tinting)

- ✓ Method of showing relief by using colors.
- ✓ The series of colors for showing different altitudes starts from sea level

➤ 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

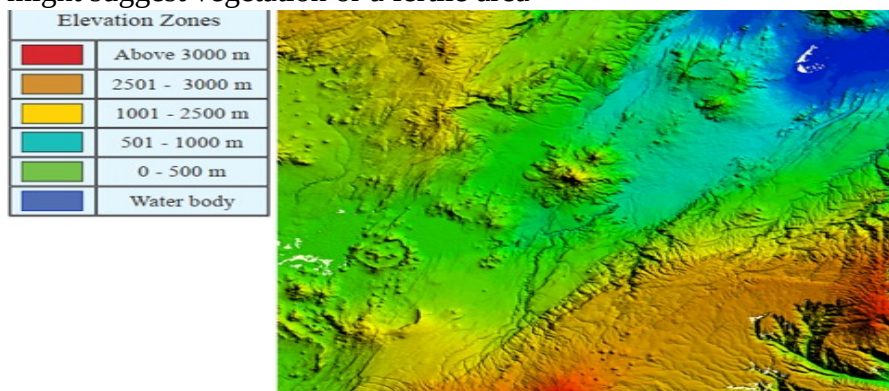


Figure 1.18: Map with layer coloring

E. Form lines

- ✓ imaginary pecked or broken line joining points with the same approximate height on a map
- ✓ are useful for showing sea depths

➤ Disadvantage

- 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

2.12. Modern Methods of Relief representation

A. Contour Lines or Isohypsies

- ✓ Are the most common and accurate way of showing relief.
- ✓ A shoreline is a good example of a contour line
- ✓ are lines drawn on a map joining places of the same elevation above mean sea level
- ✓ They give almost true altitudes.
- ✓ Are sometimes used in combination with hachures, hill-shading, layer-coloring and spot heights.

➤ Properties of Contour Lines

- ✓ Contour lines are imaginary lines used on a map to represent relief
- ✓ A set of contour lines is drawn at a fixed height interval
- ✓ Contour lines cannot merge or cross one another on maps except at vertical cliffs, waterfalls or over hanging cliffs
- ✓ Contour lines never branch
- ✓ A contour line joins all points of the same altitude.
- ✓ Contour lines are always numbered in the direction towards which altitude increases.
- ✓ 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
- ✓ Contour lines can be printed with different thicknesses on a map
- ✓ 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
- ✓ Contour lines can show different types of landforms, such as mountains, hills, plateaus, depressions, valleys, spurs.

➤ CHARACTERISTICS OF COMNTOUR LINES

- Closed contours with more or less circular shapes, with values increasing towards the center and with the top indicated by a spot height represent **mountains or hills**
- Closed contours with more or less circular shapes, with values decreasing towards the center represent **depressions**
- Closed contours with elongated shapes, with values increasing towards the center with no specific tips indicate **mountain ranges**
- Closed contours with more or less rectangular shapes, with values increasing towards the center with the top being a very wide closed contour represent **plateaus**
- Contours with shapes downward bending and values increasing upward represent **spurs**
- Contours with shapes, upward bending and values increasing upward represent **valleys**
- Contours are drawn from spot heights by using the method called **interpolation** to determine the height of places between successive spot heights.

➤ Interpolation can be done in any one of the following ways.

1. Estimation method:

- o Used to locate contour lines by rough estimation.
- o It should be applied in areas where the ground is quite regular and
- o When very simple and small-scale work is done.
- o It does not necessarily need great accuracy.

2. Calculation method:

- o It is the most accurate method of interpolation.
- o The exact altitude of the contour will be determined by measurement and subsequent calculations.
- ✓ Despite its accuracy, the calculation method is **time-consuming and laborious**.

3. Graphical method:

- ✓ It is the quickest and the most accurate method of interpolation of contours.
- ✓ In the graphic method, a graph is prepared on tracing paper.

- Cartographers use **three types of contour lines** while representing relief on topographic maps.
These are:

1. Index Contour:

- ✓ Starting from zero elevation or mean sea level,
- ✓ Every **fifth or tenth contour** line is a **bold/darker** than the other contour lines.
- ✓ These heavier/bolder contour lines are called **index contour** lines.
- ✓ Commonly, each index contour line is numbered at some point.
- ✓ This number indicates the elevation of that line.

2. Intermediate Contour:

- ✓ Lines falling b/n the indexes contour lines.
- ✓ Lines are finer/thinner than the index contours.
- ✓ They do not have their elevations.
- ✓ In most cases, there are **four/nine** intermediate contour lines b/n index contour lines.
- ✓ Their value is decided by dividing the difference in altitude b/n two consecutive index contours by five, if there are four intermediate contours.

3. Supplementary Contour:

- ✓ These contour lines resemble/similar/ dashed or broken lines.
- ✓ They show changes in elevation of at least **one-half** the contour interval.
- ✓ These lines are normally found where there is very little change in elevation, such as on fairly level terrain

➤ **Different Methods of Showing Altitudes on Contour Maps**

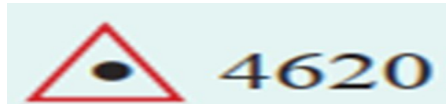
- ✓ Contour line not show the specific heights of individual features such as mountain peaks, hilltop
- ✓ heights are indicated on maps, using the following methods

i. Spot heights

- They are marked on the map with a dot followed by an altitude number
- They provide accurate altitudes for individual points, such as those along a road, on a mountain top, or between contour lines
- spot heights do not give a good visual impression of the general relief
- They exist only on maps

ii. 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



iii. Benchmarks

- They indicate precise heights along highways or railways.
- They are shown on stones, bricks or bronze plates on walls of buildings.....
- They are useful for road construction engineers and others

B. Slopes and Gradients

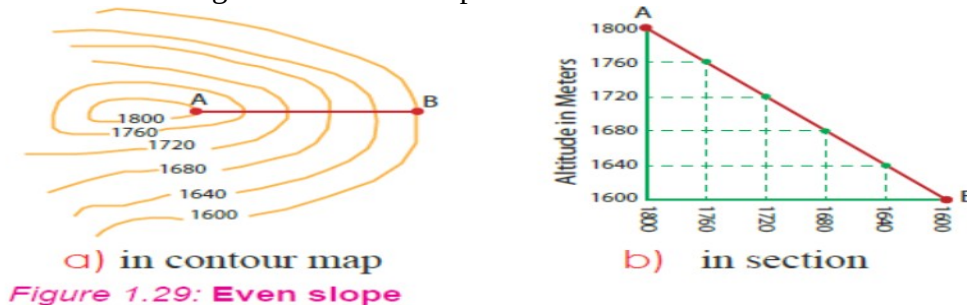
➤ **Slopes on Contour Maps**

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

C. Types of Slopes.

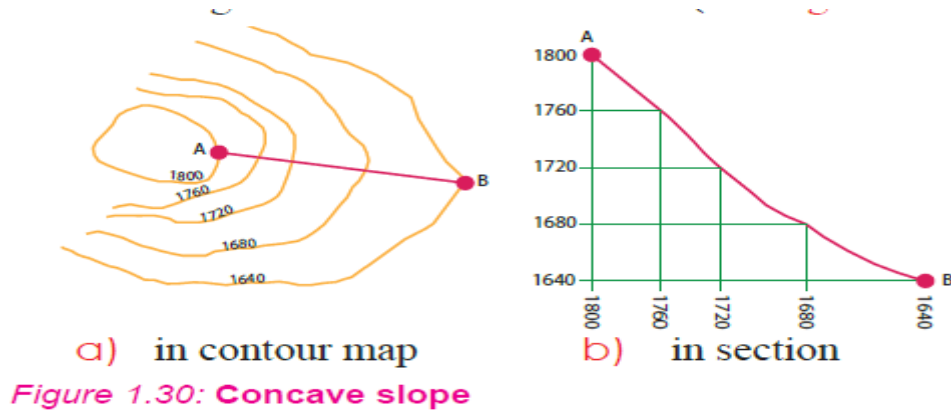
1. Even slope

- ✓ has a constant gradient from the bottom to the top
- ✓ Gradient is the degree or rate of a slope



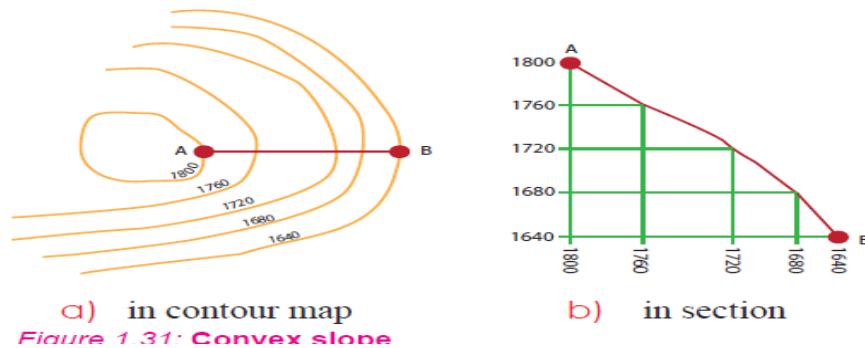
2. Concave slope:- the contour lines are widely spaced at the base & close together at top

- Has a steep gradient at the top and gentle towards the bottom.



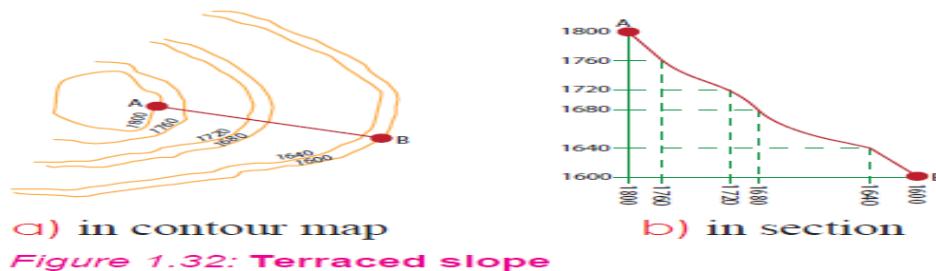
3. **Convex slope:** - the contour lines are close together at the base and widely spaced at top.

- Has a steep gradient at the bottom and gentler towards the top.



4. **Terraced or stepped slope:** - the contour lines are alternatively close together and far apart in a regular pattern.

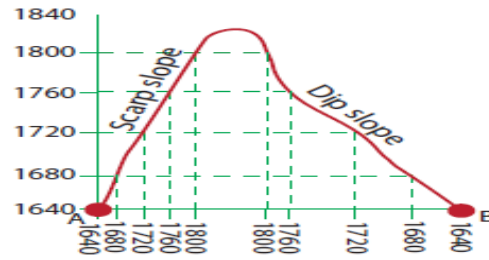
- ✓ This means the gradient changes several times b/n the bottom and the top of the slope.



5. **Escarpment:-** is the steep slope of the plateau, or cliff separating two areas at different levels, one slope is steep(scarp- slope) and the other is gentle (dip- slope)



a) in contour map



b) in section

Figure 1.33: Dip and scarp slopes

A. Gradient on contour maps

- ✓ Gradient (GR):- is the degree or rate of change of slope or elevation b/n two points.
- ✓ Gradient (GR):- is calculate using Altitude difference and map distance b/n two points.
- ❖ N.B.:- both AD and MD must be in the **same unit** of measurement.
- **Gradient can be stated in three ways :-**

1. GR in Ratio = $\frac{AD}{MD}$
2. GR in Percent = $\frac{AD}{MD} \times 100$
3. GR in Degree = $\frac{AD}{MD} \times 60^\circ$

E.g. Calculate the gradient b/n Addis Ababa and Adama on activity 1.16 page 42, in ratio, percent and degree.

➤ **Given:-**

$$AD = 2400m - 1700m = 700m \div 1000m \times km = 0.7km$$

$$Scale = 1:1000,000 \text{ (1cm to 10km)}$$

$$MD = 10cm \times 10km = 100km$$

$$GR \text{ in ratio} = \frac{AD}{MD} = \frac{0.7}{100} = \underline{1:143}$$

$$GR \text{ in percent} = \frac{AD}{MD} \times 100 = \frac{1}{143} \times 100 = \underline{0.7\%}$$

$$GR \text{ in degree} = \frac{AD}{MD} \times 60^\circ = \frac{1}{143} \times 60^\circ = \underline{0.4^\circ}$$

Table 1.1 expression gradients in three ways

Types of expressions			Types of gradient
Ratio	percent	Degree(approximate)	
1:100	1%	0.6 ⁰	Gentle
1:60	1.7%	1 ⁰	Gentle
1:20	5%	3 ⁰	Moderate steep
1:10	10%	6 ⁰	Moderate steep
1:5	20%	12 ⁰	Steep

1:2	50%	30°	Very steep
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2.13. Land Forms on Contour Maps

- ✓ Different landform (relief features) can be shown on topographic maps by using contour lines.
- ✓ Their patterns help map readers to easily identify the kind of terrain feature represented.
- ✓ Each landform will be illustrated by using contours and cross section.

1. Valley:

- ✓ It is a long narrow depression lying between two or more higher grounds.
- ✓ It is a stretched out channel in the land, usually formed by streams or rivers.
- ✓ It begins with high ground on three sides, and usually has a course of running water through it.
- ✓ A valley, three directions offer high ground, while the fourth direction offers low ground.
- ✓ Contour lines forming a valley are either U-shaped or V-shaped.
 - U-shaped contours represent valleys with **steep slopes** and **flat bottoms**,
 - V-shaped contours show valleys with relatively **gently descending slopes** with V-shaped bottoms.
 - The **closed end of the contour** line (U or V) always points upstream or toward high ground.

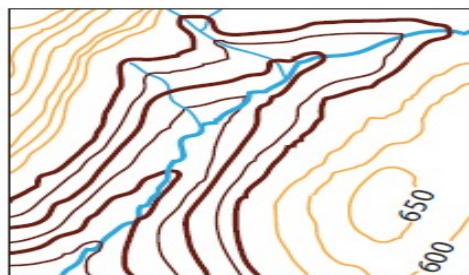
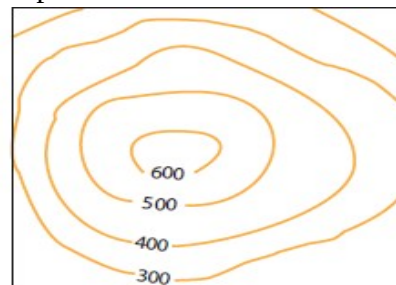


Figure 2.29: A valley and its representation on a contour map

2. Hill:

- An area of high ground but is lower than a mountain in elevation.
- It is shown by contour lines forming concentric circles.
- The inside of the smallest closed circle indicates the hilltop.



3. Saddle:

- ✓ It is a dip or low point between two areas of higher ground.
- ✓ The feature is like the seat on a riding horse.
- ✓ It is not necessarily the lower ground between two hilltops.
- ✓ It has high ground in two opposite directions.

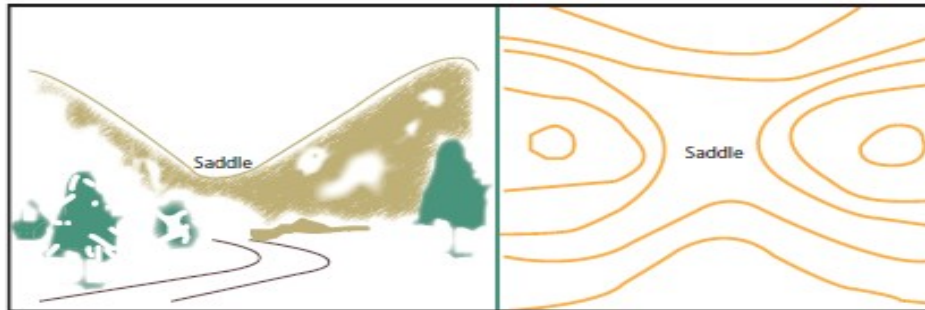
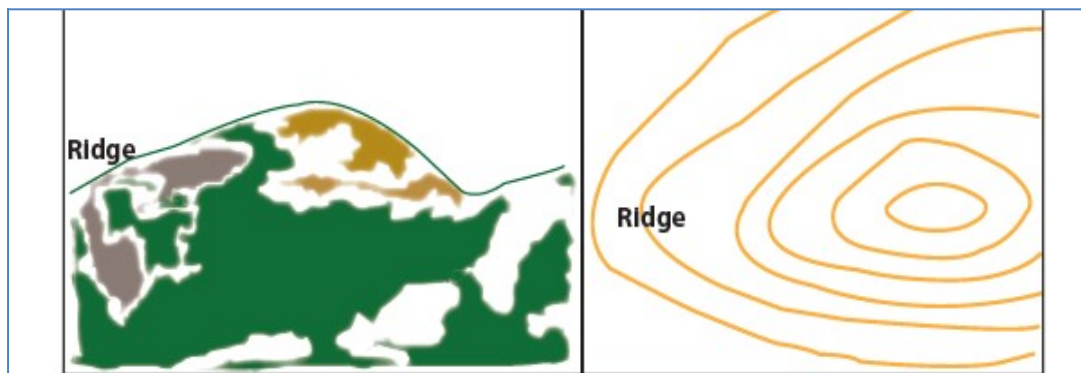


Figure 2.28: A saddle and its contour representation

4. Ridge:

- ✓ It is a sloping line of high ground.
- ✓ It is a long narrow hill top or a range of hills.
- ✓ It has low ground in three directions and high ground in one direction with varying degrees of slope.



5. Depression:

- ✓ It is an area of land that is lower in altitude than the areas surrounding it.
- ✓ It is usually formed by the down ward movement of the top of a volcanic mountain.
- ✓ It is usually represented on maps by closed contour lines that have tick marks pointing downward to lower ground.



Figure 2.31: A depression and its representation on a contour map

6. Re-intranet:

- ✓ It is a less-developed stream course that is smaller than a valley.
- ✓ It has no level ground and, therefore, little or no movement room within its limits.
- ✓ It is a small v-shaped cut in a steep slope or the side of hill or a mountain.
- ✓ A re-intranet could be considered as the initial stage in the formation of a valley.

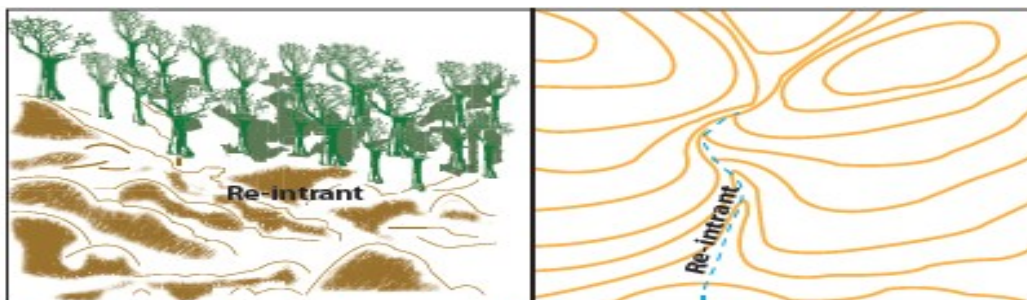


Figure 2.32: A re-intrant and its representation on a contour map

7. Spur:

- ✓ It is a short and continuously sloping line of higher ground that normally extends out from the side of a ridge.
- ✓ It is an elongated area of higher ground projecting from the main body of a mountain towards low ground.
- ✓ A spur is formed by two roughly parallel streams that cut draws along the side of a ridge.
- ✓ Spurs are shown on a contour map by using contours that point towards the lower ground with “U” or “V” shapes.

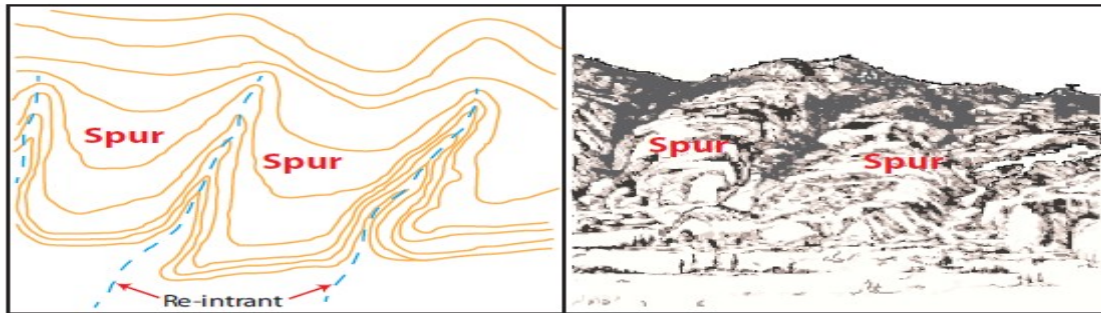


Figure 2.33: A spur and its representation on a contour map

8. Cliff:

- ✓ A cliff is a vertical or nearly vertical or steep wall of a mountain or rock face.
- ✓ Cliffs are shown on topographic maps by using contour lines that are very close together (when there is a little change in horizontal distance and rapid increase in vertical distance) and, in some cases, by contours that overlap (merge) when there is no change in horizontal distance at all.
- ✓ It is also found along sea shores, riverbanks, etc.

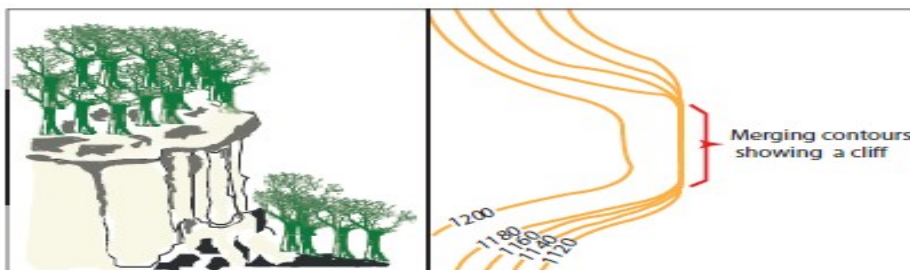


Figure 2.34: A cliff and its representation on a contour map

9. Waterfall:

- Any water which falls down a cliff, usually in the course of a stream or river.
- It is a steep fall of a river water where the course of a river is markedly and suddenly by a cliff.

10. Gorge:

- It is deep narrow valley with steep sides.
- Gorge is usually formed in the upper course of a river.

11. Mountain:

- It is a high land area that rises several hundreds of meters (over 600m elevation) from its surrounding.
- A high land area which rises under 600m elevation is not a mountain it is rather a hill.
- Both are highland relief features and represented on contour maps whose values increase upwards.

12. Plateau:

- It is a highland area with a more or less uniform, wide, and flat summit.
- Plateaus have wide, flat, top surface and uniform side slopes known as **young plateau**.
- Plateaus have been broken (cut) by deep, steep sided river valleys and gorges are known as **dissected plateaus**.

- They are represented by contour lines have circular or rectangular shape.

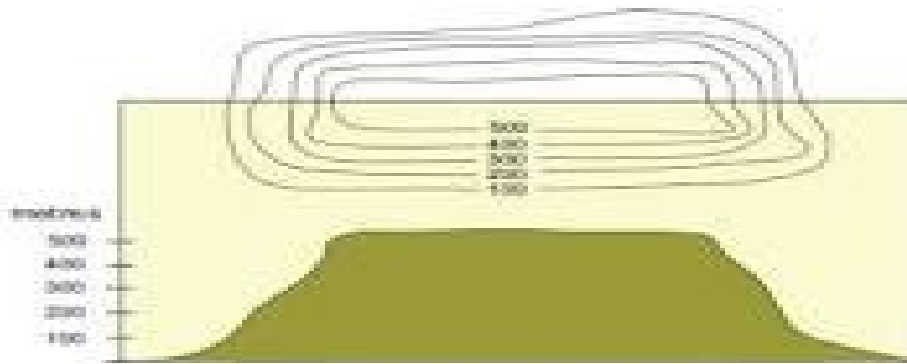


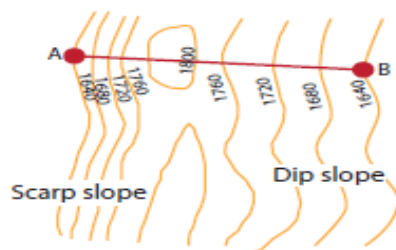
Figure 10.13 Plateau

13. Plain:

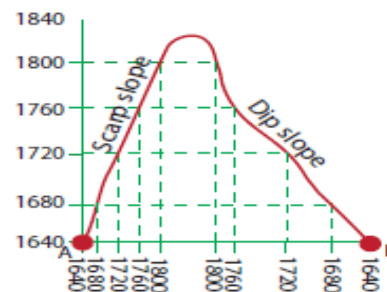
- It is a large area of flat land, generally lower than the land around it.
- It is an extensive area of level or gently undulating land usually of low altitude.
- They are represented by contours are irregular and fairly widely spaced.

14. Escarpment:

- Long steep slope or cliff separating two areas at different levels, usually a plateau and a low-lying plain.
- It has **two parts** dip and scarp
 1. **Dip-** a dip is the long and gentle slope in the opposite side of an escarpment.
 - o Dip-slope is a gentler slope of a mountain ridge.
 2. **Scarp-** is a steep slope of an escarpment.
 - o The contour lines are widely spaced on dip slope, while they are close together on scarp slope.



a) in contour map



b) in section

➤ Supplementary terrain features:

1. Cut:

- It is a human made feature resulting from cutting through raised ground.
- It is made usually to form a level led from a road or rail road track.
- They are shown on a map when they are at least 10 high.
- They are usually drawn with a contour line along the cut line.

2. Fill:

- It is a human made feature.

- It results from filling along areas usually to from a level led for a road or rail road track.
- They are shown on a map when they are at least 3m high.
- They are drawn with a contour line along the fill line.

UNIT THREE;

3. THE PHYSICAL ENVIRONMENT OF THE EARTH

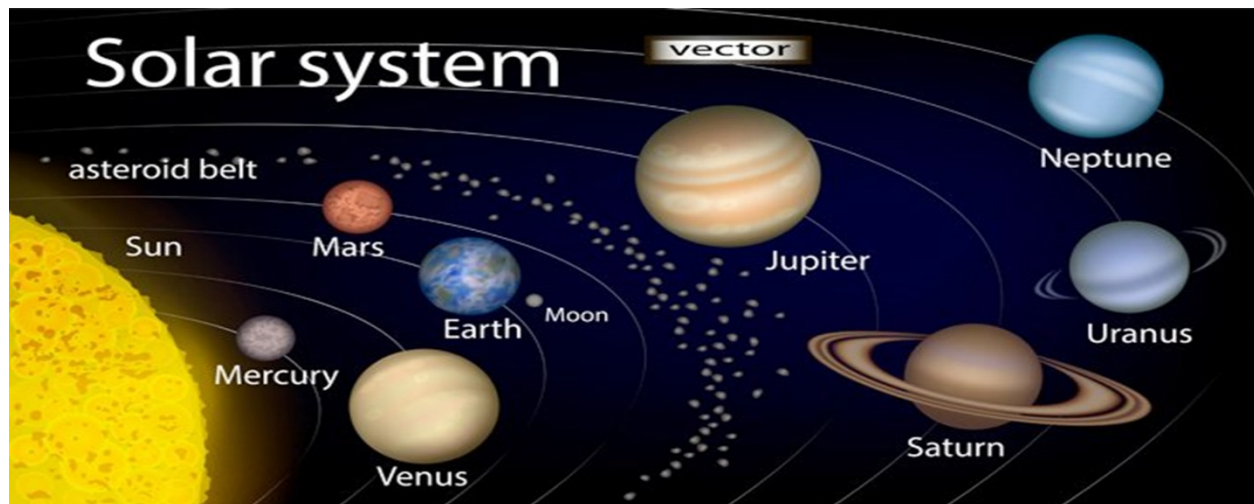
3.1. Physical environment of the world

3.1.1. The earth in the universe

- **The universe** is the totality of space and cosmos, in which everything is found.
- All heavenly bodies, including all stars, together with the sun, comets, meteors, planets and their satellites are found in the very vast space called the **universe**.
- **A galaxy** is a large group of stars. The universe contains many galaxies.
- **The Milky Way** is our galaxy. Within the Milky Way is our solar system.
- **A solar system** is a smaller group of heavenly bodies, which includes the sun at the center and the nine planets and their satellites and asteroids.
- **Asteroids:** smaller rocky planetoid revolves around the sun b/n the orbit of mars and Jupiter.

➤ The Origin and Structure of the Earth

- The solar system formed from a large flammable of hot whirling gases largely **hydrogen** and **helium**, and **dust particles** about 4.6 billion years before the present.
- The gases and dust particles gradually drew together because of gravitational pull and formed a thin disc where the sun is the center.
- Planets are objects that travel around a star sun in a path. That path is called **an orbit**.



➤ The Structure of the Earth; Is the Earth a solid planet? Liquid? Gas?

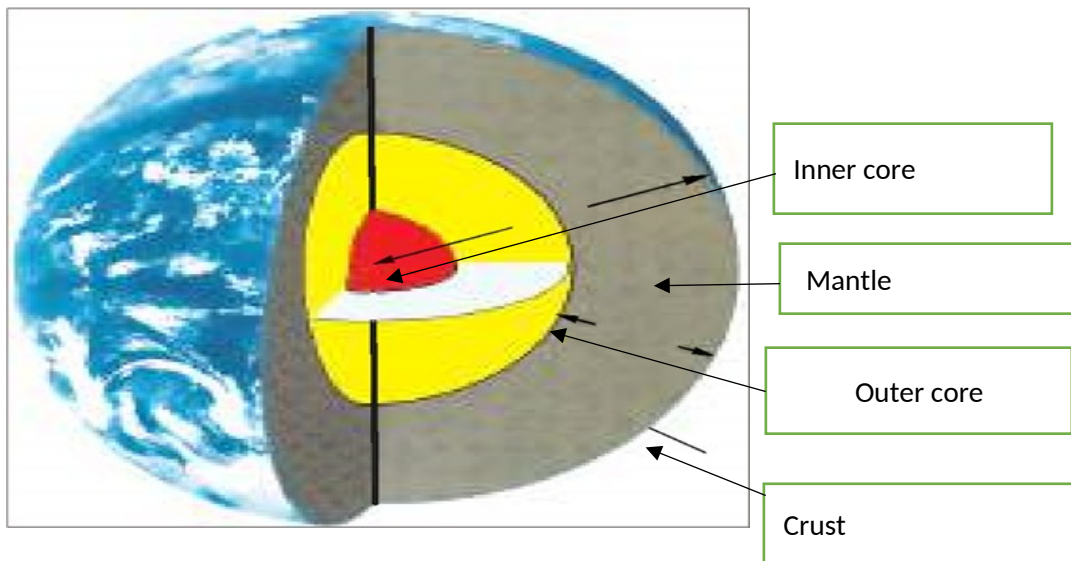
- The earth is composed of a great central core, mantle and crust.

1. The Earth's Crust: is the outermost and thinnest layer, it is relatively cool.

- ✓ It has two layers

- 1.1. **Oceanic crust** is b/n 4 and 7 kilometers thick and is composed mostly of **dark, dense basalt**. Composed of silicon and aluminum called SIAL.

- 1.2. **Continental crust** is b/n 20 to 40 kilometers thick and composed primarily of **light-colored, less dense granite** with silicate and magnesium called SIMA.
 - ✓ Relative to the earth size, crust is about as thin as an apple skin 0.01% volume
2. **The Mantle:** 2900 kms thick and makes up 80 – 84% of the earth's volume.
 - ✓ The chemical composition is **similar** throughout the mantle.
 - ✓ **Temperature and pressure increase** with depth.
3. **The Core:** It is a sphere with a radius of about 3470 kms, and is composed largely of iron and nickel.
 - ✓ The outer core is molten because of the high temperature at the center of the core.
 - ✓ The core's temperature is about 6000°C, which is as hot as the sun's surface.
 - ✓ The extreme pressure compresses the inner core into a **solid**, despite the fact that it is even hotter than the molten outer core.



3.1.1.1. The Geological Time Scale and Major Geological Events

- ✓ **The geological time scale** is a record of earth's history, starting with earth's formation about 4.6 billion years before the present.
 - ✓ Numbers on the time scale represent time in millions of years before the present.
 - ✓ The eras are major divisions of the geological time scale.
 - ✓ They are defined based on:
 - Widespread occurrences of strong tectonic activity.
 - The appearance or disappearance of particular forms of life existed.
 - ✓ Eras divided in to Period and periods in to Epochs
1. **The Precambrian Era (4.6 billion -600 million YA)**
 - ✓ The Precambrian era is the longest geological time unit of Earth's history.
 - ✓ It comprises 88% of the geological time scale. Because of great pressure and heat Precambrian rocks are largely metamorphosed called **basement complex crystalline rock**.
 - ✓ The major events known as orogeny and metamorphism process.
 2. **Paleozoic Era (600-225 million YA)**
 - ✓ Warm shallow seas covered much of earth's surface during the early Paleozoic era.

- ✓ Because of this, most of the life forms were of **marine origin**
- ✓ **There was heavy erosion caused series of Denudation and peneplanation due to pluvial rain**

3. Mesozoic Era (225-70 million YA)

- ✓ At the beginning, all continents were joined as a single land mass that we call **Pangaea**.
- ✓ It separated into two large land masses during the Triassic period.
- ✓ The **northern mass** Laurasia and **southern mass** Gondwanaland.
- ✓ Reptiles were the dominant animal life form in the Jurassic period.
- ✓ The Horn of Africa was also sank down and was invaded by water from **Indian Ocean**. This was known as **transgression** of the area.
- ✓ The regression and invasion of the sea resulted the three oldest layers of marine sedimentary rocks formation. These are:
 - i. **The Triassic:** During this period, there was sinking of the land in the eastern part of the continent --**Adigrat Sandston** – the oldest rock
 - ii. **The Jurassic:** The land remained under the sea –formed **Hintalo limestone**
 - iii. **The Cretaceous:** Rising (uplifting) of the land-- formed **Upper sandstone** – the youngest rock formed due to regression of the Indian Ocean water.

4. Cenozoic Era (70 to present)

- ✓ The era of recent life, when dinosaurs and many other life forms became extinct.
- ✓ The climate became cooler, and ice ages occurred.
- ✓ The present-day period is the Quaternary. We live in the Holocene epoch, which began after the last ice age. Our species, Homo sapiens.

➤ **Geological events in Ethiopia**

- ✓ The whole of Africa essentially consists of a basement of ancient crystalline rock.
- ✓ **During the Precambrian era**, Ethiopia was made up of huge mountains which were folded and faulted.
- ✓ **During the Paleozoic era**, the land was greatly affected by persistent denudation (erosion) and peneplanation, there was no significant rock formation in this era.
- ✓ **During Mesozoic era:** At the beginning of the Mesozoic era, the land surface sank, very slowly. As a result, the sea invaded the land from the southeast towards to the northwest sedimentary rocks formed.
- ✓ The uplift of the Ethiopian landmass, followed by crustal deformations and the emission of an immense lava flow, Trapean (old) lava series.
- ✓ During the middle tertiary, the land was subjected to major vertical displacements, which produced the formation of the Ethiopian Rift Valley.
- ✓ In the quaternary period, the earth experienced a marked climatic change resulting in rains known as the Pluvian Rains in Africa. During this period the Ethiopian plateaus were affected by heavy erosion.

➤ **The Movement of Continents/Continental Drift**

- ✓ Wegener suggested that once there was a single supercontinent, a huge landmass, that he called Pangaea (pan = all, gaea = Earth).

- ✓ Then break apart into two. Namely Gondwanaland (which consisted of South America, Africa, the Arabian Peninsula, the Indian subcontinent, Australia and Antarctica) and Laurasia which included the North America and Eurasia.



➤ **Components of the Earth's Physical Environment**

- ✓ Basically the physical environment of the earth can be divided into five major geo-sphere namely:-
 1. **Lithosphere**- The solid part of the earth sphere- related to Geomorphology, Soil geography.
 2. **Hydrosphere**- The water surface – oceans, seas, lakes - Ocean geography.
 3. **Troposphere**-The lower part of Atmosphere- weather changes- related to Climatology.
 4. **Biosphere**- Supports all sorts of life- related to Biogeography.
 5. **Anthropo-sphere**– The Cultural landscape- related to Cultural and population geography.

1. Lithosphere

- ✓ Lying beneath the atmosphere and the oceans is the solid earth, referred to as the lithosphere.
- ✓ The lithosphere consists of three major layers: the crust, mantle and core.
- ✓ The outermost layer is a thin layer called the crust beneath found the mantle and core.

2. Hydrosphere:

- ✓ Includes all of the earth's water, which circulates among oceans, continents and the atmosphere.
- ✓ About **71%** of the earth's total surface is covered by waterbodies.
- ✓ The majority is covered by seas and oceans, of which **97.5%** occupied by alkaline seas and oceans.
- ✓ The remaining **2.5%** is fresh water, of which nearly:
 - 68.7% glacier
 - 30.1% ground water
 - 0.8% permafrost
 - 0.4% surface water (lakes, rivers, atmosphere, soils, and wetlands).
- ✓ **Permafrost** is soil, rock or sediment that is frozen for more than two consecutive years.

3. Atmosphere

- ✓ The earth is surrounded by a life-giving gaseous envelope called the atmosphere.
- ✓ It is a mixture of gases, mostly nitrogen and oxygen, with smaller amounts of argon, carbon dioxide and other gases.
- ✓ One-half of the mass of the atmosphere lies below an altitude of 5.6 kilometers, and 90 percent occurs within just 16 kilometers.
- ✓ About 99 percent is concentrated in the first 30 kilometers above the surface of the earth.

4. Biosphere

- ✓ The biosphere is the zone inhabited by life.
- ✓ It is concentrated near the surface in a zone that extends from the ocean floor upward for several kilometers into the atmosphere.
- ✓ It includes the uppermost lithosphere, the hydrosphere, and the lower parts of the atmosphere.

5. Anthropos-sphere– The Cultural landscape- related to Cultural and population geography.

➤ Components of the Lithosphere/

1. Rocks; Types, Formation & Characteristics

➤ Igneous rocks (ignis = fire) form when the molten rock cools and solidifies, either in the crust or on the surface of the earth.

- ✓ The melted rock is called **magma**. Magma that gets to the surface is called **lava**.

➤ Types of Igneous Rocks: There are two main groups of igneous rocks: **intrusive and extrusive** igneous rocks.

a. **Extrusive igneous rocks:** Sometimes, when magma breaks through and erupts onto the relatively cool surface of the earth, it solidifies rapidly.

- ✓ Because it cools quickly when it reaches the earth's surface the molten rock, called **lava**, solidifies rapidly, and there is insufficient time for large crystals to form.
- ✓ As a result, many extrusive rocks have fine-grained textures, consisting of crystals too small to be seen with our eyes.
- ✓ An abundant and important example is **basalt and obsidian**

b. **Intrusive (plutonic) igneous rocks:** When magma solidifies within the crust, the magma cools slowly, and the crystals form over hundreds of thousands to millions of years.

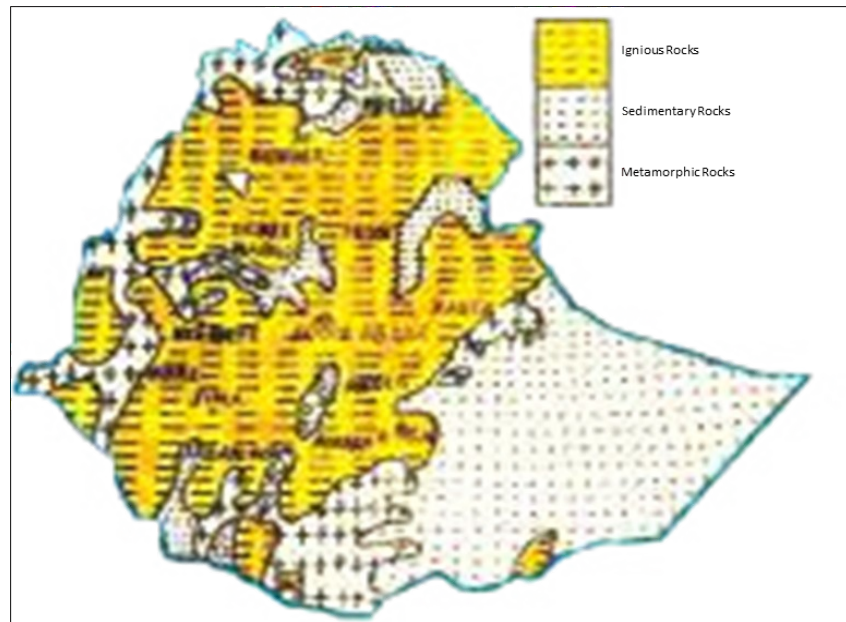
- ✓ As a result, most **plutonic rocks** are coarse-grained.
- ✓ Granite is the most abundant rock in continental crusts.
- ✓ It is coarse-grained, and the crystals are clearly visible.

➤ Sedimentary rocks:

- ✓ Are made of small particles of matter, or sediments, of weathered rocks.
- ✓ They may be shells or other remains of living things.
- ✓ Water, wind and ice picked up sediment and transported it.
- ✓ Eventually they dropped the sediment in places where it collected into layers.
- ✓ Most common sedimentary rocks are formed when sediment is **compacted or cemented** together.
- ✓ The weight of layer upon layer of sediment on top of each other compacts or squeezes sediment together to form sedimentary rocks.

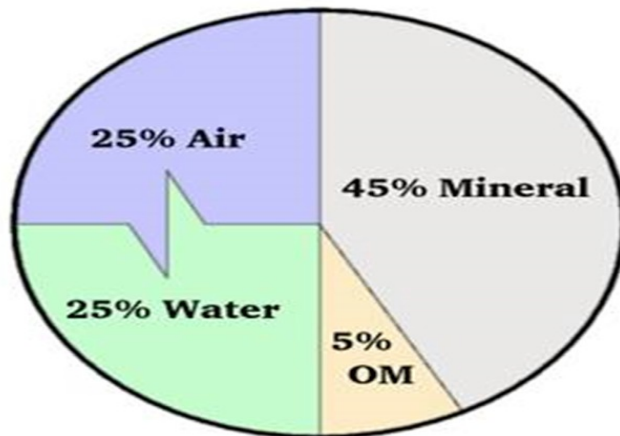
➤ Types of Sedimentary Rocks:

- ✓ About 5% of the earth's crust is made up of sedimentary rocks.
- ✓ They are broadly grouped into **four categories**: clastic, chemical, bio clastic and organic sedimentary rocks.
 - a. **Clastic sedimentary rocks**: They are composed of fragments of weathered rocks called **clasts**,
 - b. **Chemical sedimentary rocks**: They are formed by direct precipitation from minerals in water.
 - c. **Bioclastic sedimentary rocks**: They are composed of broken shell fragments and similar remains of living organisms.
 - d. **Organic sedimentary rocks**: They consist of the solidified remains of plants or animals. Coal is an organic sedimentary.
- **Metamorphic Rocks**
 - ✓ Metamorphic rock results from changes in other kinds of rock.
 - ✓ Metamorphic rocks are produced from pre-existing igneous, sedimentary, and even other metamorphic rocks.
 - ✓ Through heat and pressure inside the earth's crust.
 - ✓ Under the influence of heat, limestone and sandstone change, respectively, to marble and meta-quartzite.
 - ✓ Mudstone and shale change to schist or quartzite, respectively, under the influence of both heat and pressure.
 - ✓ They change to slate when subjected only to pressure.



- 2. Soil**
- **Soil components**:
 - Inorganic materials (minerals 45%) come from rock fragments
 - Air and water each 25% and
 - Organic material 5%.
 - ✓ Soil is a complex mixture of inorganic minerals, decaying organic matter, water, air and living organisms.
 - **Organic matter**: Decayed plant and animal parts create a rich, dark-colored soil called **humus**

- ✓ Organism in soil: you may see earthworms, mites, millipedes, centipedes, grubs, termites, and other large and small creatures.
- ✓ Soil provides nutrients for plants, which directly or indirectly provide the food all animals need to stay alive and healthy
- **Soil texture:** sand is a bigger soil grain/size, Clay & silt soils have a fine.
- ✓ The ideal soil is a loam, which is a mixture of sand, clay and silt
- **Soil formation:** takes hundreds or thousands of years



3.1.2. Forces That Change the Surface of the Earth

i. INTERNAL FORCES

- Those forces that drive energy from the interior part of the earth are called internal forces.
- Internal forces form the ups and downs on the earth's crust by breaking and bending (faulting and folding) it.
- Forces inside the crust cause folding, faulting (cracking), volcanism and earthquakes.

1. Folding

- The process by which folds are formed due to compression is known as **folding**.
- Due to this force, rock layers are bent into folds.
- **Types of folding:**
 - ✓ If the fold is upward and convex, it is called **anticline**.
 - ✓ If the fold is downward, it is called **syncline**.
- **Fold Mountains**
 - Fold Mountains are formed by crust which has been uplifted, and folded by **compressional forces**.
 - The compressional force which is created as a result of this movement pushes sedimentary rocks upwards into a series of folds.
 - Fold Mountains are usually formed from sedimentary rocks and are usually found along the edges of continents.

- **There are two types of Fold Mountains:-**

- **Young fold mountains** (10 to 25 million years of age, example, the Atlas, Rockies and the Himalayas)
- **Old fold mountains** (over 200 million years of age, example, the Cape Range, the Urals in Russia and the Appalachians of the USA).

2. Faulting

- Movements in the crust of the earth sometimes make cracks.
- These cracks are called faults.
- Faulting can be caused by either lateral or vertical forces, which can be either tensional or compressional.
- Tension causes a normal fault, and compression causes a reverse fault.
- Major features formed by faulting include rift valleys and block/Horst Mountains.

3. Rift Valleys

- A **rift valley** is a linear shaped lowland area between highlands or mountain ranges created by geologic rifts or faults.
- A rift valley is a valley formed by faulting.
- When two parallel faults occur on the surface of the earth, and when the land between the two faults sinks down, a rift valley is formed.
- **The largest rift valley** in the world is the East African Rift Valley.
- It extends from Syria to Mozambique, passing through the Red Sea, Eritrea, Ethiopia, Kenya, Tanzania, DR Congo, Rwanda and Burundi.
- The total length of the East African Rift Valley is about 7,200 km, of which 5,600 km is in Africa.
- The Ethiopian Rift Valley is extends from northeast to south west.
- Features found in the Rift Valley include **active volcanoes, lakes, hot springs and fumaroles.**

1. Block (Horst) Mountains

- **Block Mountains** are formed when land between two parallel faults is pushed upward due to pressure from inside the earth.
- Examples:
 - ✓ The Sierra Nevada Mountains in North America.
 - ✓ The Harz Mountains in Germany.
 - ✓ The Afar block mountain in Ethiopia.
 - ✓ The Ruwenzori in Africa.

2. Volcanism

- **Volcanism** is the process by which magma; gases, water vapor, ashes and other solid materials are forced out to the surface. Inside the earth the temperature is very hot.
- This high temperature changes rocks into molten **magma**.
When the **magma** emerges on to the surface, it cools and hardens. It is then called **lava**.
- **Magma** reaches the earth's surface through two kinds of holes. They are **vents and fissures**.
- Magma may force its way violently through a small hole called a **vent**.
- Vent builds up into a volcano (cone-shaped mound), a crater is formed.

- Magma may pour quietly through **long cracks (fissures)** onto the earth's surface.
- It builds up to form a **lava plateau or lava flow**.
- Volcano erupts very forcefully, the top part of the volcano is blown away and forms a large crater called a **caldera**.
- **Water collects** in the crater or in the caldera and forms a lake. We call this a **Crater Lake or caldera lake**. Example: In Ethiopia there are many crater lakes such as Zuquala, Wonchi and Dendi.
- Part of the magma may **not reach** the earth's surface, and when this magma cools, solidifies and forms rocks **inside the crust**, features such as **batholiths, laccoliths, sills and dikes**, are formed.
 - ✓ A **batholith** is a very large mass of magma which accumulates in the crust. It is the largest structure.
 - ✓ A **laccolith** is a mushroom shaped body of intrusive igneous rock. Smaller than a batholith.
 - ✓ A **dike** is formed when magma solidifies in a vertical or near-vertical crack.
 - ✓ A **sill** is formed when magma solidifies horizontally or nearly horizontally along a bedding plane
- **Types of volcanoes**
 - **Active volcano**- Erupts from time to time- ex -Erta'li, Fentale Dubbi
 - **Dormant volcano**- Has not erupted for a long time but may erupt again in the future ex-Tatali and Dabbahu
 - **Extinct volcano** Has not erupted within historic time Mt. Zuquala, Ras Dashen and Batu, etc
- **Importance of volcanic eruptions:**
 - ✓ Give us some ideas about the interior of the earth
 - ✓ Provide fertile soil.
 - ✓ Provide hot springs (with medical value).
 - ✓ Generate geothermal energy.
 - ✓ Help in the formation and concentration of minerals.
 - ✓ Help in the creation of new land.

4. Earthquake

- Earthquakes are sudden movements in the earth's crust.
- They are caused by internal movements deep down inside the earth.
- Earthquakes are frequently associated with faults.
- When an earthquake occurs, vibrations from the center spread out in the form of waves in all directions.
- The point at which an earthquake originates is called the **focus**.
- The point on the earth's surface immediately above the focus is called the **epicenter**.
- The intensity of an earthquake is measured by an instrument called a **seismometer**, and is recorded on a **seismograph**.
- The scale which gives the magnitude is called the **Richter scale**. It ranges from 0 to 9.
- An earthquake with a magnitude of 4.0 is **ten times** stronger than one that measures 3.0.
- Readings of **7.0** or higher indicate a strong or major earthquake.

- The strongest ever recorded earthquake was the **Valdivia** earthquake in Chile that occurred on May 22, 1960 (9.5 on the Richter scale).

Table 2.2: Richter scale values and the corresponding magnitude of earthquakes

The Richter scale	Effects
< 3.5 -----	Only by instruments (seismometers)
3.5 – 4.8 -----	Feels like a lorry passing
4.9 – 5.4 -----	Loose things fall
5.5 – 6.1 -----	Walls crack
6.2 – 6.9 -----	Chimneys fall, some buildings collapse
7.0 – 7.3 -----	Many buildings fall, landslides
7.4 – 8.1 -----	Most buildings and bridges are destroyed
> 8.1 -----	Total destruction

- In addition to destruction of life and property, an earthquake causes:
 - ✓ Displacement of parts of the earth's crust vertically or laterally.
 - ✓ Landslides and deep cracks in surface rocks.
 - ✓ The devastation of cities, fires and diseases.
 - ✓ The rise or lowering of the sea floor.
- About 80% of all earthquakes occur in three regions. They are
 - ✓ Around the Pacific Ocean zone. This zone is known as the Pacific Ring of Fire.
 - ✓ Across Southern Europe and Southern Asia.
 - ✓ The west-coast areas of North and South America.
- The two most recent earthquakes in Ethiopia measuring more than 5 on the Richter Scale occurred:
 - ✓ July 14, 1960, near Lake **Shalla** with a magnitude of 6 on the Richter Scale.
 - ✓ June 2, 1961, in **Kara kore**.

ii. EXTERNAL FORCES

- **External forces** can lower the level of the land by washing it away, and this process is called **denudation**.
- They also can raise the level of the land by **deposition**.
- **Denudation** consists of **weathering and erosion**.

1. Weathering:

- ❖ **Weathering** includes disintegration (physical weathering), which breaks rocks into smaller pieces and decomposition (chemical weathering), which forms new substances.
- ❖ **Physical (Mechanical) Weathering**- is breaks the rocks into smaller pieces.
- ❖ Its main agents (causes) are:
 - a. Temperature changes=The effects of temperature changes:
 - ✓ The temperature variation between day and night causes rock to expand and to contract.
 - ✓ This process causes **cracks** to develop.
 - ✓ In time, the cracked layer peels off and falls to the ground. This process is called **exfoliation**.
 - b. Frost action= The effects of frost action:

- ✓ It is very common in the winter season in the **temperate zone** and in some **high mountains** all year round.
- ✓ Due to frost action, rock breaks up into pieces, called **scree** (fragments accumulation).
- c. The action of plants and animals= The effects of plant and animal action:
 - ✓ As plants develop their roots may push the rock apart and cracks.
 - ✓ Some animals burrow, and this also helps to break up rocks and exposed to erosions.
- ❖ **Chemical Weathering (Decomposition and rusting)**
 - ✓ It is a process that forms new substances, and it is affected by the minerals in the rock.
 - ✓ Its main agents are **rain action, plant and animal actions**.
 - **As rain water passes** through the atmosphere, it takes reaction within carbon dioxide (CO₂) and forms a **weak carbonic acid**. , it comes and begins to dissolve minerals in the rock.
 - ✓ **Limestone**, for example, dissolves very quickly.
 - ✓ This process is known as **carbonation**.
 - ✓ $H_2O + CO_2 \Rightarrow \text{carbonic acid} \Rightarrow$ dissolves and erodes limestone and forms caves.
 - **Example:** Sophomore Cave along the River Weiyb in Bale.
 - ✓ These caves contain features such as stalactites, stalagmites and pillars.
 - ✓ **A stalactite** is a limestone column that hangs down from the ceiling of the cave.
 - ✓ **A stalagmite** is a limestone column that builds upwards from the floor of the cave.
 - ✓ **A pillar** is formed when a stalactite and a stalagmite join together.
 - **When rain water** dissolves **oxygen** (O₂) and reacts with iron in rocks, the rocks become rusty.
 - **Plants absorb minerals**, and decaying vegetation produces organic acid, which causes a further breakdown of minerals.
 - **Bacteria** in the presence of water break down certain minerals in the soil.
 - **Leaching** is a major soil-forming process. It occurs when substances are dissolved in water that percolates through soil.

2. Erosion

- Erosion is the transporting of weathered material by various natural forces such as moving water, wind and moving ice.
- Erosion occurs when particles of rock or soil are:
 - ✓ Washed away by a river.
 - ✓ Removed by waves of the sea.
 - ✓ Crushed under a glacier.
 - ✓ Blown away by the win.

➤ Erosion by Running Water

- The work of running water includes eroding, transporting and depositing eroded material.
- There are three types of running water erosion:
 1. **Sheet erosion:** occurs when surface water moves in a wide flow.
 2. **Rill erosion:** occurs when surface water cuts relatively small channels.
 3. **Gully erosion:** occurs when floods cut deep wide gorges.

- **The course of a river**, from its source to its mouth, can be divided into 3 stages.
- The action of the river is different in these three parts.
- The stages are upper course, middle course and lower course.

A. Upper course of river

- ✓ small in volume water
- ✓ flows very fast down steep- slopes
- ✓ Vertical erosion and destruction
- The land form associated
 - ✓ Water falls
 - ✓ V-shaped valley
 - ✓ Deep gorges are formed.

B. The middle course of river

- ✓ The river valley becomes wider and large with gentle slope
- ✓ The volume of water increase, because of many tributaries join the main river
- ✓ Lateral erosion
- ✓ Forms meanders, Flood plains, River cliff.

C. The lower course of river

- ✓ Alluvial transportation
- ✓ Large channel
- ✓ big-meanders, Ex-bow lakes,
- ✓ Large flood plain or levees
- ✓ Deltas /estuaries/ - such as- Nile delta, Mississippi delta etc.

1. Erosion and deposition by sea waves

- ✓ Water waves are formed when wind moves over the surface of sea.
- ✓ The work wave of the sea along the coast includes erosion, transportation and deposition.
- ✓ It formed along the shore line different features: such as,
 - a. **Beach**: a strip of land along the sea coast covered different types of sediments.
 - b. **Spit**: a linear deposit attached to the land at one end and extending in to open water.
 - c. **Lagoon**: Is an area of salt water separated from the sea by loose sand banks.
 - d. **Cliff**: a perpendicular or steep face of a rock formed by several process of erosion /waves/
 - e. **Tombolo** -when a spit or a bar joints the mainland to an island.
 - f. **Coral coast**: cost line that consists of with corals.
 - ✓ It is things of marine animals that excrete external skeletons of calcium carbonates.
E.g. Shell of crocodile and snail

2. Wind erosion and deposition

- ✓ **Wind** erosion is common in desert and semi-desert area.
- ✓ **Wind** erosion and deposition form different land forms , such as,
 - a. **Sand dunes**: a small hills of sand formed by the action of the wind blows.
 - b. **Barchans**: is a sand hill that has a crescent-moon shape.
 - c. **Losses deposition**: is a deposition of fertile soil in the desert by wind.

3.1.3. Weather and Climate

➤ Earth and Atmosphere

- The air that surrounds the earth is called the atmosphere.
- The earth's atmosphere is a mixture of gases, suspended dust particles and condensed moisture droplets which are collectively known as **aerosols**.
- The gases are different in their volume

Major gases	Minor gases	Rare gases
Nitrogen 78%	Argon 0.93%	Hydrogen, ozone, methane, neon, helium, krypton, xenon, carbon monoxide
Oxygen 20.95%	Carbon dioxide 0.03%	

➤ Structure of the Atmosphere

Name of the layer	Average height	Major characteristics
Troposphere	Extends from sea level to 8/16 kms	<ul style="list-style-type: none"> • Contains 75% of the atmospheric mass. • Uniformly, temperature decreases with an increase of altitude. • The top boundary is known as the tropopause, which is characterized by jet streams (high velocity winds).
Stratosphere	Extends upward to 50 kms	<ul style="list-style-type: none"> • Has constant temperature. • High concentration of ozone gases. Its upper limit is called the stratopause.
Mesosphere	Extends from 50 to 80/85 kms	<ul style="list-style-type: none"> • It is the coldest part of the atmosphere. • Its upper surface is known as the mesopause. • Temperature decreases to nearly -100°C at the top of the mesosphere. • Meteorites burn and disintegrate because of friction here.
Thermosphere ⇒ Ionosphere ⇒ Exosphere	Extends from 80/85 kms upward into space	<ul style="list-style-type: none"> • Have extremely low density • Very little heat can be absorbed, held or conducted. • Temperature rises as high as 1200°C. • The ionosphere is a layer of electrically charged particles. These electrons and ions are useful for communication because they reflect radio waves. • The exosphere begins at an altitude of about 500 to 700 kms above the earth's surface and extends to interplanetary space.

➤ Meaning of Weather and Climate

- ❖ **Weather** is the condition of the atmosphere over a short period of time

- ❖ **Climate** is the average of all weather conditions of an area over a long period of time more the 30 years.
- **Major Elements of Weather and Climate**
 - ❖ The **major elements** of weather and climate are temperature, rainfall, winds, air pressure, clouds, etc.
- i. **Temperature**
 - Temperature is the amount of hotness or coldness of an object.
 - The sun is the primary heat source for the earth and its atmosphere.
 - The sun's energy is called insolation or solar radiation, and this turns into heat energy at the earth's surface.
- **How is energy transferred in the atmosphere?**
- Not all the energy that originates from the sun reaches the earth's surface.
- Heat transfer takes place in three ways. These are
 - a. **Radiation** –
 - ✓ It is the transfer of energy from one body to another by means of electromagnetic waves.
 - ✓ Energy transmitted from the sun reaches the earth's surface through the process of radiation.
 - ✓ Electromagnetic waves usually travel through empty space.
 - ✓ Energy transmitted from the sun reaches the earth's surface through the process of radiation.
 - b. **Conduction**-
 - ✓ It refers to the transfer of heat through molecular contacts within and between bodies.
 - ✓ Molecules are always in motion.
 - ✓ The process of conduction is more important in solids.
 - ✓ Air and water are poor conductors of heat.
 - c. **Convection**-
 - ✓ It is the transfer of heat due to differences in density.
 - ✓ As gas or liquid either warms and rises or cools and falls, it creates convection currents.
 - ✓ It is the method by which heat moves through gases or liquids.
 - ✓ As gas or liquid is heated, it warms, expands and rises because it becomes less dense.
 - ✓ Heat gained through radiation or conduction usually transfers by convection.
- **Measuring and Recording Air Temperature**
 - We measure temperature with thermometer.
 - There are **two types of thermometers**: maximum and minimum thermometers.
 - ❖ **A maximum thermometer** is a mercury-in-glass thermometer that has a constriction near the bulb end.
 - Registers the highest temperature reached in a day.
 - The freezing point of mercury is -38.83°C , and the boiling point is 356.73°C
 - Alcohol freezes at a temperature of negative one hundred thirty degree Celsius (-130°C)
 - ❖ **A minimum thermometer** has alcohol as its liquid, and it sets a metal index.
 - When the temperature falls, the alcohol column drags the index towards the bulb end.

- When the temperature rises, the alcohol column expands and runs past the index without disturbing it.
- Alcohol thermometers may be used to measure temperatures from -130°C (freezing point of alcohol) to 785°C (boiling point of alcohol).
- The standard thermometer for environmental measurements needs only to cover the range between -30°C to 50°C .
- **Maximum and minimum thermometers** are **kept** in a box-like shelter which is known as a **Stevenson screen**.
- **The temperature of the air changes from time to time.**
- The change between the highest and the lowest temperatures during
 - ✓ 24 hours of daily march of temperature or the diurnal range.
 - ✓ Month to month within a year is known as the annual march of temperature.
- a. Daily average (mean) temperature: is obtained by adding the maximum and minimum temperatures of a day and dividing the sum by two.
 - ✚ Example 1: If the maximum daily temperature is 25°C , and the minimum daily temperature is 5°C ,
 - ✓ daily average temperature = $25^{\circ}\text{C} + 5^{\circ}\text{C} \div 2 = 15^{\circ}\text{C}$
 - ⇒ **Monthly average (mean)** temperature is calculated by adding all daily averages and dividing the sum by the number of days of the month.
 - ⇒ **Annual average** is obtained by adding the average monthly temperatures and dividing the sum by 12.
 - ⇒ **Daily (diurnal) range** is the difference between the maximum and minimum temperature in a day.
 - ✚ Example 2:
 - If the maximum temperature is 25°C , and the minimum temperature is 5°C .
 - Daily range = maximum – minimum = $25^{\circ}\text{C} - 5^{\circ}\text{C} = 20^{\circ}\text{C}$.
 - Annual range is the difference between the temperatures of the hottest and coldest months in a year.
 - ✚ Example 3:
 - If the hottest month is 40°C , and the coldest month is -10°C ,
 - Annual range = $40^{\circ}\text{C} - (-10^{\circ}\text{C}) = 50^{\circ}\text{C}$

ii. Rainfall

- Rainfall is liquid precipitation.
- Any moisture that falls from the clouds towards the earth's surface is called **precipitation**.
- **Precipitation** may occur in the form of rain, snow, hail, sleet and drizzle.
- Precipitation is part of the water cycle or hydrological cycle.
- **Basic terms:**
 - **Evaporation** is the process by which liquid water is converted into gases.
 - **Transpiration** is the transfer and change of water from plants to water vapor in the air.
 - **Evapotranspiration** is the combined loss of water through the process of evaporation and transpiration.
 - **Condensation** is the process by which vapor becomes liquid.

- **Sublimation** is the process in which ice changes into water vapor without first becoming a liquid, and vice versa.

➤ **Types of rainfall**

⇒ **Rain** is given three different names according to the different ways in which moisture is forced to rise. They are:

1. Convictional rainfall
2. Orographic or relief rainfall
3. Cyclonic rainfall

1. **Convictional rainfall:**

- When the ground surface is heated by the sun, the air above it is warmed up.
- This type of rainfall is common in humid areas where temperature is high throughout the year

2. **Orographic (relief) rainfall:**

- ✓ Occurs when moist air is forced to rise over mountains.
- ✓ As it rises, it cools, then condenses and falls as rain.
- ✓ Almost all orographic rainfall falls on the windward side of mountains.

3. **Cyclonic or Frontal rainfall**

- When two air masses (warm and cold) meet, they do not mix freely with each other.
- The warmer and less dense air is forced to rise over the colder and heavier air.
- As the warmer air rises, it cools and condenses. Then clouds form and rain falls.
- The place where warm air and cold air meet is called a **front**.
- Frontal rainfall is very **common** in the middle and high latitudes (**60°** North and South from the Equator).

➤ **Measuring and Recording Rainfall**

- Rainfall is measured using an instrument called rain gauge.
- Rain water passes through the funnel into the container below.
- The water in the container is poured into a measuring cylinder, and then the amount of rainfall is measured in millimeters and is recorded.

➤ **Air Pressure**

- The air around us has weight.
- This weight exerts pressure on the surface of the earth.
- We call this atmospheric pressure.
- Atmospheric pressure is not the same all over the earth, and it is not the same even in one place all the time.

⇒ **Pressure** is measured by a mercury barometer.

⇒ Normal pressure, at sea level, is about 760 mm/1013 mb.

➤ **The distribution of pressure over the earth's surface depends on:**

⇒ The **altitude** of places above sea level and,

⇒ Most importantly, on **temperature**.

- Pressure decreases with an increase in altitude.
- **High temperature** makes air expand, so that it has a lower density and pressure.
- **Low temperature** makes the air to contract, resulting in a higher density and creating an area of **high pressure**.

- The distribution of air pressure over the globe is known as the **horizontal distribution of pressure**.
- Pressure distribution can be shown on a map.
- **Lines** connecting all places that have the same pressure are called **isobars**.

➤ **Global Pressure Belts:**

1. **Equatorial low pressure belt (Doldrums):**

- ✓ Located from 5° North to 5° South.
- ✓ There is tremendous heat, and thus warm air, creating low pressure.
- ✓ Also, the centrifugal force is very high at the equator, because the earth's velocity of rotation is high.
- ✓ Hence, the air masses tend to be thrown outwards, resulting in **low pressure**.
- ✓ Wind speed is low, that is why this pressure belt is called the doldrums (Belt of Calm).

2. **Tropical high pressure belt (Horse Latitude):**

- ✓ Located from 30° to 35° North and South.
- ✓ Except for two months, temperature is usually high.
- ✓ Here the pressure is high, because pressure depends on the rotation and movement of air (as winds from the Doldrums rise up and accumulate here).
- ✓ Also winds from the sub-polar low pressure belt accumulate here).

3. **Sub-polar low pressure belt:**

- ✓ Located from 60° to 65° , North and South.
- ✓ Here the low pressure is created because of intense high pressure at the poles.

4. **Polar Highs**

- ✓ Located near the north and south poles.
- ✓ The polar zones have permanent centers of high pressure known as polar highs.
- The pressure distribution over the earth's surface is not a continuous belt, due to eastern highlands.
- Except in the higher latitude of the southern hemisphere, they form belts due to the small land areas which do not affect the free flow of the atmosphere.
- However the position of the pressure belts and cells does not remain fixed in one position.
- They move north or south with the apparent movement of the sun.
- During summer, the pressure belts move north or southwards by a few degrees from their average position.

➤ **Wind**

- ✓ Wind is air in horizontal motion.
- ✓ Winds have speed and direction.
- ✓ Wind force (speed) and wind direction are affected by:-
 - ⇒ Pressure gradient
 - ⇒ Frictional force
 - ⇒ Coriolis force
- ✓ On weather maps, pressure is indicated by drawing isoclines of pressure, **called isobars**.
- ✓ The difference in distance between Isobars is called the **pressure gradient**.
- ✓ Wind speed is often measured with **anemometer**.
- ✓ Winds are named according to the compass direction of their source.

- ✓ Direction is measured by an instrument called **wind vane**.

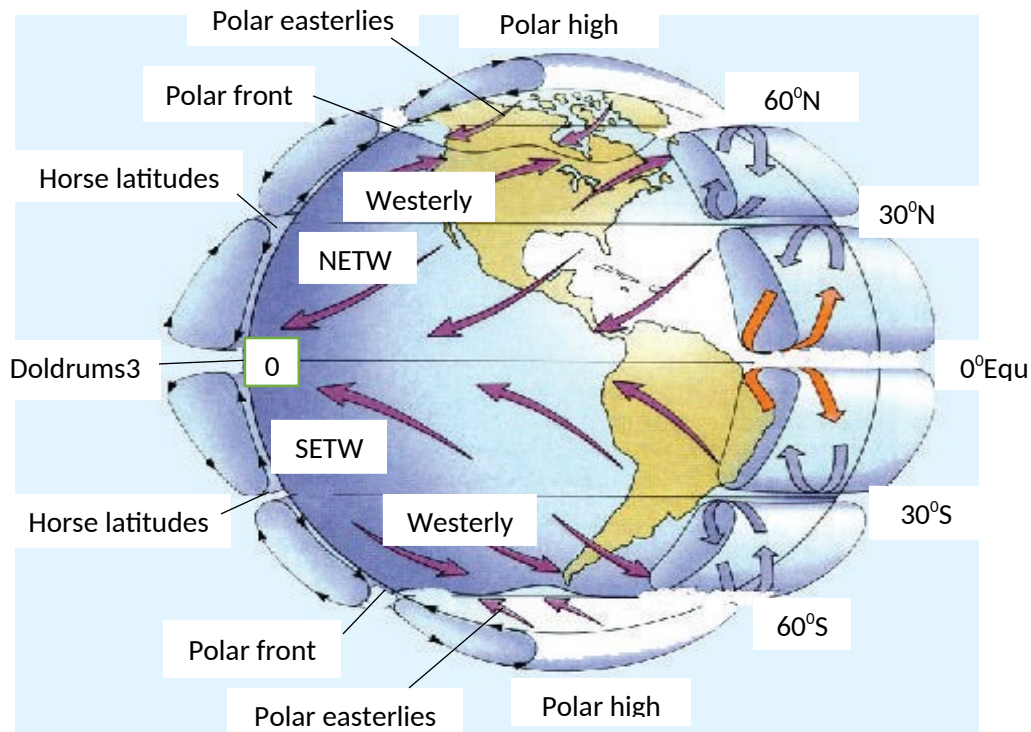
➤ **Types of Winds**

⇒ There are three types of surface winds. They are:

1. Planetary
2. Monsoon
3. Local winds.

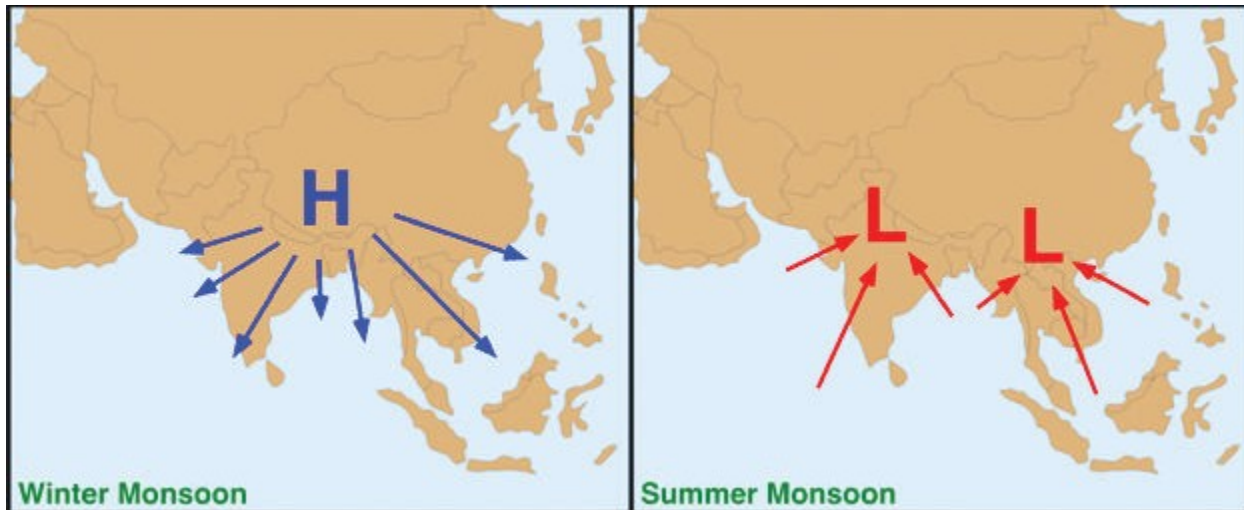
1. Planetary

- Planetary winds blow over large areas of the earth's surface.
- They are closely associated with the world pressure belts.
- Winds blow from areas of high pressure to areas of low pressure.
- The most common planetary winds are **trade winds, westerlies** and **polar easterlies**.
- They have wide influence over the earth's surface



2. Monsoon winds:

- They are seasonal winds whose movements are controlled by pressure that differs during different seasons.
- Seasonal changes in the direction of these winds are caused by the unequal heating of land and water surfaces.
- The direction of monsoon winds changes between summer and winter.
- They are very common in South and South East Asia.



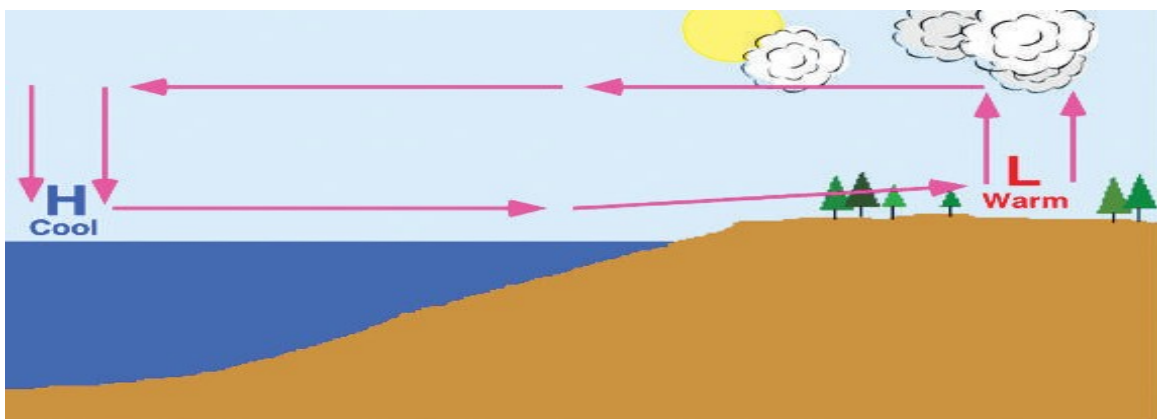
3. Local winds:

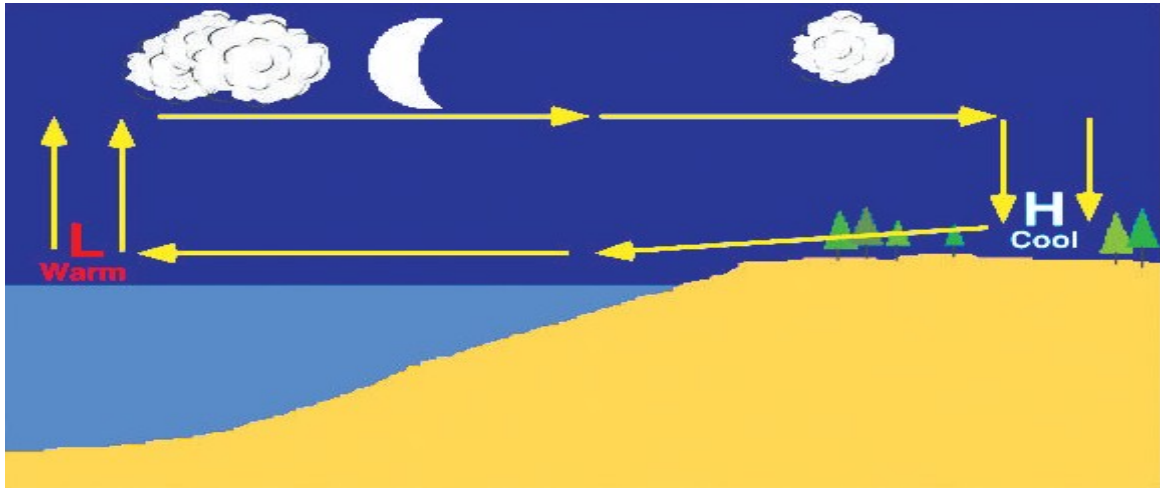
- They affect only limited areas and blow for a short period of time.
- They affect climate conditions on a small scale.
- Local winds are caused by the nature of the physical features of the area.

➤ The main local winds are:

3.1. **Land and sea breezes**

- These winds are common along coastal areas.
- Change their directions daily and affect very small areas.
- **During the daytime**, temperature on the land is higher than on the water/sea.
- So low pressure is formed on the land, while it is relatively high on the sea.
- Wind blows from the sea towards the land is known as a **sea breeze**.
- **During night** the land is colder than the sea. So low pressure develops over the sea.
- The wind blows from land towards the sea is known as a **land breeze**.





3.2. **Mountain and valley breezes:**

- Mountain and valley breezes arise from contrasts in temperature between a valley floor and mountain slopes.
- **During the day** the air at the bottom of the valley becomes warmer.
- As a result it expands and rises along the mountain slopes. This is known as a **valley breeze**.
- **At night** the wind over the slope of the mountain becomes cool.
- Then this cooler and heavier mountain air slides down slopes towards the valley. This is called a **mountain breeze**.