

UNIVERSITY OF GONDAR

COLLEGE OF SOCIAL SCIENCE AND THE HUMANITIES

Department of Geography and Environmental studies

Course Title : Geography of Ethiopia and The Horn

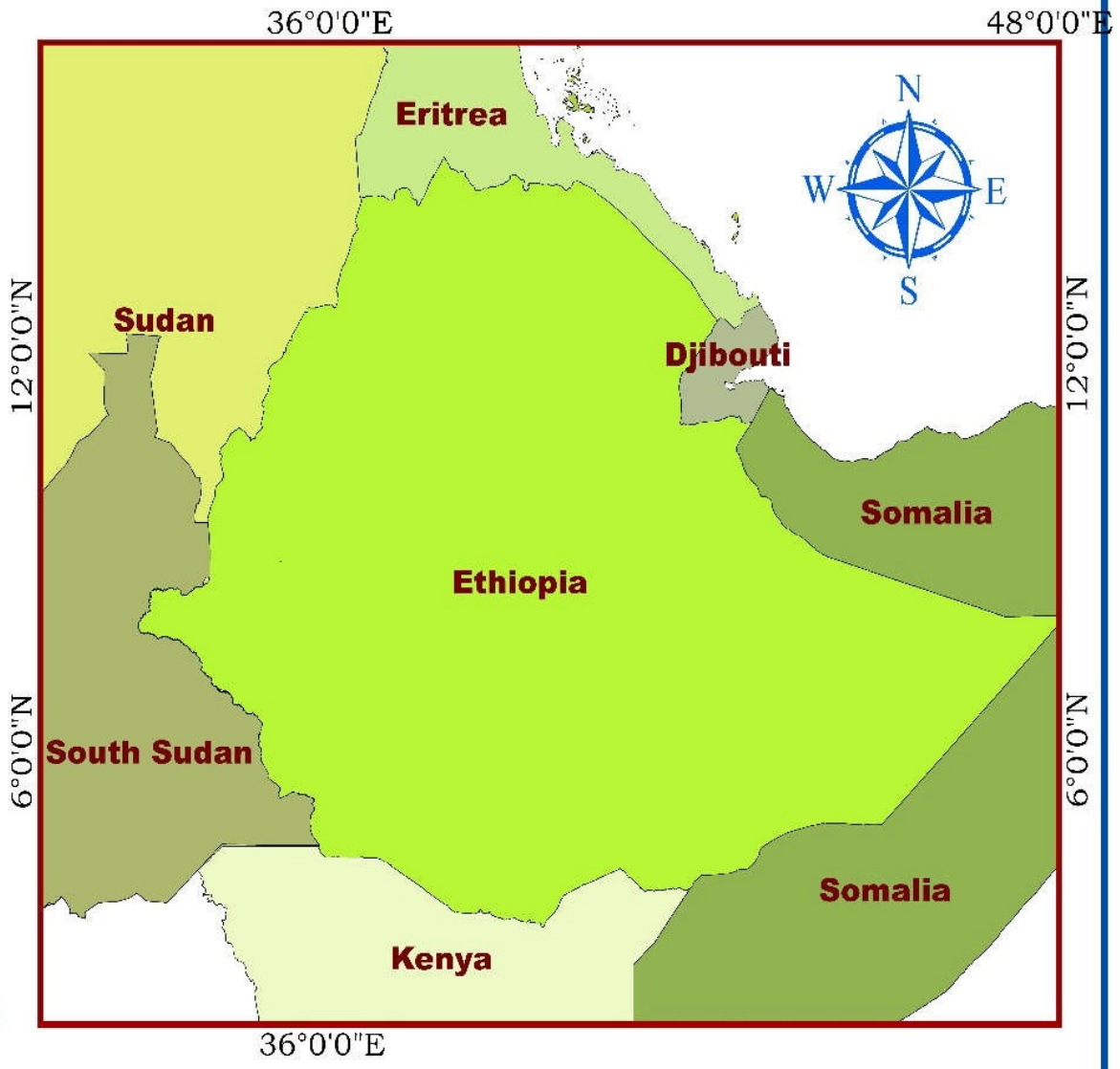
(For Freshman undergraduate students)

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Geography of Ethiopia and The Horn





UNIT ONE
INTRODUCTION
BASIC DEFINITIONS AND CONCEPTS
(3hrs)

1.1. Geography: Definition, Scope and Themes

1.1.1. Meaning of Geography

- *Difficult to forward a definition acceptable* to all geographers at all times and places due to:
  - *Dynamic nature of the discipline*
  - *Changes in its scope and method of study*
- Accepted and a working definition is
  - *The scientific study of the Earth that describes and analyses spatial and temporal variations of physical, biological and human phenomena, and their interrelationships and dynamism over the surface of the Earth*

1.1.2. Scope of Geography

Geography:

- Explains the *arrangements* of various natural and cultural features on the earth surface
- *Holistic and interdisciplinary field* of study contributing to the understanding of the changing spatial structures from the past to the future
- Its scope is the *surface of the earth*, which is the very thin zone that is the interface of the
  - *Atmosphere*
  - *Lithosphere*
  - *Hydrosphere*
  - *Biosphere*

- Approached by considering two continuums

  A. Human-physical continuum

  B. Topical- regional continuum

- Topical (systematic) fields of Geography
  - Categories of *physical or human phenomena* as distributed over the earth

- Regional geography
  - Concerned with *the associations within regions* of all or some of the elements and their interrelationships
  - An area on earth's surface marked by a degree of *homogeneity of some phenomenon*

1.1.3. Themes of Geography

Geography has *five basic themes*

❑Location

- Defined as a *particular place or position*
- Can be of two types:

A. Absolute location

- *The location of a place is defined by its latitude and longitude (specific geographic coordinates) or its exact address*

B. Relative location

- *The position of something relative to another landmark*

Place

- The *physical and human aspects* of a location
- Associated with:
  - Toponym: *name of a place*
  - Site: *description of the features of the place*
  - Situation: *environmental conditions of the place*
- Each place in the world has *unique features* that make it different from the others expressed in terms of
  - *Landforms*
  - *Hydrology*
  - *Biogeography*
  - *Pedology*
  - *Characteristics and size of human population*
  - *Distinct human cultures*
- Aids geographers to *compare and contrast* two places on Earth

Human-Environment Interaction

- Humans
  - have always been on *ceaseless interaction* with their natural environment
  - No other species that has lived on our planet has a *profound effect* on the environment as humans
  - have adapted to the environment in ways that have allowed them to dominate all other species on Earth.

- Involves *three distinct aspects*:

A. Dependency

- *Ways in which humans are dependent on nature for a living*

B. Adaptation

- *How humans modify themselves, their lifestyles and their behavior to live in a new environment with new challenges*

C. Modification

- *Allowed humans to "conquer" the world for their comfortable living*

❑Movement

- The study of *transport and relocation* of *human ideas, culture, habits, language* and many more to the different parts of the world
- Its aspects/dimension are the
  - *Physical movement of people*
  - *Transport of goods from one place on the earth to another*
  - *Flow of ideas that allows:*
    - *Unification of the human civilization*
    - *Promotes its growth and prosperity*

Region

- A geographic area having *distinctive characteristics* that distinguishes itself from adjacent unit(s) of space
- Portions of earth's surface that have *uniform characteristics*
- The places *sharing common physical and human features*
- Could be a formal region and functional region

A. Formal region

- Characterized by *homogeneity* in terms of a certain
  - *Natural phenomenon: soil, temperature, rainfall*
  - *Cultural elements: language, religion and economy*
- Characterized by *human-centered* properties, such as a *common*
  - *Language*
  - *Political system*
  - *Physical properties*
- Also known as *a uniform or homogeneous region*
- *A nation* is a formal region

B. Functional region

- Also be *nodal region*, a region organized around *a focal point*
- Characterized by *functional interrelationships* in a spatial system
- Region is *tied to* the central point by:
  - *Transportation systems*
  - *Communication systems*
  - *Economic or functional associations*
- Example the *circulation* area of a *newspaper*

1.2. Location, Shape and Size of Ethiopia and the Horn

Horn of Africa Countries

- A region of *eastern Africa*, is a narrow tip that protrudes into the *northern Indian ocean*, *separating it* from the *gulf of Aden*
- The *easternmost extension of African land*
- The region that is home to the countries whose cultures have been *linked throughout their long history* which includes:
    - *Djibouti*
    - *Eritrea*
    - *Ethiopia*
    - *Somalia*

- Although they *share many common features*, there is also *great diversity among them*
- In terms of **size from** *all the horn of African countries*
  - Ethiopia is the *largest*
  - Djibouti is the *smallest*
- The ***horn*** contains such diverse areas as the highlands of the
  - *Ethiopian plateau*
  - *Ogden desert*
  - *Eritrean and Somali coasts*

- Its coasts are washed by the
  - *Red sea*
  - *Gulf of Aden*
  - *Indian ocean*
- It has long been in contact with the
  - *Arabian peninsula*
  - *Southwestern Asia*

1.2.1. Location of Ethiopia

- The location of a country or a place on a map or a globe is expressed in ***two different ways***

1. Astronomical locations

- Also known as *absolute or mathematical* location
- States location of places using the lines of
  - *Latitudes*
  - *Longitudes*

- Astronomically, Ethiopia is a *landlocked* country located between:
  - *3°N (Moyale) to 15°N (Bademe - the northernmost tip of Tigray) latitudes*
  - *33°E (Akobo) to 48°E(the tip of Ogden in the east) longitudes*
- The *east-west* distance (*15°*) is longer than the *north-south* distance (*12°*)

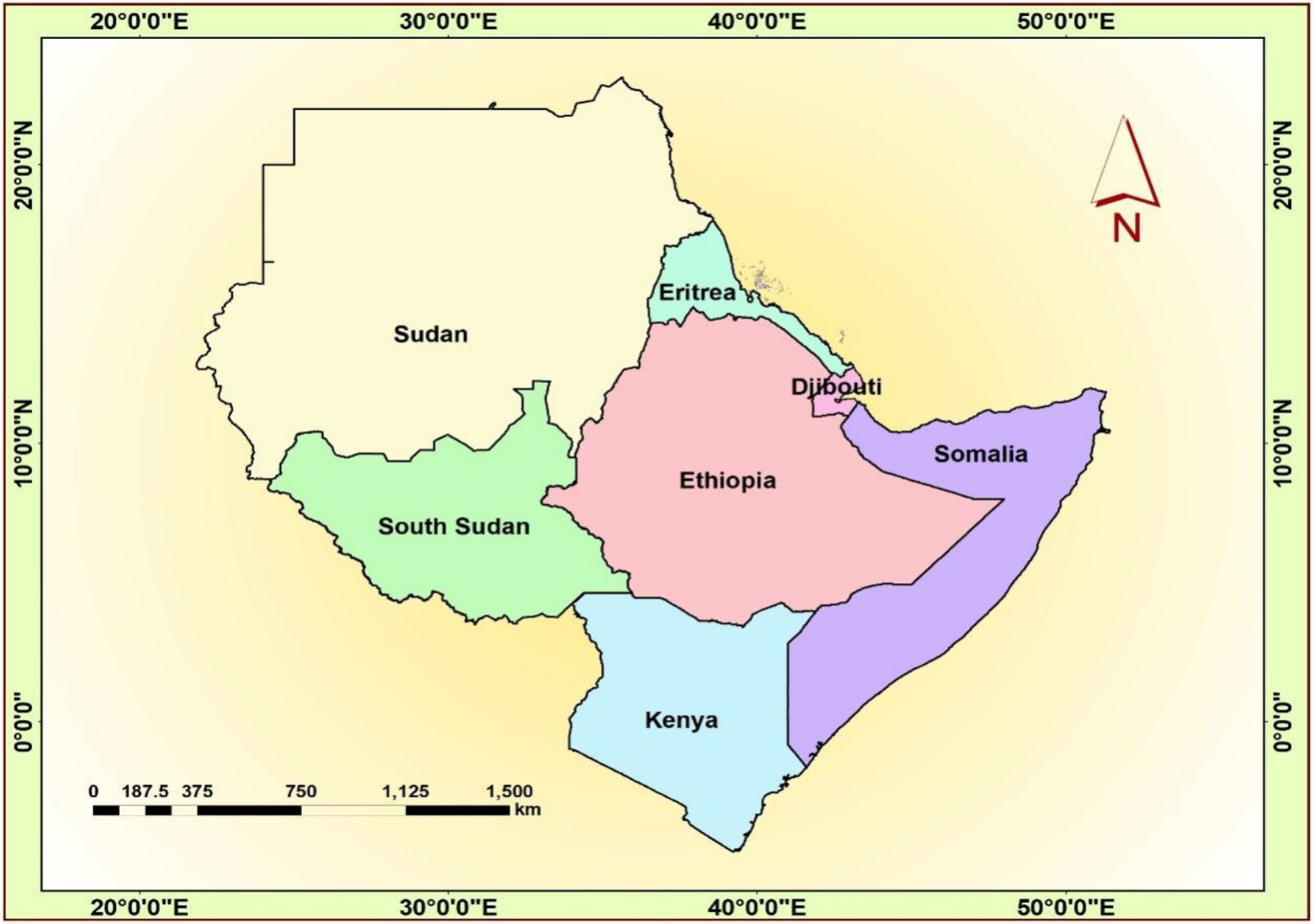
- The latitudinal and longitudinal extensions are important in *two ways*
- First
  - *As a result of its latitudinal extension the country experiences tropical climate*
- Secondly
  - *Due to its longitudinal extension there is a difference of one hour between the most easterly and most westerly points of the country*
  - *It is only for convenience that the 3 hours-time zone is used in all parts of the country*

2. Relative location

- Expresses the location of countries or places with reference to the
  - *Location of other countries (vicinal)*
  - *Relation of landmasses or water bodies*

Table 1.1: The relative location of Ethiopia

Vicinal location	In relation to water bodies and land masses
Sudan to the west and northwest	In the Horn of Africa
South Sudan to southwest	Southwest of the Arabian Peninsula
Djibouti to the east	South of Europe
Somalia to the east and southeast	Northwest of the Indian Ocean
Eritrea to the north and northeast	In the Nile Basin
Kenya to the south	


20°0'0"E
30°0'0"E
40°0'0"E
50°0'0"E
20°0'0"N
10°0'0"N
0°0'0"
N
Sudan
Eritrea
Djibouti
Somalia
Ethiopia
South Sudan
Kenya
0 187.5 375 750 1,125 1,500
km

- **Implications of the location** of Ethiopia are described as follows:

A. Climate

- Ethiopia is located implies that the country has a *tropical climate, though modified by its altitude*
- Ethiopia relative to the Indian Ocean, the Atlantic Ocean and the African and Asian landmass has also *various bearings on the climate of Ethiopia*

B. Socio-cultural

- Ethiopia is one of the *earliest recipients of the major world religions* namely Christianity, Islam and Judaism due to its proximity to the middle East, which was the origin of these religions
- The *linguistic and other cultural relationships*, which Ethiopia shares with its neighbors, reflect the influence of location

C. Political

- The political history of Ethiopia has been considerably influenced by:
  - *Geopolitical considerations of superpowers*
  - *Adjacency to the red sea (a major global trade route)*
  - *The middle east geopolitical paradigms*
- As a result, Ethiopia has been *exposed for external invasions in a number of times*; though the country resisted foreign intervention and remains free of external domination

1.2.2. Size of Ethiopia

- Ethiopia
  - A total area of approximately 1,106,000 square kilometers
  - *8th* largest country in Africa
  - *25th* largest country in the world
  - Extends about 1,639 kilometers *east-west*
  - Extends 1,577 kilometers *north-south*
  - About **0.7%** of the country is covered by *water bodies*
  - Its size also affects both the *natural and human environment of the country*

Table 1.2: Advantages and disadvantages of Ethiopia's large size

Possess *diverse* agro ecological zones	*Demands greater capital* to construct infrastructural facilities
Variety of natural resources	Requires *large army to protect* its territory
Own extensive arable land	*Difficult* for effective administration
Have *larger population size*	*Difficult* for socio-economic integration
Home for *diverse cultures*	
Greater depth in *defense external invasion*	

1.2.3. The shape of Ethiopia and its Implication

- Countries of the world have *different kinds of shape* that can be divided into five main categories:
  - *Compact*
  - *Fragmented*
  - *Elongated*
  - *Perforated*
  - *Protruded*
- These shapes have implications on
  - *Defense*
  - *Administration*
  - *Economic integration* within a country
- Whether some kind of shape is *advantageous to a country or not*, however, depends on many other factors

- **Compact shape countries**
  - The distance from the geographic center of the state to any of the *borders does not vary greatly like Poland*
  - It is easier for *defense, socioeconomic and cultural integration*
- **Elongated shape countries**
  - They are geographically *long and relatively narrow like Norway and Chile*
- **Fragmented shape countries**
  - They are divided from their other parts *by either water, land or other countries like Philippines, Indonesia, and Fiji*

- **Protrude shape countries**
  - Countries that have one portion that is *much more elongated* than the rest of the country like *Myanmar, Thailand and Eritrea*
- **Perforated shape countries**
  - A country that *completely surrounds another country* like the republic of South Africa

- There are *various ways of measuring shape* of countries
- Indices of compactness
  - Measure the ***deviation*** *of the shape of a country from a circular shape*, which is the most compact shape
  - There is *no country with absolutely circular shape*, those approximating a circular shape are said to be more compact
  - There are *four most commonly* used measures of compactness.
  - These are:

1. **The ratio of area of country to its boundary length**:

- *Area-Boundary* ratio
- The *higher the A/B* ratio, the greater the *degree of compactness*

2. **The ratio of boundary length of a country to the circumference of a circle having the same area as the country itself:**

- *Boundary-circumference* ratio
- Measures how far the boundary of a country approximates the circumference of a circle of its own size.
- The *nearer the ratio* to 1 the *more compact* the country is

3.The ratio of the area of the country to the circumference of the smallest inscribing circle:

- *Area-circumference* ratio
- Compares the area of the country with the circumference of a circle that passes touching the extreme points on the boundary of the country
- The *higher the A/C ratio*, the greater the *degree of compactness*

4. The ratio of the actual area of a country to the smallest possible inscribing circle:

- *Area-area* (A/A') ratio
- The area of the inscribing circle is the area of the smallest possible circle whose circumference passes through the extreme points on the boundary
- Half-length of the longest distance between two extreme points gives radius of the inscribing circle
- The *nearer the ratio* to 1, the *more compact* the country is.

Table 1.3: Ethiopia's shape compared to its neighbors in the Horn

Country	Area (km2)	Boundary (km)	A/B ratio	B/C ratio	A/C ratio
Ethiopia	1,106,000	5,260	210.27	1.41	296.61
Djibouti	22,000	820	26.83	1.56	41.83
Eritrea	117,400	2,420	48.51	1.99	96.83
Kenya	582,644	3,600	161.85	1.33	215.28
Somalia	637,657	5,100	125.03	1.80	225.22

1.3. Basic Skills of Map Reading

What is a Map

- A two-dimensional scaled *representation of part or whole of the Earth surface on a flat body*
- Map reading encompasses *a systematic identification of natural features and manmade features*
  - Natural features: *mountains, plateaus, hills, valleys, river, ocean, rocks, plain etc.*
  - Manmade features: *roads, railway, buildings, dam etc.*

- A special significance for geographers as *primary tools for displaying and analyzing spatial*
  - *Distributions*
  - *Patterns*
  - *Relations*
- Since these features *cannot easily be observed and interpreted* in real landscapes, maps are essential to geographers

Importance of maps

- Provide *geographical details of regions represented*
- Powerful tools for making *spatial analysis of geographical facts*
- Useful for *giving location of geographical features*
- *Used on various disciplines*
- *Storage of the geographical data*
- Potentially used to *asses' reliable measurements of the geographical features such as area, size, distance etc*

❑Types of Map

- There are many types of maps according to *their purpose and functions*

A. Topographical maps

- Depict one or more *natural and cultural features* of an area
- Could be *small, medium or large scale* depending on the size of the area represented
- Contents of topographical maps depend on
  - *Purpose of a map*
  - *Scale of a map*
  - *Date of compilation*
  - *Nature of the land represented*

B. Special purpose/statistical maps

- Show distribution of different aspects such as
  - *Temperature*
  - *Rainfall*
  - *Settlement*
  - *Vegetation* etc.

❑Marginal Information on Maps (Elements of Maps)

- Shown on a map to enable the *reading and interpretation of the geographical information* of an area represented.
- This includes:

A. Title

- Heading of the given map which tells *what the map is all about*

B. Key (legend)

- *List of all convectional symbols and signs* shown on the map with their interpretation

C. Scale

- Ratio between the *distance on the map* and the actual ground distance
- Enable the map user to interpret the ground measurement like road *distance, areal sizes, gradient* etc.
- Expressed as representative *fraction, statements/verbal scale, and linear (graphic) scale*

D. North arrow

- Indicated with the *north direction* on a map
- Used to know the other *important directions of the mapped* area like *east, west, south, and west*

E. Margin

- The *frame of the map*
- Important for *showing the end of the mapped area*

F. Date of compilation

- Date of *map publication*
- Enables map users to realize whether the map is *updated or outdated*

1.3.1. Basic Principles of Map Reading

- In developing map reading abilities and skills, certain *basic principles must be applied* by the map-reader to *translate map symbols into landscape images*
  - Map readers *must have ideas about the symbol*
  - Every map symbol *must be visualized by the reader*
  - **Symbols** refer to *landscape features and knowledge of directions*

- Maps are covered in a *series of lines* that make up a grid
- The lines allow you to *accurately pinpoint your location* on a map
- **Grid system**
  - Give an *accurate description of your location.*
  - This description, which will be a series of numbers, is known as **a grid reference**

UNIT TWO
THE GEOLOGY OF ETHIOPIA AND THE HORN
(4hr)

2.1. Introduction

Geology

- An *Earth science* that studies
  - *Evolution of the earth*
  - *Materials of which it is made of*
  - *Processes acting upon them*
  - *How earth's materials, structures, processes and organisms have changed over time*
- Also concerned with *events that took place in the remote past*
- A great deal of *geological understanding* must, therefore, be *obtained by inference, using clues from what can be*
  - ***Seen***
  - ***Measured***

- **Clues are** *not only the rocks and landforms* which can be observed and studied directly but also those provided by *indirect methods* such as:
  - **Geophysics**
    - *Studying earthquake waves which can penetrate deep beneath the Earth's surface*
  - **Geochemistry**
    - *Analysis of the detailed composition of rocks which can give clues as to their origin*
  - **Geochronology**
    - *Methods for finding the ages of rocks, usually from the radioactive elements they contain*

Alfred Wegener (1880-1930)

- Was a German *scientist and meteorologist*
- He believed that the *continents are moving*
- He is most notable for his *theory of "continental drift"*, which he proposed in 1912
- He believed that the earth's continents were once *bunched up/assembled together* in to a single huge continent called *Pangaea*

- **Continental drift** means
  - *The continents have drifted and moved apart*
  - *Continents were slowly drifting around the earth*

❑Pangaea

- A Greek term which means "*all the earth or entire earth*"
- Supercontinent that existed ***250*** million years ago
- All continents were once joined together in a single landmass (*supercontinent*)
- Existed during *Paleozoic and early Mesozoic era*
- Began to break apart about ***200*** million years ago
- Divided in to ***Gondwanaland*** and ***Laurasia***

- Gondwanaland includes
  - *Africa*
  - *South America*
  - *India*
  - *Antarctica*
  - *Australia*
- Laurasia includes Eurasia that is
  - *Europe*
  - *Asia*
  - *North America*
- Subsequently *fragmented and the pieces now accounts* for earths current continents

❑ Alfred Wegener's evidence (principles)

▪ The apparent fit of the continents

- The costliness of the continents appear to fit together like the pieces of puzzle
- Example: the coastlines of eastern America and the coastlines of western Africa

Fossil correlation

- Identical fossils had been found in the rocks on either side of the oceans
- **Example**: Evidence of life…fossils of entire creatures where they are located…ancient freshwater reptiles only found in *two places*: southern tip of south America and southern tip of Africa

- **Rock and mountain correlation**
  - *Identical* rocks and mountain structures have been found on either side of the oceans
  - Geological structure (rock structure)…fossil distribution with rock distribution
  - **Example**: mountains of NE united states have *exact type and age of rocks with mountains* of UK and Northern Scandinavian

- **Palo climate data (past climate data)**
  - Coal has been found in *colder regions and glacial* evidence has been found in warm regions
  - Evidence of glaciers: when glaciers move on the surface of the earth, they live evidence behind in the form of glacial striations in deep scratches in the rock that *shows the direction of ice move* that dragged over the surface

Example-1: In Amazon rainforest in equator of South American countries and stick jungles of central Africa

- In the past these places were located closer to the *poles where colder climate* that supports glacier, but today, because of they are too close to equator and getting sun light, the places are too intense and hot

Example -2: *Bituminous coal, sedimentary rock*, that is made from compacted and sediment plant remains, tropical plant remains, from hot sticky humid jungles which is found in *Northern Asia and Antarctica*

2.2: Geological Process

- Geological processes are divided into *two major groups:*
  - **A. Internal processes**
    - Also called *endogenic forces*
    - Include
      - **Volcanic activity** and all the tectonic processes of
        - *Folding*
        - *Faulting*
        - *Orogenesis (mountain building)*
      - **Epeirogenesis**
        - *Slow rising and sinking of the landmass*
        - Result in *building of structural and volcanic features* like
          - *Plateaus*
          - *Rift valleys*
          - *Block mountains*
          - *Volcanic mountains, etc.*

B. External process

- Also called exogenic forces
- They are *geomorphic processes*
- Include
  - *Weathering*
  - *Mass transfer*
  - *Erosion and*
  - *Deposition*
- Act upon the volcanic and structural landforms by
  - *Modifying*
  - *Roughening*
  - *Lowering* them down

In Ethiopia

- Ethiopia's land mass is *result of the combined effect* both processes
- Geological history of Ethiopia and the horn will be dealt *chronologically starting from the oldest era of the earth's history to the recent*

- Geological history is divided in to *eras*
- Each era is divided into *periods*
- The eras are given names that *indicate the kind of life* that existed in them
  - Paleozoic Era (ancient life): *the age of invertebrates*
  - Mesozoic Era (the middle life): *the age of reptiles*
  - Cenozoic Era (recent life): *the age of mammals*
- *Earth* is believed to have been *formed* approximately ***4.5*** *billion years ago*
- The *earliest forms of life* were thought to have originated approximately ***3.5*** *billion years ago*

Geological time scale

- Describe the *geology and history* of life on earth
- Divisions basically differ from each other in such characteristics as
  - *Relative position of land and sea*
  - *Kind of climate*
  - *Kind of animal and plant life that developed and existed*
- Difficult to measure *precisely*
- *Do not usually* consist of a *uniform length of time*
- Built largely on the basis of *life and evolution*
- Measures time on a scale involving **four** main units
- Division of time units is usually based on the *occurrence of significant geological events* (example: mass extinctions)

- **Eon**
  - *Largest* period of geological time
- **Eras**
  - Periods are combined to make subdivisions
- **Periods**
  - Epochs are clumped together into *larger units*
- **Epoch**
  - *Smallest unit* of time on the scale
  - Encompasses a period of millions of years

Table 2.1: The Geological time scale

Era	Period	Began (in Million Years)	End (my)	Major Events (million years ago)
Cenozoic	Quaternary	1.6	Present	Major glaciers in North America and Europe (1.5)
	Tertiary	70	1.6	Rocky Mountains (65), individual continents take shape.
Mesozoic	Cretaceous	146	70	Dinosaurs extinct (65), western interior seaway and marine reptiles (144 – 65)
	Jurassic	208	146	Pangaea (one land mass) begins to break up (200)
	Triassic	225	208	First mammals and dinosaurs
Paleozoic	Permian	290	225	Greatest extinction on Earth (245)
	Pennsylvanian	322	290	First reptiles
	Mississippian	362	322	Coal-forming forests
	Devonian	408	362	First land animals and first forests (408)
	Silurian	439	408	Life invades land
	Ordovician	510	439	First fish appeared
	Cambria	600	510	Great diversity of marine invertebrates
Precambrian	Proterozoic	2,500	600	Marine fossil invertebrates (600)
	Archean	4,500	2,500	Earliest fossils recorded (3,500), earliest rock formation (4,000)

Age Dating Techniques

- *Two techniques* of knowing the age of rocks:

A. Relative Dating

- Uses geological evidence to assign *comparative ages* of fossils
- Use two ways to know the relative age of a rock
  - **One way-**look at *any fossils the rock may contain*
  - **Second way** is to use the "*what is on top of the older rocks*?
- **But** these two methods only give the *relative age of rocks* -which one is younger and which is older

B. Absolute Dating

- Determining the ***actual age of rock***/ fossil using radioactive decay
- Age of a rock in years
- Determine the absolute age (exact age) of rock using ***radiometric dating***
- Geologists find absolute ages by measuring the amount of certain ***radioactive elements in the rock***
  - When rocks are formed, *small amounts of radioactive* elements usually get included
  - As time passes, the "parent" radioactive elements change at a regular rate into *non-radioactive "daughter" elements*.
  - Thus *the older a rock is the larger the number of daughter elements and the smaller the number of parent elements are found in the rock*

- At the end of the period constituting one half-life, half of the original *quantity of radioactive element has decayed*; after another half-life, half of what was left is halved again, leaving one-fourth of the original, and so on
- Two of the major techniques include:

A. Carbon-14 Technique

- Upon the organism's death, carbon-14 begins to disintegrate at a known rate, and no further replacement of carbon from atmospheric carbon dioxide can take place
- Carbon-14 has half-life of 5730 years

B. Potassium-Argon Technique

- The decay is widely used for *dating rocks*
- Geologists are able to date entire rock samples in this way, because potassium-40 is abundant in micas, feldspars, and hornblendes.
- Leakage of argon is a problem if the rock has been exposed to temperatures above 125° C (257° F), because the age of the rock will then reflect the last episode of heating rather than the time of original rock formation

2.4. Geological Processes and the Resulting Landforms of Ethiopia and the Horn

2.4.1. Precambrian Era Geologic Processes

- Span of time before life appeared
- From 4.5 billion - 600 million years ago
- Covers 5/6th of the earth's history
- *Limited* knowledge of the events due to:
  - *Its remoteness in time*
  - *Absence of well-preserved fossils*
- Major geologic event was **orogenesis**
  - *Intense folding*
  - *Intrusive igneous activity…when magma cools slowly below earth's surface*
  - *Formation of huge mountain ranges*

- In *between* the orogenic periods and *after the last* orogenesis:
  - Long periods of *denudation*.....reduces mountains to *near-level (pene-plained)*....was later covered by *younger rock formations*
- Ethiopia rocks belonging to this Era are found *beneath all other rocks, forming the basement rocks*
- Rocks had been subjected to
  - *Pressure and heat from overlying weight*
  - *Earth movements (folding, orogenesis)*
  - *Intrusive igneous activity*

- Then, the *original rocks* (both sedimentary and igneous) were *altered* into *metamorphic rocks* of varying stages of metamorphism
- The processes have allowed *mineralization and crystal formation*,
- The rocks are also collectively described as *crystalline rocks*
- The Precambrian rocks are *overlaid* by recent rock formations

- Precambrian rocks **covering 25% of the land mass** of Ethiopia found in the following areas:

A. Northern part

- *Western lowlands, parts of northern and central Tigray*

B. Western part

- *Gambella, Benishangul-Gumuz (Metekel and Asossa), western Gojjam, western Wellega, Illuababora, and Abay gorge*

C. Southern part

- *Guji, southern Omo, and parts of southern Bale and Borena*

D. Eastern part

- *Eastern Hararghe*

2.4.2. Paleozoic Era Geologic Processes

- From *600 - 225* million years ago
- Lasted for about *375* million years
- Major geological process was *denudation*
- Denudation*: collective process of:*
  - ***Weathering**-breaking down of rocks*
  - ***Mass movement**-transfer of rocks due to gravity*
  - ***Erosion**-removals of materials*

- Gigantic mountains that were formed by the precambrian orogeny were
  - *Subjected to intense and prolonged denudation*
  - *Reduced to a "pene-plained" surface*
- The sediments were transported
  - **Southward**-*to form continental (in Africa)*
  - **Eastward**- *for marine deposits*
- Because of the *limited deposition within Ethiopia*, rocks belonging to this Era are *rare in the country*

2.4.3. Mesozoic Era Geologic Processes

- From *225-70* million years ago
- Lasted for about *155* million years
- Major geological process was *slows sinking and rising (epeirogenesis) of the landmass*
- Epeirogenesis affected the whole *present-day*
  - *Horn of Africa*
  - *Arabian landmass*

- Land was tilted eastward and therefore
  - *Lower in the southeast*
  - *Higher in the northwest*
- As the *land sank slowly*, the sea invaded it starting from *Somalia and Ogaden* and slowly spreading northwestward
- This was in **late Triassic and continued up to Jurassic period**

- Mesozoic rocks are considered to have the *greatest potential for oil and gas deposits*
- Through time, *overlying rocks and by cementing minerals* compacted to form *sandstone and limestone layers* respectively

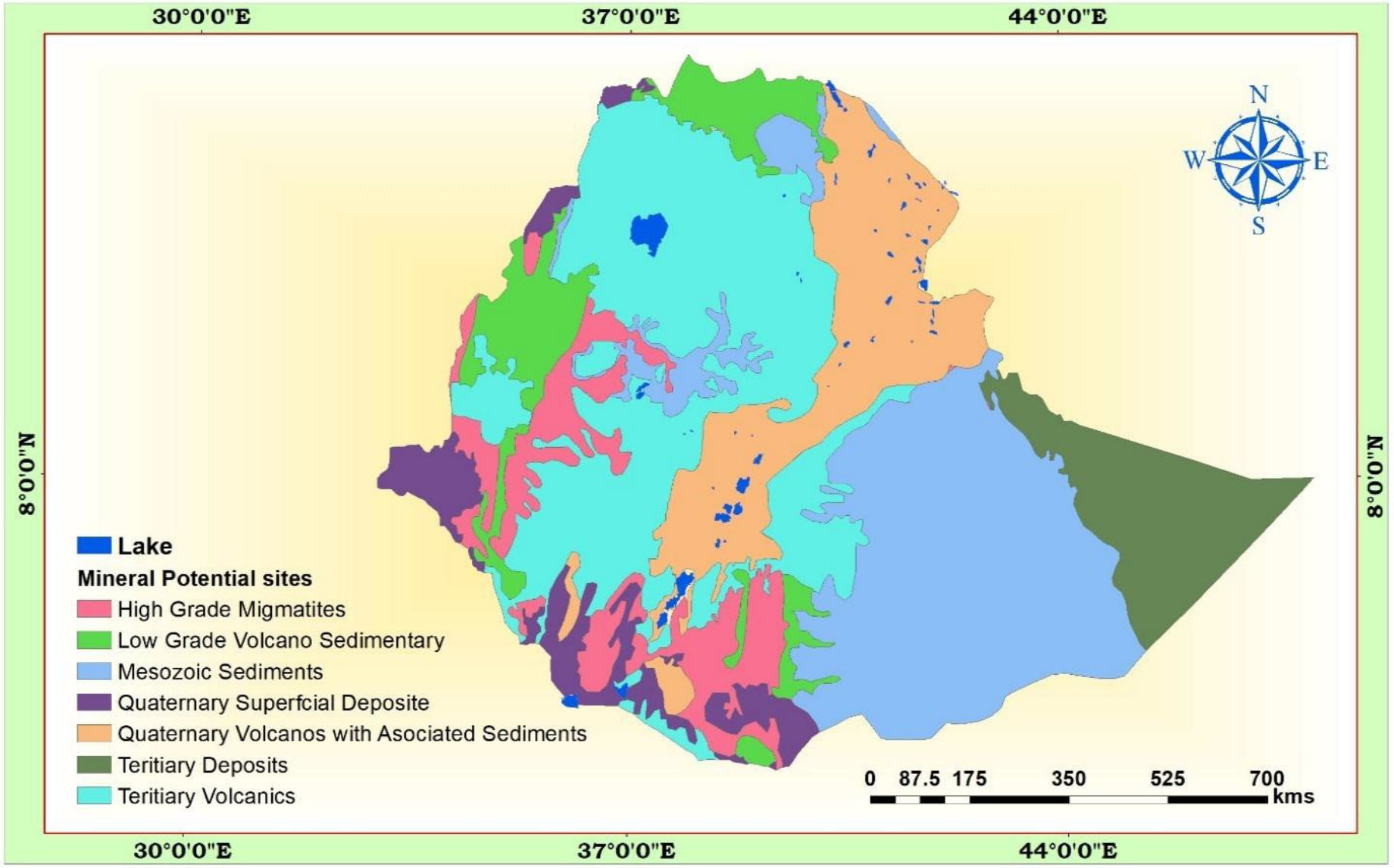
- These are known as the ***Adigrat sand stone and Hintalo limestone layers***
- Due to epeirogenesis, the *regression of the sea began in the Upper Jurassic and continued throughout cretaceous period*
- In the country *sedimentation ended with the deposition of clay*, *silt, sand conglomerate that were laid over the Hintalo limestone*

- By the end of the Mesozoic Era, when the land emerged out of the sea, *three major sedimentary formations* were laid and formed upon the precambrian rock:
  - *Adigrat sand stone -lower sandstone*
  - *Hintalo limestone*
  - *Upper Sandstone-uppermost layer*
- Age and thickness of the sandstone layers vary in a *southeast - Northwest* direction due to:
- Tilting of the landmass during the transgression and regression of the sea
- The direction of the invading and retreating sea

- **Therefore,**
  - Adigrat sandstone is
    - *Older and thicker* in the **southeast**
    - *Decreases in age and thickness* **northwestward**
  - Upper sandstone is
    - *Thicker and younger* in the **southeast**
    - *Older and thinner northwest*

- The transgressing sea and Mesozoic sediments nearly covered the *whole of Ethiopia*
- In most parts of Ethiopia, the Mesozoic rocks are ***overlaid*** by the Cenozoic rocks
- The old marine sediments are extensively found in the *Southeast* lowlands
- The Mesozoic sedimentary rocks cover **25%** *of the land mass of the country*

Figure 2.1. Geological map of Ethiopia



2.4.4. Cenozoic Era Geologic Processes

- From *70 million years ago - present*
- The ***most recent*** of the geologic Eras
- Major geological events were ***tectonic and volcanic activities*** that making of the *present-day landmass of Ethiopia and the Horn of Africa*
- The land was subjected to ***three major geologic events***
- These geologic activities are
  - *Uplifting of the Arabo-Ethiopian landmass and outpouring of huge quantity of lava*
  - *Formation of the Rift Valley*
  - *Quaternary volcanism and deposition*

A. Uplifting of the Arabo-Ethiopian landmass and outpouring of lava flood

- A continuation of the slow rise that began in the *upper jurassic and cretaceous periods*
- Uplifting continued to the paleocene and oligocene epoch of the tertiary period
- Greatest uplift was in central Ethiopia (up to **2,000 m.a.s.l**)
- Occurred during the *eocene epoch*
- Was of an *epeirogenic character*
- This immense tectonic force**---**fractured the crust**…** Huge quantity of lava came out**….**widely and extensively covered a large part of:
  - *Ethiopian plateau surface*
  - *Floor of the present-day rift valley*

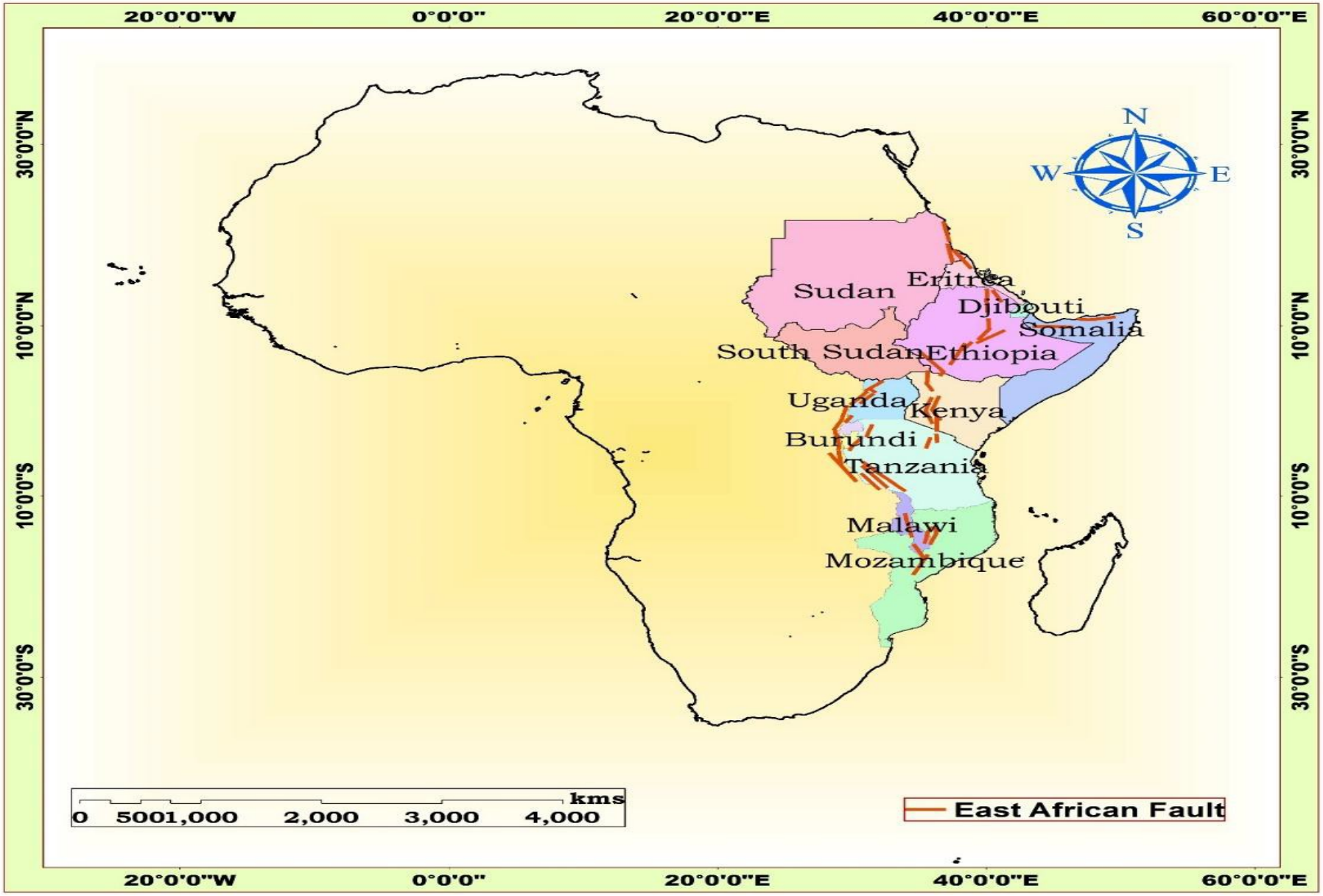
- The mass of lava formed many and huge volcanic mountains“ ***towering the flat basaltic plateau***
- This volcanic material is known as ***Trappean lava or Trap Series lava*** that is
  - *Not dissected by erosion*
  - *Makes the Ethiopian plateau had flat and nearly horizontal*
- This is an expression of the
  - *Pene-planed precambrian surfaces*
  - *The smothering effect of the mesozoic deposition*
  - The *spreading of the trap series lava over the mesozoic sediments*

B. Formation of the rift valley

- Related with the theory of ***plate tectonics***
- ***Formed when*** tension widened the fractures, the ***central part of the landmass collapsed*** to form an extensive structural depression

- **Plate tectonics**
  - *Lateral movement of the crust in opposite directions producing tensional forces that caused parallel fractures or faults on the sides of the up-arched swell*

Figure 2.2.The Ethiopian and East African Rift Valley systems



- Major faulting movement
  - Began in the late *oligocene and miocene epochs* of the Cenozoic era
  - *Affecting the whole African rift system*, including that of Ethiopia and the gulf of Aden
  - Red sea and the gulf of Aden were *connected*
  - Afar depression was *down-faulted*
  - *Danakil Depression and the Red Sea* was uplifted to form the *Afar Block Mountains*

Great East African Rift

- Extends from *palestine-jordan in the north to malawi-mozambique in the south*
- A distance of about 7,200 kilometers
- 5,600 kilometers is in Africa
- 1,700 kilometers in Eritrea and Ethiopia
- Widest part of the Rift Valley is *the Afar Triangle* (200-300 km)

- **Afar Triangle**
  - Also called afar depression
  - Its northern part is Danakil depression…*hottest place in the world*
  - Bordered by:
    - Ethiopian plateau-west
    - Red sea-North east
    - Somalia plateau-South

- The *Red Sea, the Gulf of Aden, and the East African* System meet and form the triangular depression of the Afar
- The formation of the Gulf of Aden and the separation of the Arabian Peninsula from the Horn of Africa also took place during the ***Tertiary period***

Rift Valley region of Ethiopian

- The *most unstable part of the country*
- Numerous *hot springs, fumorales, active volcanoes, geysers, and frequent earthquakes*
- Formation of the rift valley has the following *structural (physiographic) effects:*
  - *Divides the Ethiopian plateau into two*
  - *Separates the Arabian landmass from African landmass*
  - *Causes the formation of the dead sea, red sea and the gulf of Aden troughs*
  - *Creates basins and fault depressions on which the rift valley lakes are formed*

C. Quaternary Volcanic Eruptions and Depositions

- Recent volcanic activities that took place after the formation of the rift valley
- Occurred in the pliocene-pleistocene epochs
- A continuation of the tectonic and volcanic processes
- Renewed rifting/faulting and more volcanism
- Occurred in the floor of the rift valley and the region south of lake Tana
- **Aden volcanic** and **recent faulting** are more extensively developed in the afar region
- Aden volcanic have relatively *well-preserved* and *visible morphological features*

- The *basic volcanic features* of the Aden series include:-
  - Numerous and freshly preserved volcanic cones
  - Example:
    - *Dubi*
    - *Aftera*
    - ***Erta Ale--***the most active volcano in Ethiopia
  - Volcanic hills and mountains
    - *Fantale, Boseti-Gouda near Adama*
    - *Aletu north of Lake Ziway*
    - *Chebbi north of Lake Hawassa etc*
  - Extensive lava fields and lava sheets.
  - Lava ridges
  - Thermal springs, fumaroles etc

Quaternary Deposition

- In quaternary period of the Cenozoic era
  - Earth experienced a *marked climatic change*
  - Time of the last **"ice age"** in the *middle and high latitude*
  - Time of the "**pluvial rains**" *in Africa*

- **Pluvial rains---*relatively high precipitation***
  - Eroded the Ethiopian plateau
  - Eroded materials were *deposited* in the rift valley lakes
  - Resulted in an excessive surface flow; rivers were many and large
  - Carried a lot of water and sediments
  - Lake and marshy areas became *numerous and deep*
    - *For example, Ziway-Langano-Shalla; Hawasa-Shallo; Chamo-Abaya; and Lake Abe and the nearby smaller lakes and marsh basins formed huge lakes*

- After the “Pluvial Rains“
  - Earth's climate became *warmer and drier*
  - *Increased the rate of evaporation*
  - *Diminished the sizes of the lakes*
  - Today, *lacustrine deposits* in many of the Ethiopian lakes, river valleys and lowlands
  - Deposits are divided as follow.

***A. Lacustrine deposits**: lakebeds, and swampy depressions*

***B. Fluvial deposits**: on the banks of rivers*

***C. Glacio-fluvial deposits** : occurred on high mountains*

***D. Aeolian deposits**: windblown deposits*

- Quaternary deposits are mainly found in
  - *Rift valley* (afar and lakes region)
  - *Baro lowlands*
  - *Southern borena*
  - Parts of *northwestern low lands*
- Cenozoic rocks cover **50%** of the land mass of the country that include
  - *Highland tertiary volcanic* (basalt…*hard and black volcanic rock*)
  - *Tertiary as well as quaternary volcanic*

2.5. Rock and Mineral Resources of Ethiopia

- Abundant mineral resources
- Its is associated with the *Precambrian rocks*
- A great variety of such minerals occur in the *basement rocks*
- Rocks contain *most of the metallic deposits known at present*
- Taking place for the *past 2,000 years*
- *Gold production and utilization* has become part of Ethiopia's history, tradition and folklore
- However, presently mineral production from Ethiopia has been *negligible by world standards*

2.5.1. Brief Facts and Current State of Main Minerals in Ethiopia

- **Gold**
  - Mined for quite long time
  - Mainly from benishangul-gumuz (metekel) and adola
- **Platinum**
  - Yubdo area in Wellega, is the only active Ethiopian Platinum mine
- **Tantalum**
  - Found in southern ethiopia
  - It occurs in adola area where kenticha
  - Extensive lignite deposits in Ethiopia are found in
    - Nedjo (wellega)

Tantalum

- Found in southern Ethiopia
- It occurs in adola area where kenticha
- Extensive lignite deposits in Ethiopia are found in
    - Nedjo (wellega)
    - Small amounts in chilga (Gondar)

- **Gemstones**
  - Occur in many parts of Ethiopia, mainly in
    - Amhara Regional States
    - Oromia Regional States
  - Quality Opal was first discovered by local people in Wadla and Dalanta woredas, North Wello in Amhara Regional State
- **Potash**
  - Reserve in the danakil (dallol depression) of the afar region

- **Gypsum and Anhydrite**
  - Produced for domestic consumption
  - Occur in sedimentary formations of the
    - Red sea coastal area
    - Danakil depression
    - Ogaden, shewa, gojjam, tigray, and hararghe
- **Marble**
  - Found in
    - West of mekelle
    - South of Adwa in Tigray

Clay

- Ethiopia is endowed with industrial clay material
- Alluvial clay occur in
  - Adola area
  - Abay gorge
  - Rift Valley lakes region
- Ceramic clay found at
  - Ambo
  - Adola

Construction stones

- Include important *building stones* such as
  - Basalt
  - Granite
  - Limestone
  - Sandstone
- Found in
  - Muger valley
  - Abay gorge (dejen)
  - Tigray (messebo)

2.5.2. Mineral Potential Sites of Ethiopia

- Most mineral potentials of Ethiopia includes three major greenstone belts

1. The Western and South-western-greenstone belt

- Contain various minerals: primary gold occurrences such as
  - *Dul,Tulu-Kape*
  - *Oda-Godere*
  - *Akobo*
  - *Baruda*
  - *Bekuji-Motish*
  - *Kalaj*

2. The Southern greenstone belt

- Known as the adola belt
- Comprises the primary gold deposits and occurrences of
  - *Lega-dembi*
  - *Sakaro*
  - *Wellena*
  - *Kumudu*
  - *Megado-Serdo*
  - *Dawa Digati*
  - *Moyale*
  - *Ababa River*

3. The Northern greenstone belt (Tigray)

- Comprises of the primary gold occurrences of
  - Terakemti
  - Adi-zeresenay
  - Niragueu

UNITE THREE
THE TOPOGRAPHY OF ETHIOPIA AND THE HORN
(3hrs)

3.1. INTRODUCTION

- The topography of Ethiopia is largely determined by *the geologic activities of the Cenozoic Era*
- The *uplifting of the Arabo-Ethiopian* swell and the subsequent outpouring, spreading and *thick accumulation of Trapean lava* have given rise to an outward sloping highland plateau and mountains
- The *major faulting resulted* in the *division of the plateau* into two broad units and the *formation of a great structural valley*

- Faulting elsewhere and on the floor guided part of the course of some rivers
- They also formed depressions on which *lakes were subsequently created*
- Geomorphic processes brought some *modification to the structural landform by river dissection* and roughening on the highlands, and deposition on the lower areas

General Characteristics of the Ethiopian Physiography

- Ethiopian landform is characterized by *great diversity*
- There are
  - *Flat-topped plateaus*
  - *High and rugged mountains*
  - *Deep river gorges*
  - *Vast plains*

- Altitude ranges from **125** meters below sea level ***(Kobar Sink***) to the highest mountain in Ethiopia, Mount ***Ras Dashen*** (**4,620 m.a.s.l),** which is the *fourth highest* mountain in Africa
- Ethiopia has the *largest proportion of elevated landmass* in the African continent
- It is sometimes described as the ***Roof of East Africa*** because of its *height and large area*

- More than **50%** of the Ethiopian landmass is above **1,000** meters of elevation; and above **1,500** meters makes **44%** of the country
- Half of this, in turn, is at more than **2,000** meters above sea level
- Most of the ***Ethiopian Highlands*** are part of *central and northern Ethiopia*, and its northernmost portion extends into Eritrea
- The highland core, on the other hand, is ***encircled*** *by semi-arid and lowlands*
- The Ethiopian Highlands are *rugged mass of mountains*, situated in the Horn of Africa

- They are the *most significant physical features* of the country, which form the *largest continuous area of its elevation* in the continent
- They have been ***dissected*** *by several rivers and ravines* which have cut deep gorges
- They have been divided into *several regions and mountain systems*
- Most of the country consists of *high plateau and mountain ranges* that are *sources of many rivers and streams* that made the country to be described as the "***Water Tower of East Africa***"

- The *diversity in topography* is accompanied by differences in other natural features such as *soil, climate, vegetation and wild life*
- Likewise, the *socio-cultural and economic phenomena* are also affected by the topography
- Taking the **1,000** meters contour line for the highland-lowland demarcation, one observes the following contrasting features between the Ethiopian highlands and lowlands

Characteristics of Ethiopian highlands

- *Moderate and high amount of rainfall (>600 mm per year)*
- *Lower mean annual temperature (<200C)*
- *The climate is favorable for biotic life*
- *Rain-fed agriculture is possible*
- *Free from tropical diseases*
- *Attractive for human habitation and densely settled*

- The cumulative effect of all this is that, the **highlands** have been *significant throughout* Ethiopian history in the *economic, cultural and political* life of the people
- These highlands make up nearly **56%** of the area of the Ethiopia
- This is further subdivided into
  - *Lower highland **(1,000 - 2,000 m.a.s.l**), which make up **35%***
  - *Higher highland **(>2,000 m.a.s.l**) constituting nearly **22%***

- In contrast to the highlands, the remaining **44%** of the Ethiopian lowlands are characterized by:
  - *Fewer amounts of rainfall and higher temperature*
  - *High prevalence of tropical diseases*
  - *Lower population densities*
  - *Nomadic and semi-nomadic economic life*
  - *Vast plain lands favorable for irrigation agriculture along the lower river basins*

3.2. The Physiographic Divisions of Ethiopia

- Structural divisions by the geologic processes of the Cenozoic Era
- **Three major physiographic**

1. The Western highlands and lowlands

2. The South-eastern (Eastern) highlands and lowlands

3. The Rift Valley

3.2.1. Western Highlands and Lowlands

- All the area *west of the Rift Valley*
- Nearly the *whole western half of Ethiopia*
- Makeup **44%** of the area of the country
- Subdivided into
  - ***Four groups of highlands (76.3%)***
  - ***Four groups of lowlands (23.7%)***

1. The Western Highlands

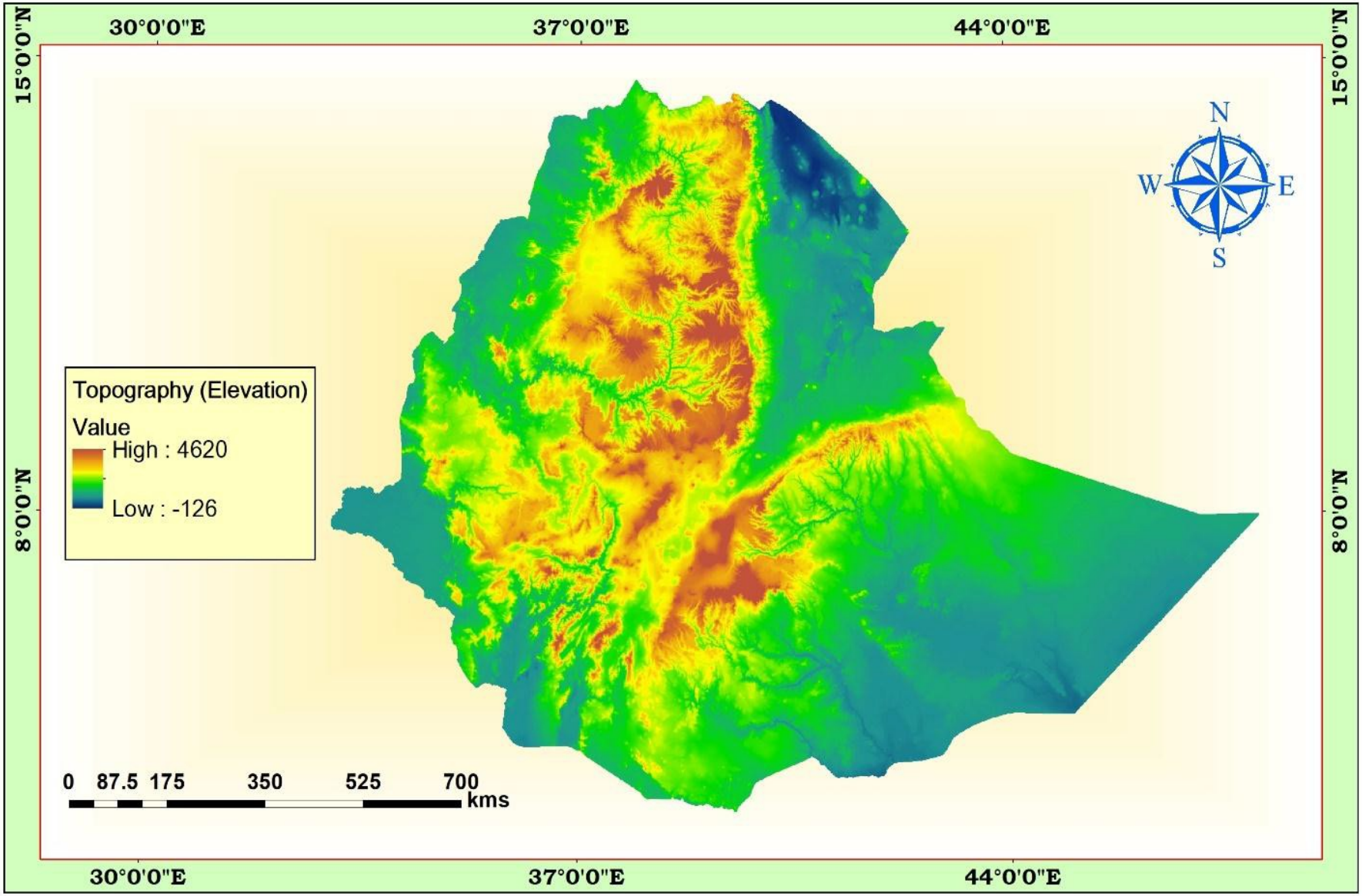
A. Tigray Plateau

- **Extends** *tekeze gorge (S)* to *central Eritrean HLs*
- Separated from the Eritrean plateau by *the mereb river*
- **Lies** to the
    - *Southeast of mereb/gash river*
    - *Northeast of tekeze river gorge*

- **Constitutes 13%** of the area of the region
- Highlands b/n **1,000-2,000** m.a.s.l
- Features of:
  - *Granite hills*
  - *Rugged topography*
  - *Ambas: steep-sided, flat-topped mountain surrounded by farmland*

- High mountains over **3000** meters:
  - Mount Tsibet (3988 m.a.s.l)
  - Mount Ambalage (3291 m.a.s.l)
  - Mount Assimba (3248 m.a.s.l)
  - Debre-Damo:
    - *Famous monastery*
    - *Tableland climbed only by a rope pulley*

Figure 3.1. Ethiopian Topography



B. North Central Massifs

- *Largest* in the western HLs
- Follows the *Abay and Tekeze gorges*
- Plateau and tablelands are still *capped by the Trappean lava*
- Its central part accommodates:
  - *Lake Tana basin*
  - *Plains of Fogera and Dembia*

- Consists of the *Gonder, Wello and Gojjam* Massifs
- ***Most popular*** mountains:
    - ***Ras Dashen*** *(**4,620** m.a.s.l)*
    - ***Weynobar/Ancua*** *(**4462** m.a.s.l)*
    - ***KidisYared*** *(**4453** m.a.s.l)*
- ***Bwahit*** (4437 m.a.s.l) *in Simen Mountain System*
- ***Guna*** *(*4,231 *m.a.s.l) in the Debre Tabour Mountain System*
- ***Abune Yoseph*** *(**4,260** m.a.s.l) in the Lasta highlands of Wello*
- ***Birhan*** *(**4,154** m.a.s.l) in the Choke Mountain System in Gojjam*

- These mountains have:
  - *Steep cliffs*
  - *Rugged terrain*
- Gonder and Gojjam are
  - *Separated from wello by impenetrable and deep gorges*
  - *Connected by **yeju-wadla delanta** land bridge*
  - ***Woreta-debre tabor-woldya** road constructed to link the northwestern region with asseb through woldya and dessie*

C. Shewa Plateau/Central highlands

- Bounded by:
  - **Rift Valley** in the *east and southeast*
  - **Abay gorge** in its *northern and western*
  - **Omo gorge** in the *south and west*
- Occupies a *central geographical position* in Ethiopia
- ***Smallest*** of the Western HLs
- Only **11%** of the area of the whole physiographic region
- Drained by *Abay, Omo and Awash*
- ***Highest*** mountain:
  - ***Abuye-Meda*** *(**4,000** m.a.s.l) in Northern Shewa*
  - ***Guraghe (3,721** m.a.s.l **)** in the south*

D. Southwestern Highlands

- Consists of the highlands of:
  - *Wellega*
  - *Illuababora*
  - *Jimma*
  - *Kaff*
  - *Gamo and Gofa*
- Separated from the *adjacent* highlands by:
  - ***Abay*** river valley
  - ***Omo*** river valley
- Extends from the *Abay gorge in the N*

  To

  Kenya border and Chew Bahir in the S
- Accounts for **22.7%** of the area of the region
- **Second largest** in the Western HLs
- About **70%** of its area is lies within **1,000-2,000** m altitude

- The **wettest** in Ethiopia
- Drained by:
    - *Dabus, Deddessa, rivers*
    - *Baro, Akobo rivers*
    - *Ghibe/Omo rivers*
- Accommodates the *most numerous and diverse* ethnic linguistic groups in Ethiopia
- Highest peak*:*
    - **Guge Mountain (4,200** m.a.s.l)

2. Western Lowlands

- *Western foothills and border plains*
- Extend from *Western Tigray in the N* to *southern Gamo-Gofa in the S*
- Make **11%** of the area of the physiographic region
- Ranges between **500 and 1000** m.a.s.l
- Subdivided into **Four:**
  - *Tekeze lowland*
  - *Abay-Dinder lowland*
  - *Baro lowland*
  - *Ghibe lowland*
- Except **baro lowland**, it characterized by *arid or semi-arid* conditions

- Economic activities:
  - *Pastoral or semi-pastoral**-dominate***
  - *Irrigation agriculture is highly feasible*
  - *Mechanized agriculture*
- Small but important towns:
  - *Humera*
  - *Metema*
  - *Omedla*
  - *Kurmuk*
  - *Gambella*

- ***Ghibe/Omo lowland***
  - *Includes:*
    - *Lower ghibe/omo valley*
    - *Northern section of the turkana basin*
  - ***Geographical**, it is classified in the western lowlands*
  - *But **Structurally**, it also belongs to the rift valley*
  - *Faulted and tectonically depressed area*

3.2.2. Southeastern Highlands and Lowlands

- **Second largest** physiographic region in *terms of area*
- Accounts for **37%** of the area of Ethiopia:
  - Highlands (**46%**)
  - Lowland (**54%**)
- Subdivided:
  - *Two units of highlands*
  - *Two units of extensive lowlands*

1. Southeastern Highlands

A. Arsi-Bale-Sidama Highlands

- Found to the *east of the Lakes Region*
- Located in the *south western* section
- Make up:
  - **28.5%** of the area of the region
  - **62%** of the south - Eastern HLs
- Made up of:
  - *Flat rolling uplands*
  - *Dissected mountains*

- Well-known mountains:
  - ***Kaka*** *(****4,180*** *m.a.s.l)*
  - ***Bada*** *(****4,139*** *m.a.s.l)*
  - ***Chilalo*** *(****4,036*** *m.a.s.l)*
- Dissected by rivers Wabishebelle and Ghenale along with their tributaries

❑Sof Omar cave

- Found near *Bale Mountains*
- World's most *spectacular and extensive* underground
- Cut by **Web River**, tributary of Ghenale through the *Mesozoic Limestone rocks*

Bale highlands

- Separated from the Arsi highlands by the *head and main stream of Wabishebelle*
- Consist of:
  - *Basaltic plateau* in the north-central part
  - *High mountain* massif to the south
- Highest mountain peaks:
  - *Tulu-Demtu (**4,377** m.a.s.l)*
  - *Batu (**4,307** m.a.s.l)*
- Modified by ***Erosion features*** belonging to Pleistocene glaciation
- Important *grains producing areas* with still high potential

Arsi highlands

- *Afro-Alpine summit of Senetti plateau* is found on the Arsi highlands
- Modified by **fluvial processes:**
  - *Gorges*
  - *Hanging valleys*
  - *Depressions*
- Important *grains producing areas* with still high potential

Sidama Highlands

- Separated from the Bale Highlands by the *Ghenale river valley*
- Occupy the *southwestern* corner of this region
- Prominent feature: *Jemjem plateau*
- Important coffee growing area

B. Hararghe Plateau

- *A north-easterly extension* of the south-eastern HLs
- Extends from: ***Chercher highlands*** *in SW*

  to

  Jigjiga *in East*
- Makes up:
  - **38%** of the SE highlands
  - **17.4%** of the whole physiographic region
- A *low lying* and *elongated region*
- Highest mountain*: Gara-Muleta* (**3,381** m.a.s.l)

2. Southeastern Lowlands

- Located in the *southeastern* part of the country
- ***The most extensive*** lowlands in Ethiopia
- Make up:
  - **54%** *of the area of the physiographic region*
  - **1/5** *th of the country*
- Sub-divided:
    - *Wabishebelle plain (**60%**)*
    - *Ghenale Plain (**40%**)*

- Include the plains of:
    - *Ogaden*
    - *Elkere*
    - *Borena*
- Interrupted by:
    - *Low hills*
    - *Low ridges*
    - *Inselbergs: small mountain*
    - *Shallow river valleys*
    - *Broad river valleys*
    - *Depressions*

- Due to *harsh climatic* conditions:
  - *Little used*
  - *Support very small population*
  - *Sparsely inhabited*
  - *Pastoral and semi-pastoral communities*
- The economic potential:
  - *Animal husbandry*
  - *Irrigation*
  - *Agriculture*
  - *Exploitation of petroleum and natural gas*

3.2.3. Rift Valley

- A *tectonically formed* structural depression
- Bounded by *two major* and more or *less parallel escarpments*
- Separated the *Ethiopian Highlands and Lowlands* in to two
- Extends from: **Afar triangle** in *N*
  to
  Chew Bahir in S
- About **1,700** km2
- Covers **18%** of the area of Ethiopia
- **Elongated** and **funnel shaped**, with a NE-SW orientation
- Opens out:
  - **Afar Triangle**, the *widest*
  - *Narrows* down to the south

- Its climate varies from *warm, hot and dry to cool and moderately* moist conditions due to:
  - *Altitudinal variation*
  - *Positional differences*
- *Desolate and sparsely inhabited by pastoralists* and some people practice some *rain-fed agriculture*
- Subdivided into **three:**
  - *Afar triangle*
  - *Main Ethiopian rift*
  - *Chew bahir rift*

Floor of Rift Valley

- Made up of interconnected:
  - *Troughs: elongated& low pressure region*
  - *Grabens: valley with distinct escarpment*
  - *Depressions: sunken landform*
- Covered by:
  - *Volcanic rocks*
  - *fluvial deposits*
  - *lacustrine deposits*
- Altitude ranges from:
  - **125** m.b.s.l at ***Dallol Depression***
  - **2,000** m.a.s.l in the ***Lakes region***

A. Afar Triangle

- The *largest and widest* part of the rift valley
- Makes up **54%** of the rift valley area
- Bounded by:
  - *High western escarpments in W*
  - *Eastern escarpments in the E*
  - *Afar and Aisha Horst in the NE*
- Generally of *low altitude* (**300-700** m)
- Quite different is the *morphology* of the Afar depression, triangular-shape lowland
- *Elevation drops uniformly from SW to N*
- *In E, the shores of Lake Asal, fluctuating 125 m.b.s.l, represent the lowest sub aerial point of the African continent*

- Characterized by:
  - *Faulted depressions (grabens)*
  - *Volcanic hills*
  - *Active volcanoes*
  - *Volcanic ridges*
  - *Lava fields*
  - *Low lava platforms*
  - *Lakes (abe, asale, and afrera)*
- Generally *hot and dry*
- Economic importance:
  - *Salt extraction*
  - *Irrigation along the Awash River*
  - *Electric potential from geothermal energy*
- A prominent feature: ***Danakil Depression (Kobar Sink)***

Danakil Depression (Kobar Sink)

- *The most hostile environments on Earth*
- *Max. temp. can exceed **50°C** during the summer wet season*
- *Located in **Dallol**, at the northern tip of Afar*
- *Separated from the red Sea by a 200 meters high land barrier much of it lies below sea level*
- *Its larger part covered by thick and extensive salt plain*
- *Lake Asale and Afrera occupy the lowest parts of this sunken depression*

B. Main Ethiopian Rift/Central Rift

- *Narrow belt* of the RV that extends from: **Awash River** in *the N*
  to
  Lake Chamo
  in *the S*
- Bounded by the *western and eastern escarpments*
- Except of the *Arbaminch area*, escarpments are *generally low*
- The *narrowest and the highest*
- Average width of **50-80** kilometers
- General elevation of **1,000-2,000** m.a.s.l
- The floor is dotted by:
  - *Cinder cones*
  - *Volcanic mountains*
- The big ones:
  - *Mount Fentale*
  - *Boseti-guda (near Adama)*
  - *Aletu (north of Lake Ziway)*
  - *Chebi (north of Lake Hawasa)*

- Prominent features are numerous *lakes* formed on tectonic sags and fault depressions
- Lakes are generally *milder and watery*
- Here *rain-fed agriculture* is practiced
- Other resource bases include:
    - Recreational value of the lakes
    - Agricultural importance of some streams and lakes
    - Geothermal energy potential

III. Chew Bahir Rift

- The *smallest and the southern-most* part of the rift valley
- Separated from main Ethiopian rift by Gneissic(metamorphic type of rock) ***highlands of Konso***
- Characterized by:
  - *Broad and shallow depression*
  - *Marshy area covered by tall grass*
  - *Segen and woito streams empty*

3.3. The Impacts of Relief on Biophysical and Socioeconomic Conditions

- *Highly dissected character* influence the *various socioeconomic aspects* of Ethiopia

1. Agricultural practices

- Relief influences: *farm size and shape*

  Small in size and fragmented

- *Choice of farming techniques and farm implements*
- *Crop production:*
  - Higher altitudes crops (barley, wheat…..)
  - Low altitude crops (sorghum, maize…..)
- *Practice of animal husbandry:*
  - Higher altitudes (equines and sheep..)
  - Lower altitudes (camels and goat…)

2. Settlement pattern

- ***Rugged and difficult terrain*** hinders the *development of settlement and its expansion*
- Highlands of Ethiopia
  - *Temperate type of climatic condition*
  - *Mainly free from most of the tropical diseases*
  - *Densely settled*
  - *Sedentary life*
  - *Permanent settlements*
- Lowlands of Ethiopia
  - *Inhabited by pastoralists*
  - *Sparsely settled*
  - *Temporary settlements*

3. Transportation and communication

- **Highly dissected nature**
  - Barrier *to the development of internal surface transportation*
  - Resulted in the *long-term isolation* of many communities
  - Makes *infrastructure development and maintenance costly*
  - Highly influence TV and radio communications
  - Rendered *rivers less navigable* due:
    - *Waterfalls*
    - *Deep gorges*
    - *Steep cliffs*

4. Hydroelectric power potential

- *Difference in altitude* and *high rainfall* created very *high potential for the production of hydroelectric power* in Ethiopia

5. Socio-cultural feeling

- **Rugged terrain**
  - Result *of excessive surface dissection*
  - *Long-term isolation* of communities
  - Led to *the occurrence of cultural diversity*
  - People who live in the *highlands:* **degegnas** (*Mountaineers*)
  - People who live in the *lowlands*: **kollegnas** (*Lowlanders*)

6. Impacts on climate

- Climate of Ethiopia is a result of:
  - *Tropical position*
  - *Great altitudinal variation*
- Highlands moisture *surplus*
- Lowlands moisture *deficit*

7. Impacts on soil

- Steep mountain slopes provide:
  - *Low angle of rest*
  - *Unstable surface materials*
  - *Subject to degradation processes*
  - *Shallow and little developed soils*

8. Impacts on natural vegetation

- Relief → climate and hydrology → *type of natural vegetation grown*

CHAPTER FOUR

DRAINAGE SYSTEMS AND WATER RESOURCE OF ETHIOPIA AND THE HORN

(4hrs)

4.1. INTRODUCTION

❑Water bodies

- Covered ***71%*** of the earth's total surface
- Majorly (**97.5%)** occupied by **seas and oceans…***alkaline*
- **2.5% is fresh water**:
    - Mainly(**68.7%**) deposited in glaciers
    - *Unevenly* distributed due to:
        - *Latitudinal locations*
        - *Climatic conditions*
        - *Topographic setups*
- *Surface waters:* water in:
    - *Lakes*
    - *Rivers*
    - *Atmosphere*
    - *Soils*
    - *Wetlands*

In Ethiopia

- Larger volume of *ground and surface* water due to:
  - *Diverse topographical setup*
  - *Relatively higher rainfall*
  - *Nearness to equator*
- **0.7 %** of the total land mass is covered by *water bodies*
- **124.4** BCM surface water potential
- Consequently, Ethiopia calls the "**Water Tower**" of eastern Africa

4.2. Major Drainage System of Ethiopia

Drainage

- *Well-defined channel* that water flows
- Made up of: a *principal river*

  its tributaries
- A river system *begins:* **source (headwater)**
- A river system *ends*: **mouth**

Drainage system

- Branched *network of stream* channels together with the *adjacent land slopes* they drain
- It is the outcome of:
  - *Geological processes*
  - *Nature and structure of rock*
  - *Topography*
  - *Slope*
  - *Amount and the periodicity of the flow*

Drainage basin

- *Topographic region* from which a river and its tributaries collect
- Both the *surface runoff and subsurface flow*
- Separated from and bounded by *water/topographic divide*
- Determined by:
  - *Topography*
  - *Structural formation of the rift valley*
  - *Faults and joints*

Major Drainage Systems

- **Three** broadly classification:
  - *Western*
  - *Southeastern*
  - *Rift Valley*
- Western and the Southeastern drainage systems are *separated* by the Rift Valley system

4.2.1. Western Drainage Systems

- *Largest* of all drainage systems: *Draining 40 % of the total area*

Carry 60 % of the annual water flow

- Comprises *four major* river basins:
  - *Tekeze*
  - *Abay* flow *westward joining the Nile finally ends Mediterranean Sea*
  - *Baro-Akobo*
  - *Ghibe (Omo)*-flow southward

❑Abay river basin

- Largest river in: *volumetric discharge*

  coverage western

drainage systems

- Covers an area of **199,812** km2
- Covering parts of: *Amhara*

  Oromia

  Benishangul-Gumuz

- Carries **65%** of the annual water flow of the region
- Rises from *Lake Tana* (origin from sekela, choke mountain)..**Blue Nile**
- Joins the **white Nile** from lake Victoria, Tanzania in Khartoum (Sudan) to form the great Nile River
- *Ghilgel (Little)* Abay-largest stream

Tekeze river basin

- Carries **12 %** of the annual water flow of the region
- Drains **82,350** Km2
- Erosion in the basin resulted in: *Large tablelands*

  Plateau blocks

  Isolated mountain groups
- Main tributaries: ***Angereb***

  Goang rises in *central highlands* of Ethiopia
- Termed *Atbara in Sudan*
- Mean annual flow is estimated to be **8.2 BMC**

❑Baro-Akobo rivers basin

- Drain the *wettest highlands* in the *south and southwestern* Ethiopia
- Carries **17%** of the annual water flow
- Flows across an *extensive marshy land*
- Drain **75,912** km2
- Covering parts of: *Benishangul-Gumuz*
  Gambella
  Oromia
  SNNPR
- Mean annual flow of **23.6** BMC

❑ Ghibe/ Omo river basin

- Drain the *wettest highlands* in the *south and southwestern* Ethiopia
- Carries **6** % of the annual water flow
- Drains an area of **79,000** km2
- Mean annual flow of **16.6** BMC
- Finally empties in to the *Chew-Bahir* at the mouth of Lake Turkana
- Termed as *inland drainage*

4.2.2. Southeastern Drainage Systems

- *Southeastern* physiographic region part of Ethiopia
- Mainly drained by: *Wabishebelle slopes*
  Ghenale slopes
- Include plateaus of: Arsi
  Bale
  Sidama
  Harerghe
- **Wabshebelle and Ghenale rivers**
  - *Cross the border into somalia*
  - *Carrying **25** % of the annual water flow of Ethiopia*

❑Ghenale River basin

- Area of **171,042** km2
- Covering parts of: *oromia*

  SNNPR

  somali
- Has *fewer tributaries* but carries *more water* than Wabishebelle
- Reaches the *Indian Ocean*
- Flows estimated to be **5.8** BMC
- In Somalia, it is named the *Juba River*

❑Wabishebelle river basin

- A total catchment area of **202,697** km2
- The *largest river* in terms ***catchment*** area
- Drains parts of: *Oromia*
  Harari
  Somali
- The *longest river* in Ethiopia
- Tributaries are mainly *left bank* and *intermittent*
- Despite its size, it fails to reach the *Indian ocean*
- Water disappears in the sands, just near the Juba River

Figure 4.1. Drainage Basins of Ethiopia



4.2.3. Rift Valley Drainage System

- Area of: *small amount of rainfall*

  high evaporation

  small catchment area

- Its size is restricted by the *outward sloping highlands*
- *No one general flow* direction, as the streams *flow in all directions*
- The only major river basin is **the Awash**

❑Awash river basin

- Catchment area of **114,123** km2
- Average annual discharge of **4.9** BCM
- Originates from *Shewan plateau in central highlands* of Ethiopia
- Covers parts of: Amhara
  Oromia
  Afar
  Somali
  Dire Dawa
  Addis Ababa City
- The *most utilized* river in the country
- Flows in a *northeast* direction
- Finally ends in a maze of *small lakes and marshy area*
- The largest lake is **Lake Abe** on the Ethio-Djibouti

❑ Afar drainage sub-basin

- Practically *no stream flow*
- Area of: *little rain*

  very high temperature

  very high evaporation
- Lake **Afrera and Asale**
  - *Only main surface waters in the basin*
  - *Their formation is related to tectonic activities*

❑Rift Valley sub-basin

- Characterized by: *A number of lakes*

  Small streams

- Also described as *lakes region*
- The lakes occupy *fault depression*
- There are small streams for:

  Meki and Katar rivers flow into Ziway

  Bilate into Abaya

  Segen into Chew Bahir

4.3. Water Resources: Rivers, Lakes and Sub-Surface Water

4.3.1. The Ethiopian Rivers

- **Unlike** many other African countries, Ethiopia is *endowed with many rivers*
- Majority of the rivers originate from *highland areas* and *cross the Ethiopian boundary*
- Altogether, Ethiopian rivers form ***12*** *major watersheds* separating the Mediterranean Sea from the Indian Ocean drainage systems

Table 4.1: Data on major Ethiopian rivers

River	Catchment Area(km^2)	Annual Volume BMC	Terminus/Mouth	Major tributaries
Abay	199,812	4.5	Mediterranean	Dabus, Dedessa, Fincha, Guder, Muger, Jema, Beshilo
Wabishebelle	202,697	3.4	Coast of Indian Ocean	Ramis Erer, Daketa Fafan
Genale Dawa	171,042	6	Indian-Ocean	Dawa, Weyb, Welmel, Mena
Awash	114,123	4.9	Inland (within Ethiopia)	Akaki, Kesem, Borkena, Mile
Tekeze	87,733	8.2	Mediterranean	Goang, Angereb
Gibe (Omo)	79,000	16.6	Lake Turkana	Gojeb
Baro Akobo	75,912	23.23	Mediterranean	Akobo

Source: Compiled from different basin development master plans

❑General Characteristics of Ethiopian Rivers

- Due to:

- Highland nature of landmass
- Surface ruggedness characterized as:
- Inclination of the highlands
- Climatic conditions

Et'n rivers have the following

- *Originate from the highlands*
- *Trans-boundary*
- *Extreme seasonal fluctuation*

- **wet season**, runoff is *higher and rivers are full bursting*
- **dry seasons** they became mere *trickles of water or even dry up*
  - *Rapids and waterfalls along their course*
  - *Flow on steep slopes having steep profiles*

4.3.2. Ethiopian Lakes

- Relatively Ethiopia is *rich in lakes*
- Lakes are *result of tectonic process* that took place during *Quaternary period* of Cenozoic era
- Majority of lakes are located within the *rift valley system*
- Mainly formed on *faulted depressions*

❑Lake Tana

- *Largest lake* in Ethiopia occupies a shallow depression in the highlands
- Formed *slower sinking and reservoir by lava* flow b/n Gojjam and Gonder massifs

❑Crater lakes

- Lakes formed due to *volcanic eruption*
- Ethiopia is also *gifted* with crater lakes
- Include the lakes at and around: *Bishoftu, Wonchi (near Ambo)*

Hayk (near Dessie)

Top of Mount Zikwala

- Lake **Ashenge** (Tigray) is formed on a *tectonic basin*

- **Man-made** lakes such as: *Koka*

  Fincha

  Melka Wakena

- Cluster of lakes are lined up within *main Ethiopian rift*
  - **Abaya**: *largest* of all the lakes in the system
  - **Chew Bahir *:*** *drained by Segan and Woito*

    southern tip *of the rift valley forms*
  - **Shala: *deepest*** the lakes in the central Ethiopian rift

Figure 4.2. Lakes of Ethiopia

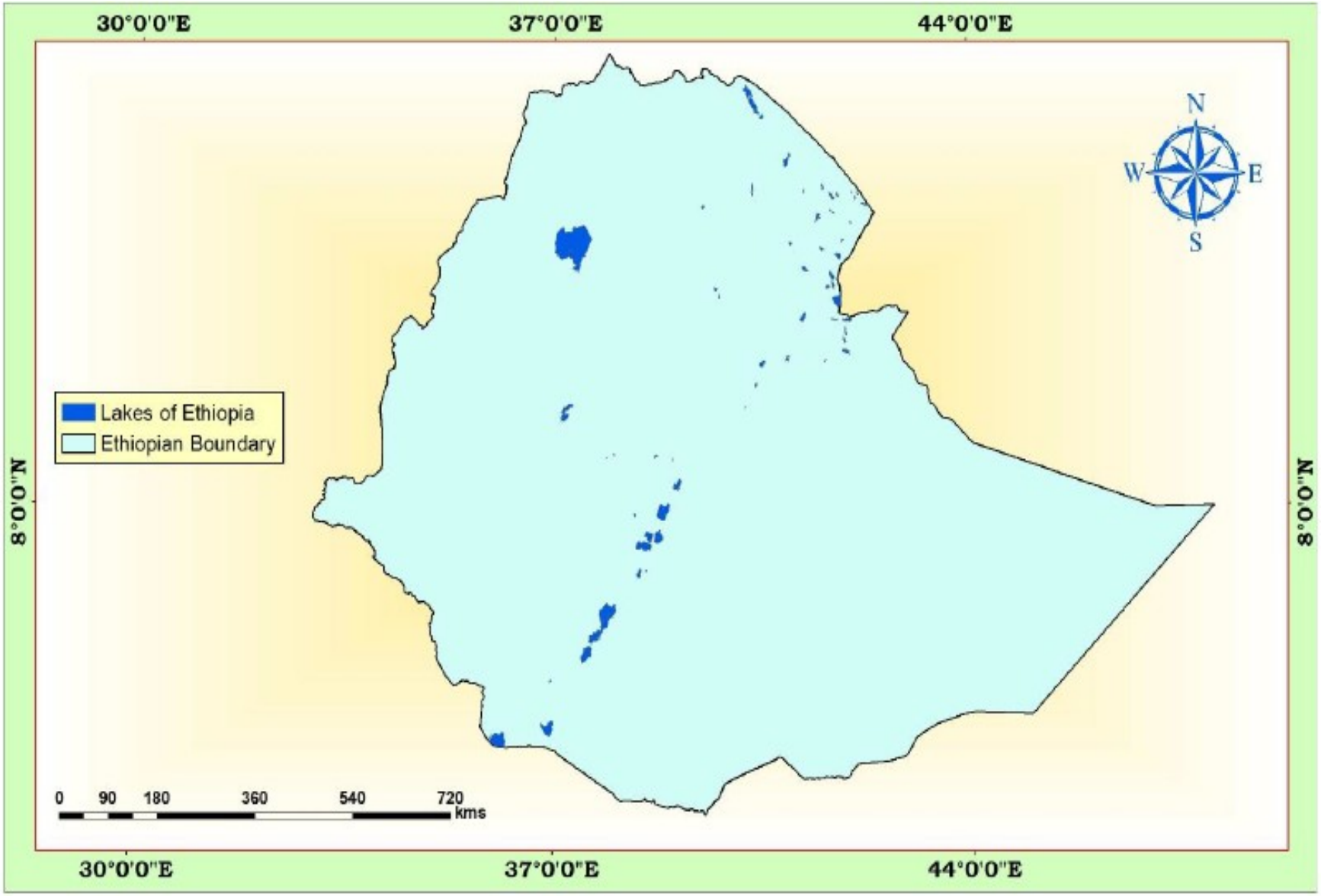


Table 4.2: Area and depth of some of Ethiopian Lakes

Lake	Area (km^2)	Max. Depth(m)	Lake	Area (km^2)	Max. Depth(m)
Tana	3600	9	Abijata	205	14
Abaya	1162	13.1	Awassa	129	10
Chamo	551	13	Ashenge	20	25
Ziway	442	8.95	Hayk	5	23
Shala	409	266*	Beseka	48.5	11
Koka	205	9			

Source: Compiled from different sources

4.3.3. Subsurface (Ground) Water Resource of Ethiopia

- *Lower* ground water potential
- Determine: *Climatic conditions*

  Geophysical conditions
- Estimated to be **2.6 - 6.5** BMC

4.4. Water Resources Potentials and Development in Ethiopia

- Underutilized due to so *many factors*
- Potential development ***uses of water resource*** of Ethiopia

1. Hydro-electric Potential

- *Very high* potential for generating electricity
- Estimated at about **45000** MW
- The **first** HEP: *Akaki River (Aba Samuel)* in 1932
- Currently, *many others are under construction*
- Grand Ethiopian Renaissance Dam (GERD) is the *country's largest dam* under construction aiming to generate **6400** MW
- **Gilgel Gibe III** hydropower project has gone operational generating *1870* MW

- Currently Ethiopia is administering *14 hydroelectric power plants* constructed on different lakes
- *Major problem to* the use of Ethiopian rivers for HEP:
  - *The seasonal flow fluctuations*
  - *Impact of climate change and variability's*
  - *Severe erosion from the highlands*
  - *Sedimentation in the reservoirs*

2. Irrigation and Transportation

- Rugged terrain limits the uses of rivers both for *irrigation and transportation*
- In the **highlands**: steep slopes, rapids, waterfalls, narrow valleys, deep valleys, gorges are important obstacles
- But on the **lowlands**, their demand for irrigation is *high*

- Baro-Akobo and Genale Dawa: large irrigation potential
- More than **60%** of the area under irrigation is located in rift valley drainage system
- Majority of Ethiopian rivers are not suitable for transportation
- The **Baro** at its lower course is the only navigable river
- Ethiopian **lakes** are much suitable for transportation than **rivers**
- Lake **Tana and Abaya: most used** for transportation

3. Fishing and Recreation

- Lakes are *rich in fish*
- Estimated to be 31.5 thousand tons
- Exploitable fish potential in lakes *varies*
- Currently lake **tana** leads the potential by estimated 8,000-10,000 tons per year
- Fish production from lake **chamo** is estimated at 4,500 tons per year
- More than **60%** of fish supplies are coming from *Ethiopian main rift valley lakes*

- However, some of the lakes are currently *threatened* by
  - *Sedimentation*
  - *Invasive species (water hyacinth)*
  - *Over exploitation*
  - *Expansion of investments around lakes*

- A variety of *fish, birds and other aquatic life* forms in the lakes
  - scenic beauty of the lakes
  - *hot springs*
  - *spectacular river gorges*
  - *impressive waterfalls*
  - *variety of wild life*

important *recreational and tourist attractions*