

Chapter Two

The Geology of Ethiopia and the Horn

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2.1. Introduction

Geology

- is an Earth science that studies the evolution of the earth, the materials of which it is made of, and the processes acting upon them.
- studies how Earth's materials, structures, **processes** and organisms have changed over time
- concerned with events that **took place in the remote past and are far beneath the earth's surface**

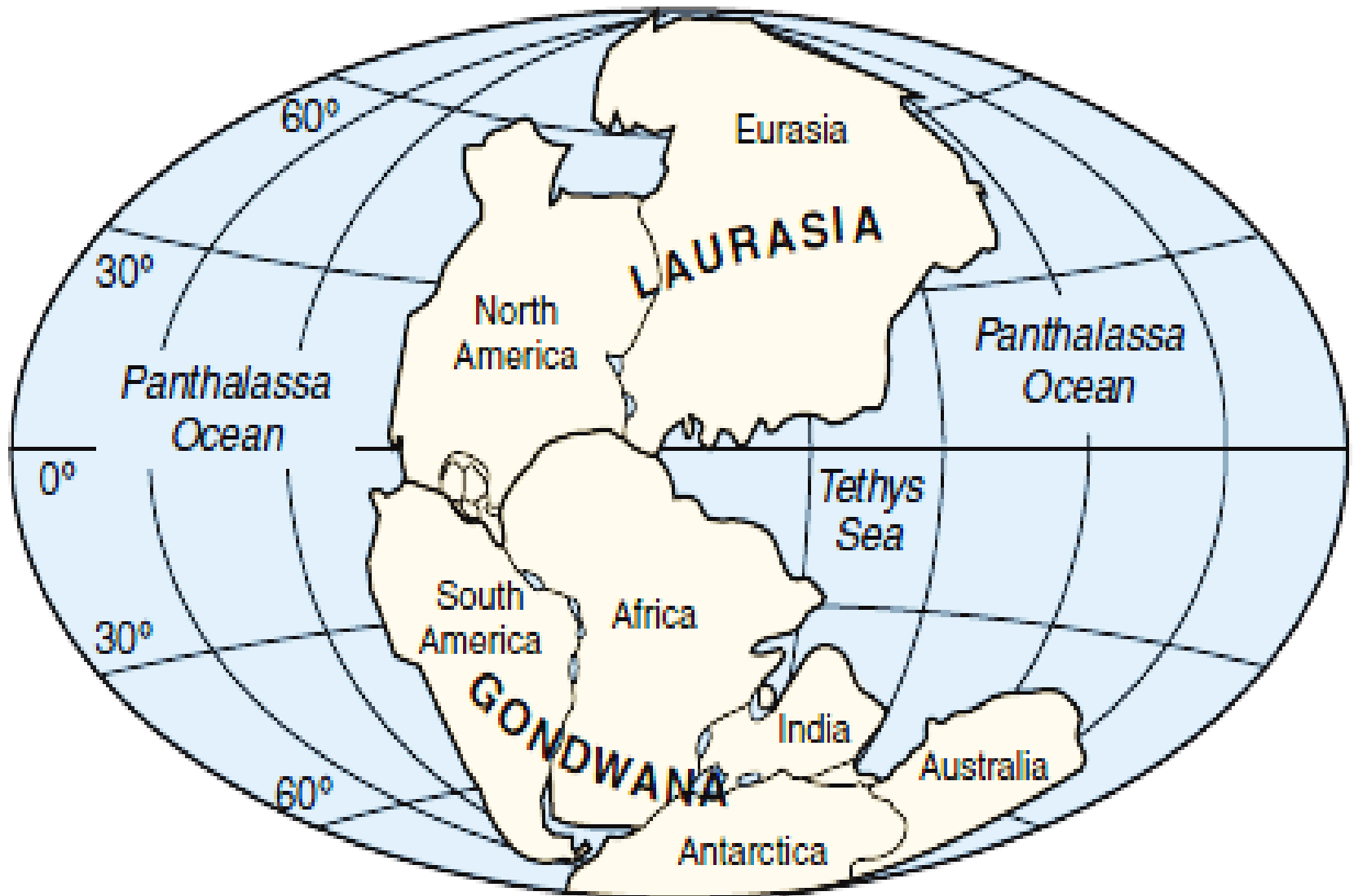
Geological understandings can be obtained from clues from:

- Indirect methods includes:
 - **geophysics** (e.g. 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) and
 - **geochronology** (methods for finding the ages of rocks, usually from the radioactive elements they contain)

Explanations on Pangaea and Continental drift Theory

- **Continental Drift Theory**
 - In 1915 Alfred Wegener proposed the hypothesis that the continents were once assembled together as a supercontinent called **Pangaea**.
 - As of 200 million years ago Pangaea began break apart
 - later split in to **Gondwanaland** and **Laurasia**
 - Then the present arrangement of continents after millions of years.

Figure : Pangaea

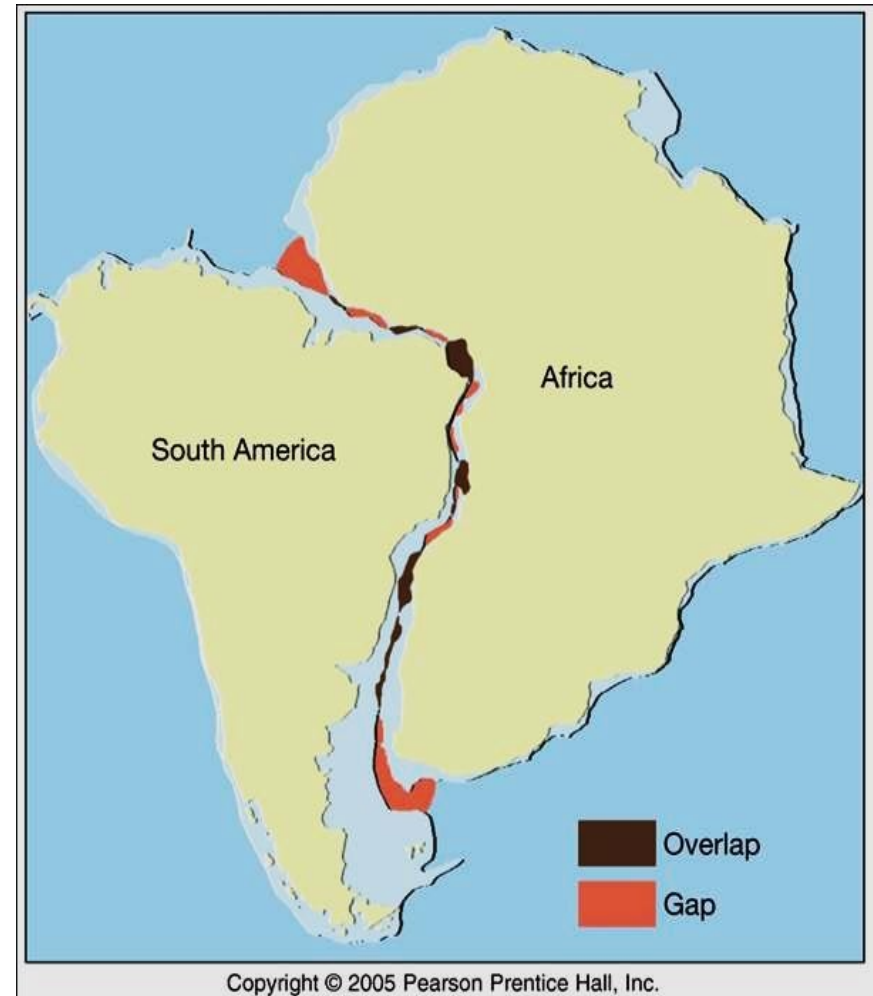


- **Wegener's principal observations:-his evidences include:**

- Fit of the continents:
- Match of mountain belts, rock types:
- Distribution of fossils:
- Paleoclimates:

Wegener's evidence for his continental drift theory

1. Close fit of continental coastlines on opposite sides of oceans

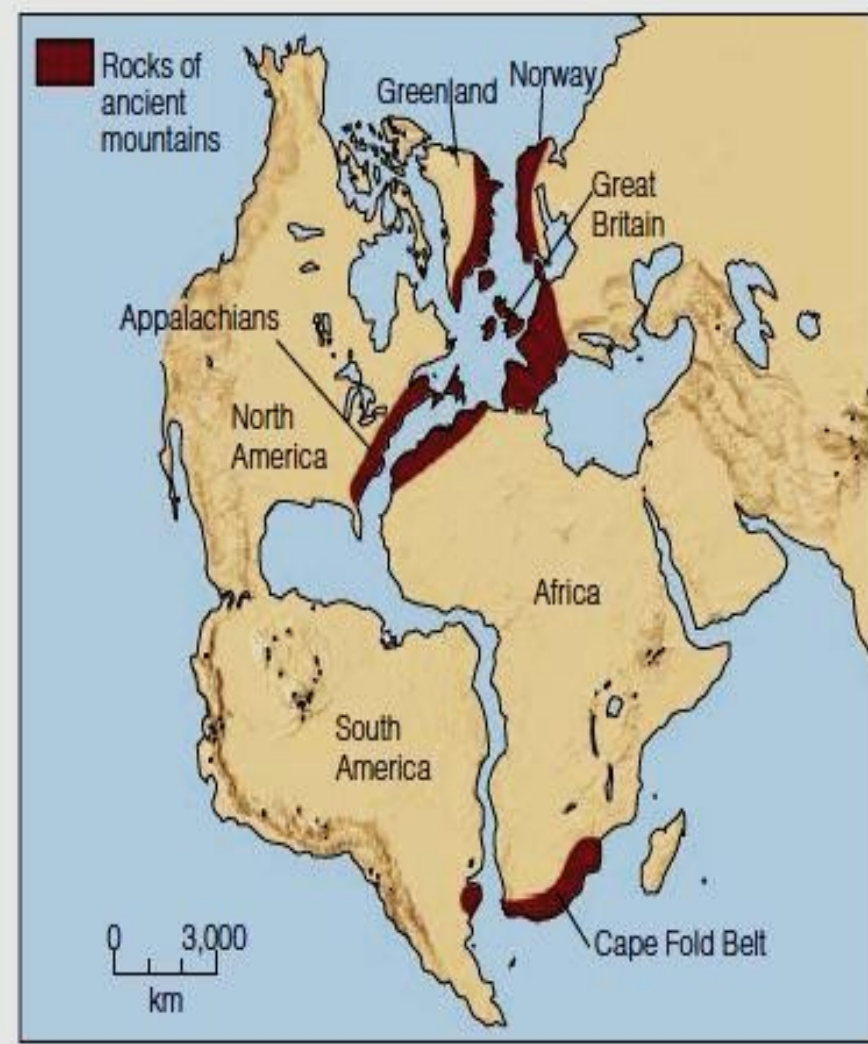


Wegener's evidence ... continued

2. The trends of mountain ranges on land areas also match across oceans.

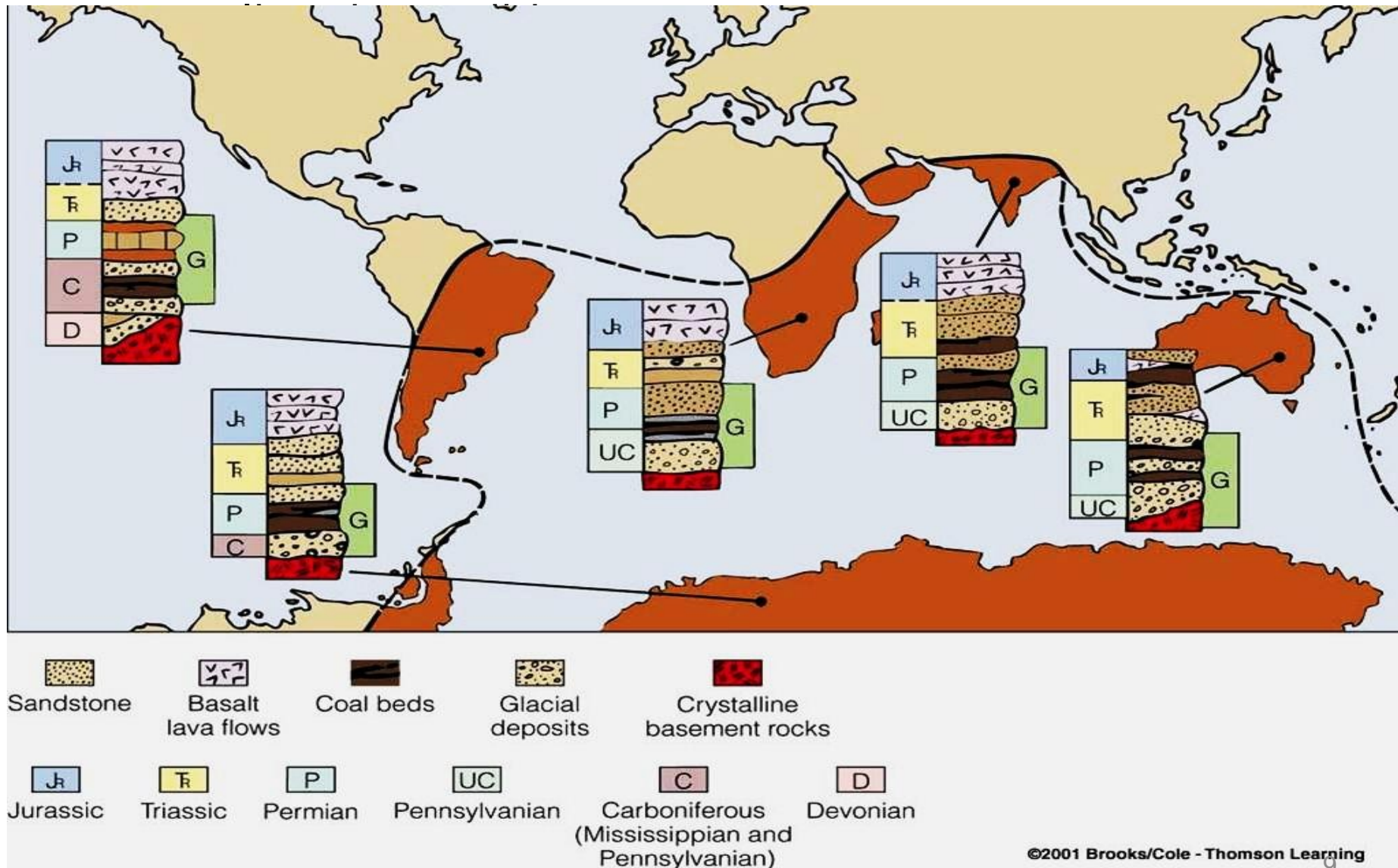


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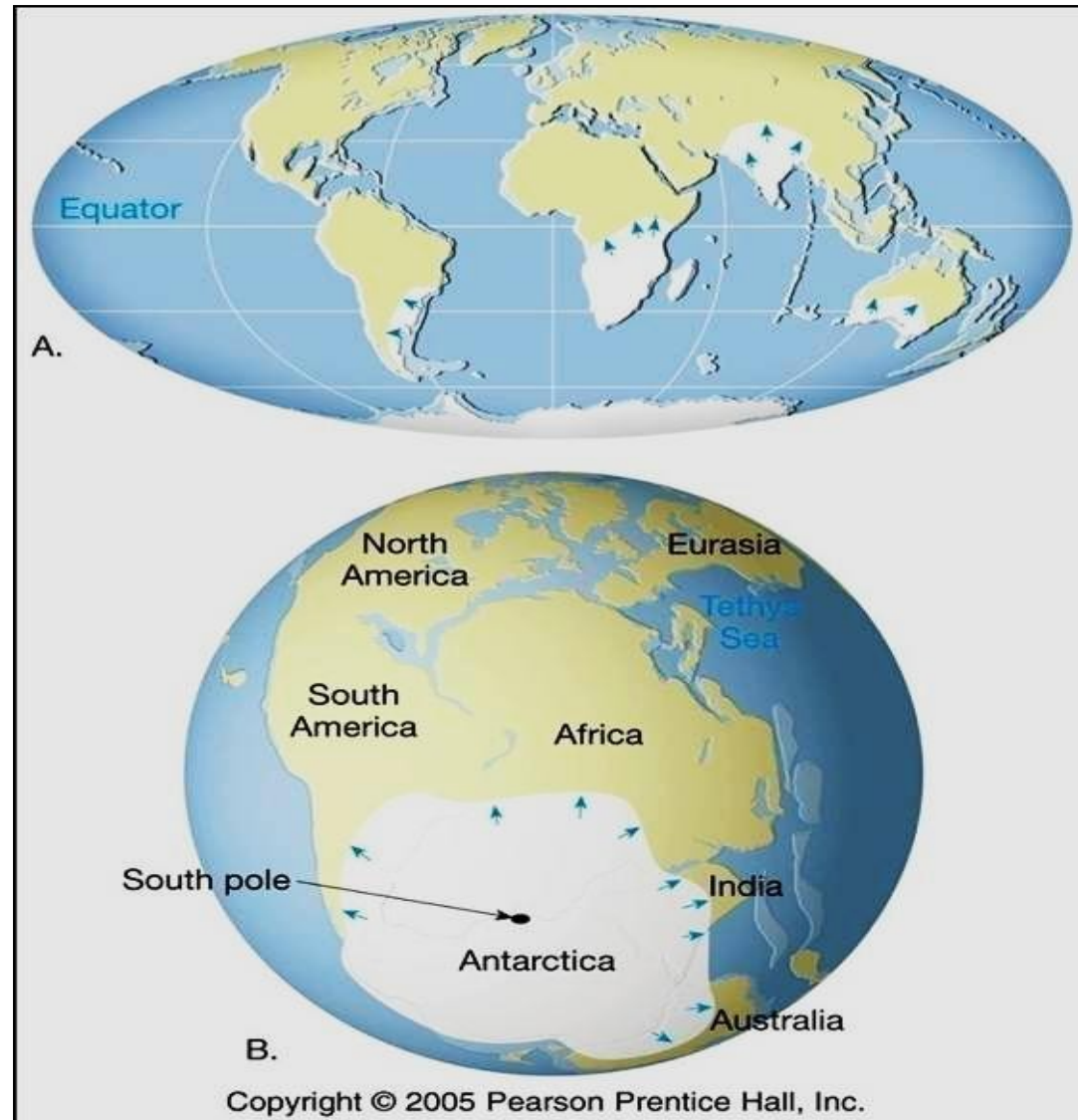


Wegener's evidence ... continued

3. Similar Patterns of fossils and rock types found on different continents could not result from chance and did not reflect



4. Evidence of great climate change, such as ancient evidence of glaciation where the **Sahara Desert** is today and tropical fossils found in Antarctica, that could be explained best by large landmasses moving from one climate zone to another.



2.2. The Geologic Processes: Endogenic and Exogenic Forces

- Geology studies how Earth's materials, structures, **processes** and organisms have changed over time.
- Geologic processes are divided into two major groups: **internal** and **external** processes.

The internal (endogenic) processes

- Include:
 - ❖ volcanic activity
 - ❖ tectonic processes
 - folding,
 - faulting,
 - orogenesis (mountain building), and
 - epeirogenesis (slow rising and sinking of the landmass)
- Endogenic processes result in building of structural and volcanic features (landforms) like:
 - Plateaus
 - rift valleys,
 - Block Mountains

The external (exogenic) processes

- Include:
 - weathering,
 - mass transfer (mass wasting),
 - erosion and
 - deposition.
- Exogenic processes act upon the volcanic and structural landforms by modifying, roughening and lowering them down.
- The landmass of Ethiopia, as elsewhere, is the result of the combined effect of endogenic and exogenic processes

2.3. The Geological Time Scale and Age Dating Techniques

Geological Time Scales

- Age of earth is approximately 4.5 billion years
- The earliest forms of life were thought to have originated approximately 3.5 billion years ago
- To describe the geology and history of life on Earth, scientists have developed the geological time scale
- The geological history of the earth is

...The Geological Time Scale and Age Dating Techniques

- The **Eras** are given names that indicate the **kind of life** that existed in them. For instance,
 - **Paleozoic Era** (ancient life) is the age of **invertebrates**
 - the **Mesozoic Era** (the middle life) is the age of **reptiles**
 - **Cenozoic Era** (recent life) is the age of **mammals**.

... The Geological Time Scale and Age Dating Techniques

- These geological time divisions basically differ from each other in such characteristics as:
 - the **relative position** of land and sea
 - the kind of **climate**
 - most important is **kind of animal and plant life** that developed and existed during that Era or period.
- Difficult to measure Geological time precisely

- The division of time units in the geological time scale is usually based on the **occurrence of significant geological events** (e.g. mass extinctions).
 - As such, the geological time categories do not usually consist of a **uniform length of time**
- The geological time scale, illustrated in Table 2.1, is built largely on the basis of life and evolution

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
	Jurassic	208	146	Pangaea (one land mass) begins to break up (144-65)
	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
	Cambrian	600	510	Great diversity of marine invertebrates
Proterozoic	Proterozoic	2,500	600	Marine fossil invertebrates (600)
	Archean	4,500	2,500	Earliest fossils recorded (2,500)

Age dating techniques

- There are two techniques of knowing the age of rocks:
 - Relative age dating
 - Absolute age dating.

1. Relative age/dating :

✓ refers to the age of a feature/ rock with respect to another feature/ rock.

✓ Uses three major principles

a) Principle of original horizontality

- Sedimentary rocks are deposited in horizontal layers(beds).
- If layers are no longer horizontal they must have undergone deformation after formation

b) The law of superposition

- States that the younger bed of the rock occur on top of older beds in undisturbed sequence of layers.

c) Law of cross cutting relation ships

- States that any feature or structure that cuts through and disturbs a rock sequence must be younger than the disturbed bed

The above principles are only useful to determine the relative age of rocks in a given locality, but little use in matching rocks found in different parts of the continents. To fill this gap the principle of correlation is used.

d) Principle of Correlation:

- determining time equivalence of rock units found in different regions, continents, and even between continents on the basis of **their physical similarity or similarities of fossil successions.**

E.g. if you find *shale* followed by *sand stone* in region **A** and is the same arrangement in region **B**, it is possible to conclude as the two sequences are formed at essentially the same time.

2. Absolute Age/dating

- is determining the numerical age of rock units by **radioactivity**.
- Radioactivity provides **a clock that begins working when radioactive elements are sealed in to newly crystallized minerals** so that the **rate at** which radioactive elements decay can be measured.
- Therefore, if we can determine the ratio of a **particular radio active element** and its **decay products** in a mineral, we can calculate how long ago that mineral crystallized.

- Dating the age of a rock through its radioactive elements is known as **isotopic dating** ([radiometric dating](#)).
- Examples: Carbon-14 Technique, Potassium-Argon Technique:
 - Carbon-14 has half-life of 5730 years.
 - **Potassium-Argon Technique:** The decay is widely used for dating rocks

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

2.4.1. The Precambrian Era Geologic Processes (4.5 billion - 600 million years ago)

- The Era covers 5/6th of the Earth's history
- we have limited knowledge due to its remoteness in time and the absence of well-preserved fossils
- The major geologic event of the Precambrian Era was **Orogenesis**
 - The land was subjecte to intense folding. This was accompanied by intrusive igneous activity
 - The result was formation of huge mountain ranges

Denudation

- between the orogenic periods and after the last orogenesis
- orogenic mountains reduced to near-level (peneplained) rock surfaces, called **peneplanation**.
- This “levelled” surface was later (in the **Mesozoic** and **Cenozoic** Eras) covered by younger rock formations.
- in most parts of Ethiopia rocks belonging to this Era are found beneath all other rocks, forming the **basement** rocks.

Metamorphism and Crystalization

- Subjected to **pressure** and **heat** from overlying weight, earth movements (folding, orogenesis) and to **intrusive igneous activity**; the original rocks (both sedimentary and igneous) were altered into **metamorphic rocks** of varying stages of metamorphism.
- Since these same processes have allowed **mineralization** and **crystal** formation, the rocks are also collectively described as **crystalline rocks**.
- In most part of the country Precambrian rocks are overlaid by **recent rock formation**.
- Only 25% of the land mass of Eth is

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- In **the northern part**: Western lowlands, parts of northern and central Tigray
- In the **western Part**: Gambella, Benishangul-Gumuz (Metekel and Asossa), western Gojjam, western Wellega, Illuababora, and Abay gorge.
- In the **southern Part**: Guji, southern Omo, and parts of southern Bale and Borena.
- In **the eastern part**: Eastern Hararghe

2.4.2. The Paleozoic Era Geologic Processes

(600 million - 225 million years ago)

- The Paleozoic Era lasted for about 375 million years.
- The major geological process was **denudation**.
 - The gigantic mountains that were formed by the Precambrian orogeny were subjected to intense and prolonged denudation.
 - The once gigantic mountain ranges were reduced to a “**peneplained**” surface.
 - Undulating plain with some residual features (**inselbergs**) here and there was formed.
 - The sediments were transported **southward** and **eastward** to form **continental deposits** (in Africa) and **marine deposits**, respectively.

2.4.3. The Mesozoic Era Geologic Processes (225-70 million years ago)

- lasted for about 155 million years.
- Era of **alternate sinking** and **rising** (**epeirogenesis**) of the landmass.

1. Sinking of the landmass □ Sea transgression

- affected the whole present-day Horn of Africa and Arabian landmass.
- the land was **tilted eastward** and therefore lower in the southeast and higher in the northwest.
- The subsidence of the land began about **225 million** years ago.
- As the land **sank slowly**, **the sea invaded** it starting from Somalia and Ogaden and slowly spreading northwestward.

- This was in **late Triassic** and the phenomenon

... cont Mesozoic Era

- As the **shallow sea spread** towards the land, **sands were deposited** **over** the peneplained Precambrian rock surface.
- As the **depth of the sea increased**, mud (shale), gypsum and later lime were deposited.
 - **Lime** is associated with the **flourishing of marine life** and **decaying** and **precipitating of their remains**, as the sea stayed long.
 - Hence, Mesozoic rocks are considered to have greatest potential for **oil** and **gas** deposits.
- Through time, **compression** by the overlying rocks and by **cementing** minerals, the **sands** and **lime** were compacted to form **sandstone** and **limestone** layers respectively
 - known as the **Adigrat sand** stone and **Hintalo limestone** layers.
 - They are named after place names in Tigray

2. Rising of Landmass □ Sea Regression

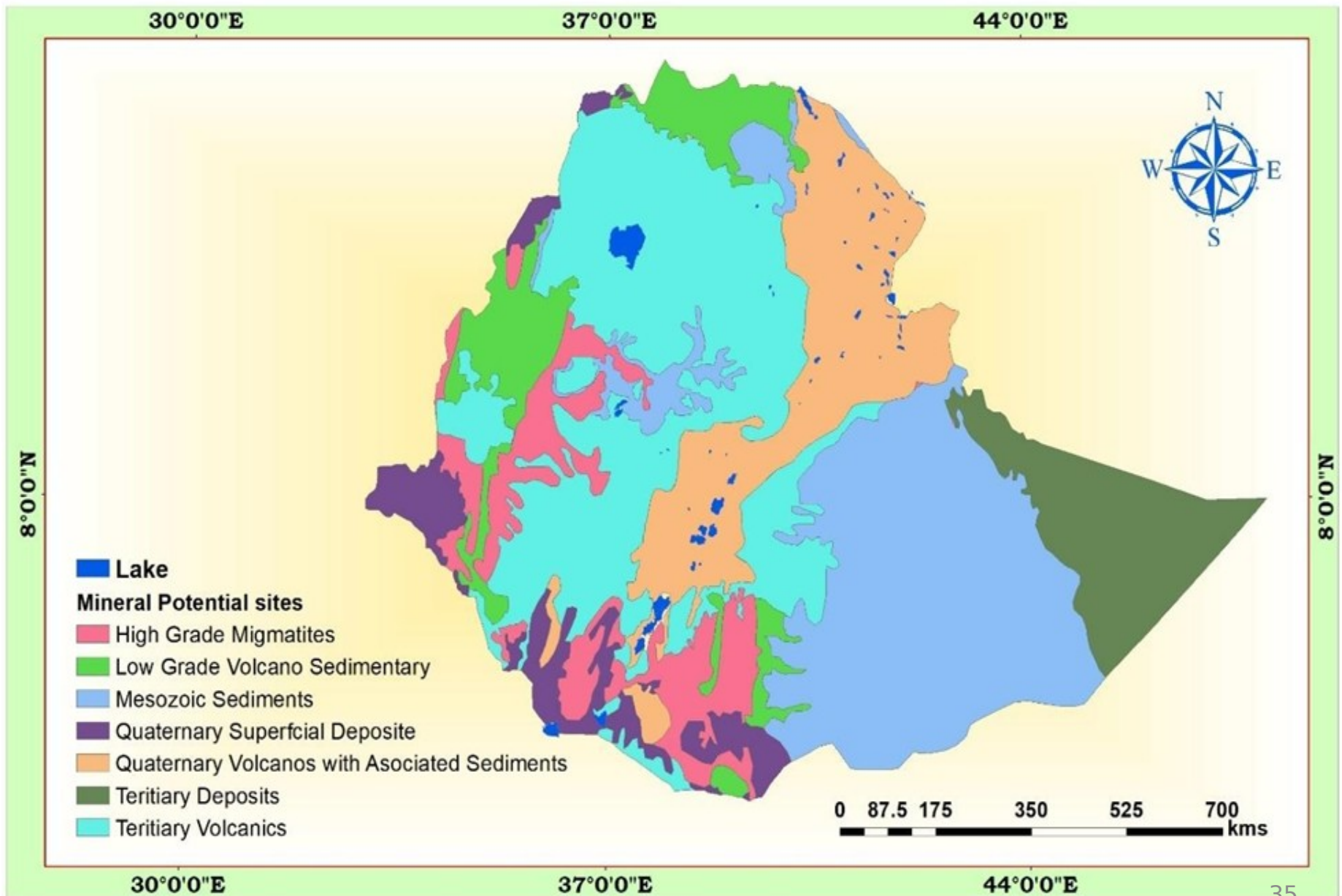
- the slow rise of the land in the Horn of Africa and Ethiopia
 - the regression of the sea began in the **Upper Jurassic**
 - It continued **throughout the Cretaceous period.**
 - Another process of deposition occurred.
 - In the country sedimentation ended with the deposition of **clay, silt, sand conglomerate brought in** from the land
 - **Gypsum, shale** and at **last sands** were **laid over** the Hintalo limesone.
 - The uppermost layer is known as the

- By the **end of the Mesozoic Era**,
 - the land emerged out of the sea
 - **three major** sedimentary formations were laid and formed upon the Precambrian rock surface.
 - 1.the Adigrat or lower sandstone,
 - gypsum and shale (interbedded)
 - 2.Hintalo limestone and
 - gypsum and shale (interbedded)
 - 3.Upper Sandstone.

- The Mesozoic sedimentary rocks cover
 - 25% of the land mass of the Ethiopia.
 - Due to the tilting of the landmass during the transgression and regression of the sea, and due to the direction of the invading and retreating sea, the **age** and **thickness** of the Sandstone layers vary in a **Southeast - Northwest direction**.
 - Adigrat sandstone
 - is **older** and **thicker** in the southeast
 - **Younger** and **thinner** in the northwestward.
 - The Upper sandstone
 - **thicker** and **younger** in the Southeast,
 - **older** and **thinner in** the Northwest

- The transgressing sea and Mesozoic sediments nearly covered the whole of Ethiopia.
 - The northwestern limit was as far as central Tigray, and western slopes of Western highlands.
 - In most parts of Ethiopia, the Mesozoic rocks are overlaid by the Cenozoic rocks.
 - As surface rocks these old marine sediments are extensively found in the **Southeast lowlands**.
 - Other **exposures** include central Tigray, and along the gorges of **Abay** and

Geological map of Ethiopia



2.4.4. The Cenozoic Era Geologic Processes (70million years ago - Present)

- The most recent of the geologic Eras.
- The present day land mass of Ethiopia and the horn of Africa is mainly resulted from the **tectonic** and **volcanic** activities of this Era.
- The two major geologic events and a geologic process took place and have been taken place in the region includes:
 - Up lifting of the Arabo-Ethiopian landmass and outpouring of huge quantity of lava.
 - Formation of the Rift Valley.
 - Quaternary volcanism and deposition.

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

- The uplifting is a continuation of the slow rise that began in the **Upper Jurassic** and **Cretaceous periods** and continued to the **Paleocene** and **Oligocene** epoch of the Tertiary period.

during the Eocene epoch uplift

- The uplift of greater magnitude and the land was pushed up to a maximum height of 2,000 meters above sea level.
- This was an **epeirogenic character**
- unparalleled anywhere else except in the **Alpine orogenic** belts of the Andes.
- The whole of the Arabo-Ethiopian landmass was pushed up in blocks as one mass.

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- This immense tectonic force also fractured the crust at many places.
- Huge quantity of lava came out through these fractures.
- The out pouring of this **flood of basalt** spread widely and extensively and covered a large part of the **Mesozoic sedimentary layer** to form **the Ethiopian plateau** surface and also the floor of the **present-day Rift Valley**.
- At that time the Rift Valley was **not yet** formed.
- The mass of lava was so immense, that it formed a thick layer of volcanic rocks on the plateau, which mounted to more **than 1,000**

... cont

- Where the lava comes out through **vents**,
 - huge volcanic rocks were piled up to form **many** and **huge Volcanic Mountains**“ towering the flat basaltic plateau.
 - This volcanic material is known as **Trappean lava** or **Trap Series lava**.
- Where it is not dissected by erosion, the **Ethiopian plateau** had **flat** and **nearly** horizontal surface.
 - This is an expression of the peneplaned Precambrian surfaces, the **smothering** effect of the Mesozoic deposition, and the **spreading** of the Trap series lava over the Mesozoic sediments.

The Formation of the Rift Valley

- Its formation related to the theory of **plate tectonics**.
- According to the theory, the Rift Valley may be lying on the Earth's crust below which 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. As the tension widened the fractures, the central part of the landmass collapsed to form an extensive structural depression known as the Rift Valley (Fig).

Figure: The Ethiopian and East African Rift Valley systems

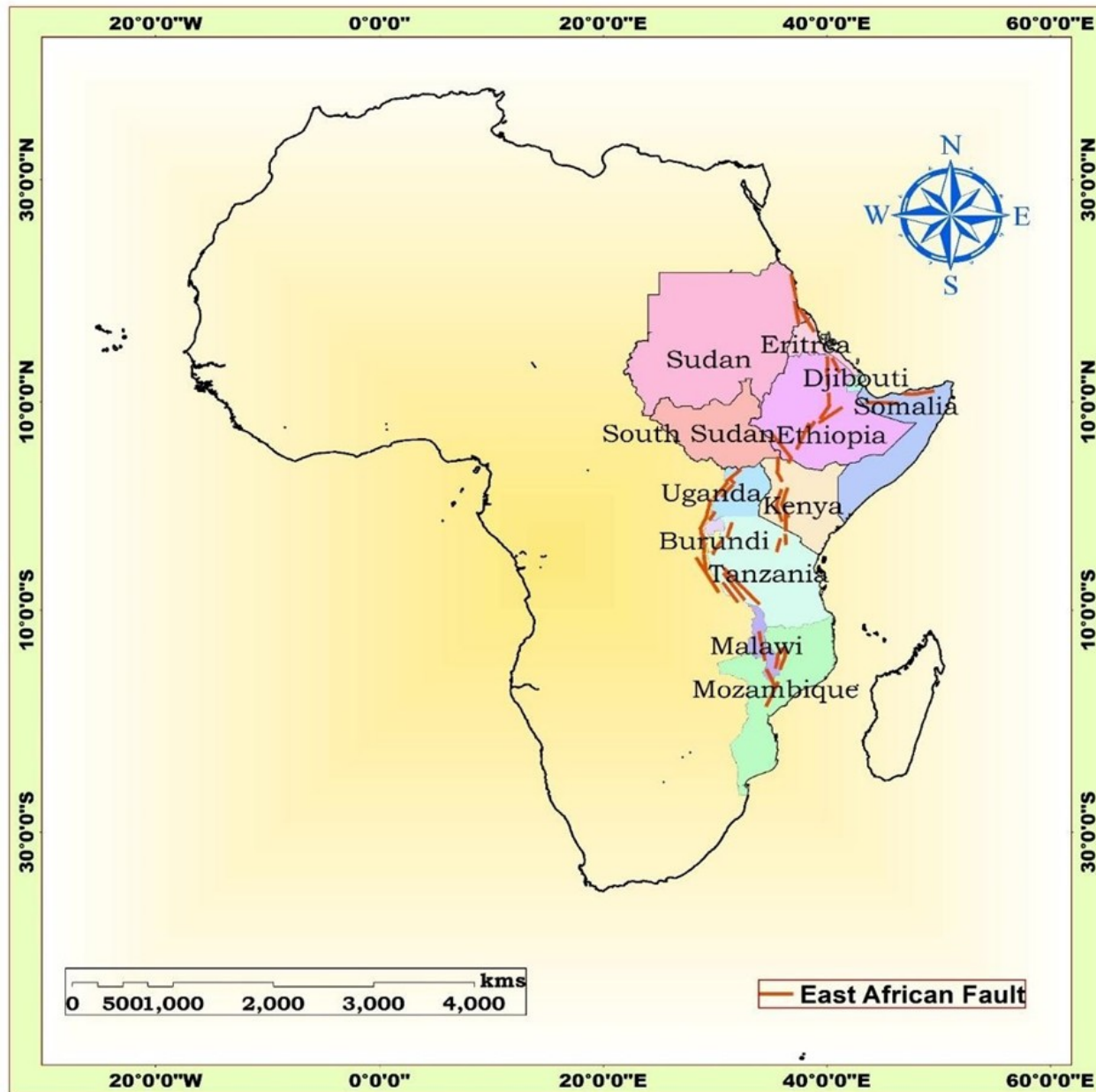
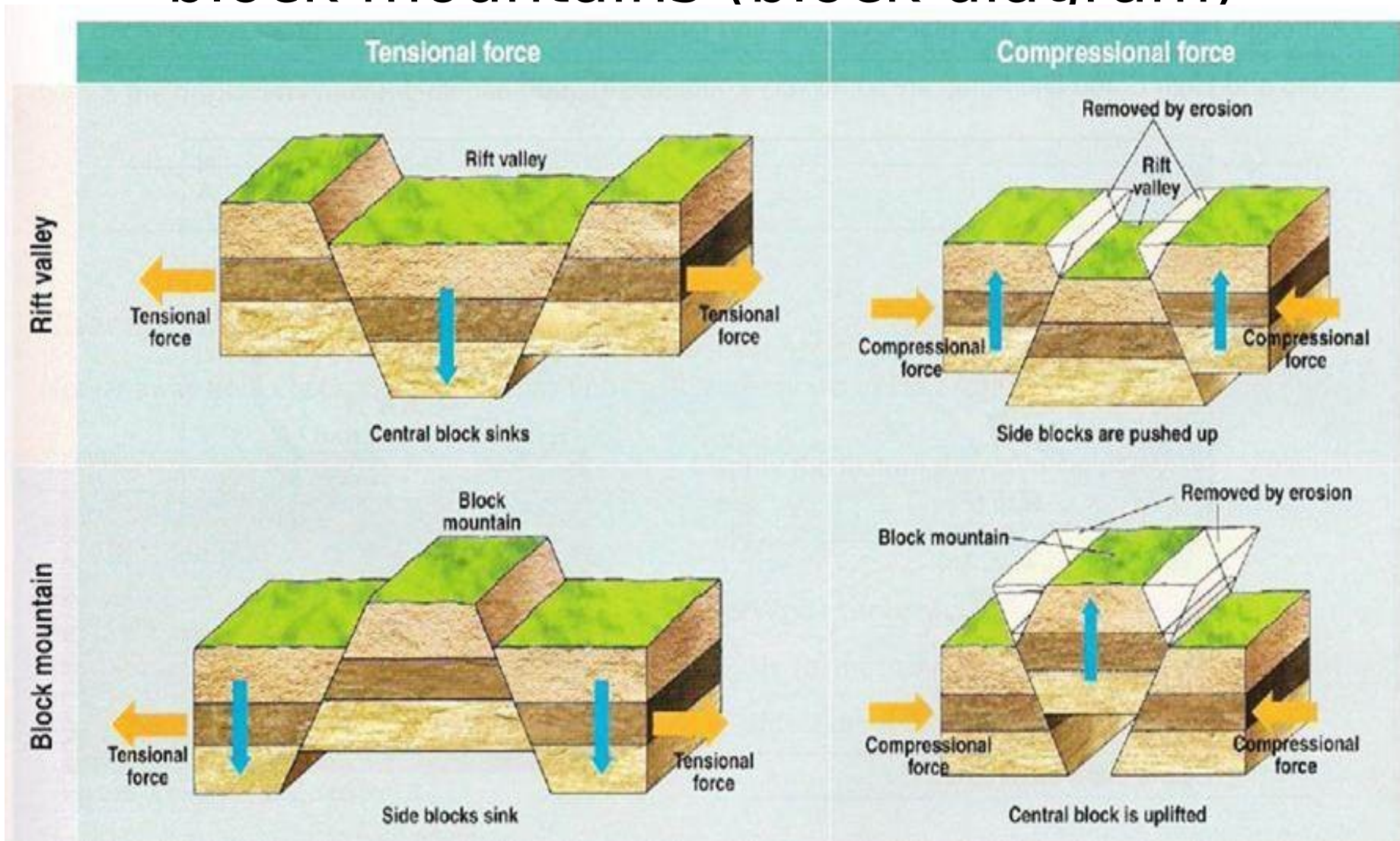


Figure: the formation of Rift valley and block mountains (block diagram)



- The **major faulting** movement probably began in the late **Oligocene** and **Miocene** Epochs of the Cenozoic Era. This rifted the Red Sea trough, which began to be flooded from the north.
- But the major rifting, affecting the whole African Rift System, including that of **Ethiopia** and the Gulf of Aden took place in the **Miocene Epoch**.
- Rifting and faulting, however, continued all the time throughout the **Pliocene** and even the **Pleistocene** Epochs.

- The Red Sea and the Gulf of Aden were connected as a result of the rifting and faulting of the land bridge that separated them.
- At the same period (**Pliocene**), the **Afar depression** (including the **Gulf of Zula**) was down-faulted allowing the Red Sea water to penetrate far inside.
- **Reversed tilting** and **volcanic activity**, later (**Pleistocene**) blocked the connection and isolated the extension of the sea, allowing much of the water to **evaporate**.
- As a result, thick saline materials accumulated.
- During the same period, the area between the **Danakil Depression** and the **Red Sea** was **uplifted** to form the **Afar Block Mountains**.

The Spatial Extent of the Rift Valley

- The Ethiopian Rift Valley is part of the Great East African Rift system that extends from Palestine-Jordan in the north to Malawi-Mozambique in the south, for a distance of about 7,200 kilometers.
- **5,600** kilometers is in **Africa**, and **1,700** kilometers in **Eritrea and Ethiopia**.
- On land, the widest part of the Rift Valley is the Afar Triangle (200-300 km).
- The **Red Sea**, the **Gulf of Aden**, and the **East African** System meet and form the **triangular depression** of the **Afar** where the **Kobar** Sink lies about 125 meters below sea level

- 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**.
- The Rift Valley region of Ethiopian is the **most unstable part of the country**.
- There are numerous **hot springs, fumorales, active volcanoes, geysers, and frequent earthquakes**.

The formation of the Rift Valley has the following structural (physiographic) effects:

1. It divides the Ethiopian Plateau into two
2. It separates the Arabian landmass from African landmass.
3. It causes the formation of the Dead Sea, Red Sea and the Gulf of Aden troughs.
4. It creates basins and fault

- Faulting and graben formation are not only limited to the Rift Valley.
- For example, similar tectonics activities have occurred in the **Lake Tana Basin**.
- However, the formation of **Lake Tana** had been accentuated by volcanic activity so that lava flow in the **southeast** had dammed part of the rim to deepen the basin. Figure
- Faulting in other places had a **structural control** along some part of **the river courses**.

Figure: Lake Tana and its surrounding



Quaternary Volcanic Eruptions and Depositions

- ❖ are recent volcanic activities that took place after the **formation of the Rift Valley**.
- ❖ occurred in the **Pliocene-Pleistocene** Epochs.
- ❖ is a continuation of the **tectonic and volcanic** processes that earlier affected the Rift Valley formation.
- ❖ It occurred in the form of renewed rifting/faulting and more volcanism
- ❖ was generally limited to **the floor of the Rift Valley and the region south of Lake Tana**, where the lava covers an area

- **Aden volcanics and recent faulting** are more extensively developed in the **Afar region**.
- Because of their recent occurrence, the Aden volcanics have relatively **well-preserved and visible morphological features**

- **The basic volcanic features of the Aden series include:**
 - **Numerous and freshly preserved volcanic cones**, many of which have explosive craters. Some of these are active **Dubi, Erta Ale, Afrera** etc. Of these,
 - **Erta Ale** is the most active volcano in Ethiopia.
 - **Volcanic hills and mountains**, some of which are semi-dormant (**Fantale, Boseti-Gouda near Adama, Aletu** north of Lake Ziway, **Chebbi** north of Lake Hawassa etc.).
 - **Extensive lava fields and lava sheets** some of which are very recent.
 - **Lava ridges**
 - **Thermal springs, fumaroles** etc.

Quaternary Deposition

- the Earth experienced **a marked climatic change**, where warmer and dry periods were alternating with cooler and wet periods.
- This was the time of the last „**Ice Age**“ in the **middle and high latitude** areas and the time of the **Pluvial Rains** in Africa.
- The heavy Pluvial Rains eroded the Ethiopian plateau and the eroded materials were deposited in the Rift Valley lakes.
- The excessive rain resulted in an excessive surface flow; rivers were many and large.
- **Lake and marshy areas became numerous and deep.**

- Many were enlarged and covered much area and even merged together. 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 the Earth's climate became **warmer and drier**.
- Thus, it increased the rate of evaporation that diminished the sizes of the lakes.
- Today, there are **lacustrine deposits of continental origin** around many of the Ethiopian lakes, river valleys and lowlands.

According to the **place and manner of deposition and depositing agents** these deposits

a. Lacustrine deposits: are divided as follow deposits on former lakebeds, and swampy depressions.

b. Fluvial deposits: deposits on the banks of rivers, flood plains both in plateau, foothills etc.

c. Glacio-fluvial deposits and erosional features: occurred on high mountains, such as Bale and Kaka Mountains.

d. Aeolian deposits: windblown deposits.

e. Coastal and marine deposits: deposits on sea invaded and sea-covered places.

- The **quaternary deposits** are mainly found in the **Rift Valley (Afar and Lakes Region), Baro lowlands, southern Borena, and parts of northwestern low lands.**
- **Cenozoic rocks cover 50% of the land mass of the country.**

2.5. Rock and Mineral Resources of Ethiopia

- The occurrence of **metallic minerals** in Ethiopia is associated with the **Precambrian rocks**.
- The exploitation and search for mineral deposits in Ethiopia has been taking place for the past **2,000 years** Such as:
- **gold** production and utilization, which has become part of Ethiopia's **history, tradition and folklore**.
- The mining and working of **iron** for the manufacture **of tools, utensils and weapons**
- the use of **salt and salt-bar** all these indicate to a fairly long mining tradition.
- presently mineral production from Ethiopia has been **negligible by World standards**.

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

- Geological surveys proved that Ethiopia has **abundant mineral resources of metals and precious metals, coal, and industrial minerals.**

Gold

- mined in Ethiopia for quite **long time**, mainly from **Benishangul-Gumuz (Metekel) and Adola.**
- Operating mines produce gold from primary sources in such localities as **Dermi-dama, Sakoro and Lega-dembi.**
- Mechanised alluvial working is confined to the **state-operated gold field of Adola.**
- Secondary gold deposits are common in the following localities: **Adola, Murmur Basin, Shakiso, Awata Basin, Dawa Basin, Ghenale Basin, Ujama Basin, Mekanisa (Guba and Wombera), Kaffa.**
- In Gambella and Illuababor (**Akobo River**), in Sidama (**Wondo**), Borena (**Negele-Yabelo** area) and in Benishangul-Gumuz (**Sherkole**), west Wellega, Mengi-Tumat-Shangul areas to the Sudanese border and the

Platinum :The **Yubdo** area in Wellega, is the **only active Ethiopian Platinum mine**.

Tantalum :Significant deposit of **tantalum and niobium** is found **in southern Ethiopia**.

- It occurs in **Adola** area where Kenticha Tantalum mine with resources of more than 17,000 metric tons of world class ore reserve is found.
- Extensive **lignite** deposits in Ethiopia are found in **Nedjo (Wellega)**, and in small amounts in **Chilga (Gonder)** are found in the sedimentary formations laid in between Trapean lava

Lignite, one of the lowest ranked coal, is known to occur in many localities such as in the **Beressa Valley and Ankober (North Shewa), Sululta (nearAddis Ababa),Muger Valley (West Shewa), Aletu valley (near Nedjo), Kariso and Selmi Valleys (Debrelibanos), Zega wodem gorge (near Fiche), Didessa Valley (southwest of Nekemte), Kindo and Challe Valley (Omo confluence), Adola,Wuchalle (north of Dessie), Chukga area (on Gonder-Metema**

Gemstones : including **amethyst, aquamarine, emerald, garnet, opal, peridot, sapphire** and **tourmaline** occur in many parts of Ethiopia, mainly in **Amhara and 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 is believed to be significant.

Gypsum and Anhydrite : A limited amount of gypsum is produced for domestic consumption in Ethiopia, mainly for the cement industry, but very large deposits are known to occur in sedimentary formations of the **Red Sea coastal area, Danakil**⁶⁰
Depression, Ogaden, Showa, Gajjam, Tigray

Clay

- Ethiopia is **endowed with industrial clay material**.
- **Alluvial clay** deposits for bricks and tile, pottery and pipe industry occur in **Adola, Abay gorge, and the Rift Valley lakes region**.
- **Ceramic clay** for the production of **glasses, plates, bricks** is found at **Ambo and Adola**.
- Tabor ceramic industry in Hawassa gets most of its raw materials from local sources.

Marble

- quarried in such localities as west of **Mekelle and south of Adwa in Tigray**.
- In the east in **Galetti, Soka, Ramis, Rochelle, Kumi** and other valleys of **Chercher Mountain in West Hararghe**.
- In the northwestern also in areas built of Precambrian **schist** in **Gonder, and the Dabus River and other neighboring river basins in Benishangul-Gumuz and Gojjam**.

Construction stones

- **Basalt, granite, limestone and sandstone** are important building stones.
- For the surfacing of **roads and compaction, basalt, scoria** and other volcanic rocks are extensively used.
- Mesozoic **limestone** is an important raw material for **cement and chalk** production.
- The earlier cement works at **Dire Dawa** and the recent ones at **Muger**

2.5.2. Mineral Potential Sites of Ethiopia

- According to the Ethiopian geological survey, the geologic formations that host most mineral potentials of Ethiopia includes three major **greenstone belts** and other formations:

1. Western and South-western-greenstone belt: They contain various minerals:

- primary gold occurrences (Dul,Tulu-Kape,Oda-Godere, Akobo, Baruda, Bekuji-Motish and Kalaj);Yubdo
- Platinum, Base metals of AzaliAkendeyu, Abetselo and Kata;Fakushu Molybdenite and the iron deposits of Bikilal Chago

2. **Southern greenstone belt(Adola belt):**
comprises the primary gold deposits and occurrences of Lega-dembi, Sakaro, Wellena, Kumudu, Megado-Serdo, Dawa Digati, Moyale and Ababa River;the columbo-tantalite of kenticha and Meleka, andthe Adola nickel deposit and other industrial minerals.

3. **Northern greenstone belt (Tigray):**
comprises of the primary gold occurrences of Terakemti, Adi-Zeresenay, and Nirague.

The base metals of Terer, Tsehafiemba and other parts of Tigray, Placer gold occurrences of Tigray.

THANK YOU