* The earth
* Musah Saeed Zango
* ETS 101- Introduction to Earth Science
* What is it?
* Why do we have to study it?
* We think it should be no man’s Business or
* Everybody's Business
* TAKE THE SCIENCE OUT
* Is that what we want to STUDY? CAN WE…….
* Yes we can BUT will limit ourselves to two Parts

***PART 1:***

* The layered structure of the Earth
* Earth materials
* Some features of the Earth content
* Minerals and rocks
  + Physical and chemical properties
  + Mineral Assemblages
  + Processes of mineral formation
* **Perhaps continue with PART 2:**
* Rock Forming Minerals
* Different types of rocks:
  + Igneous
  + Sedimentary &
  + Metamorphic
* Look at some surface Processes
  + Introduction to Weathering
* Finally look at:
* Geological Structures
* Zones of the Earth
* The Atmosphere
* **Those interested in Details**
* Our interest: The Earth
* A slice through the Earth
* Different mode of slicing..
* Let’s make it a bit Clearer
* Question 1: Three discontinuous zones have been found associated with the Earth.

1 List where these discontinuities occur with respect to distance from the Earth surface.

2 Name these discontinuities in chronological order as to their nearness to Earth surface.

3. Mention the exact interface where the first discontinuity can be found.

* Question 2: A precious metal has been identified to be located at the Centre of the Earth. This metal is so precious that we need to collect it.

1. Using the diagram on the right side label the different layers one need to cross before getting to the precious metal,
2. What distance will be covered if the trip started from:
   1. Continental crust
   2. Oceanic crust

* Question 3: A teaching assistant at Earth Science Department has carefully created a slot in the Earth and has removed a portion without destroying the layered structure of the Earth. Orientation of the removed section is important.

1. Labelled the different earth layers in the piece held by the teaching assistant.
2. What is the approximate distance covered if the excavation started at earth surface to the bottom of the inner most layer.
3. What sort of earth materials will the teaching assistant go through from the earth surface to the bottom most part of the Earth looking vertically.

* Chemical composition
* The core contains iron (Fe) and Nickel (Ni)
* The mantle contain dark minerals of Ferromagnesian (Fe, Mg) composition, and high density rocks
* The crust is made up of light and low density rocks
* The density of the Oceanic crust is 1.03g/m3
* That of the continental crust is 2.7g/m3
* In general densities increases with **DEPTH**
* Cross Section of the Earth
* The Lithosphere:
* Consist of 1. Continental and 2. Oceanic Crusts.
  + The continental crust is made up of:
    - Sedimentary & light coloured Igneous rocks (granite & diorite) they are mainly of granitic composition.
    - Sometimes referred to as SIAL & are discontinuous
* The Lithosphere:
* The Mantle
* The Core
* Chemical Composition
* The core
* Is the central part of the earth.
* It lies below the gutenberg discontinuity
* The 2260km thick outer core is believed to be fluid, composed mostly of iron and small quantities of nickel and sulphur. Density range 9-11g/cm3
* The inner core is 1220 km thick and believed to be solid with temperature of 6650 degree celcius , density 10.5-15.5g/cm3
* Summary of Structure of the Earth
* MINERALOGY
* MUSAH SAEED ZANGO
* LEARNING OBJECTIVES
* Basic definition of mineral
* Mode of formation of minerals
* Physical properties of minerals
* Identification of common minerals
* Rock forming minerals
* What is a Mineral?
* Naturally Occurring
* Crystaline and Soliid
* Definite Chemical Compositio
* 2. Ordely arrangement-Crystals
* Some minerals and their crystal shapes
* **Identify the minerals in these rocks- Rock from Nania Slave Camp**
* 3. Physical Properties
* Additional physical properties
* Some more minerals-PRECIOUS ONES
* Ore minerals
* Rock forming ones
* Examples of Minerals
* Can you imagine what is going on here…
* ERUPTION-Those who know what is happening are OK but
* To others it is JUDGEMENT DAY. The believe is

**At the end of this lecture you should be able to**

* **Know mode of formation of igneous rocks**
* **Differentiate between intrusive and extrusive rocks**
* **Distinguish mineralogical difference between granite, diorite, gabbro and ultramafic rocks**
* **Know characteristics of intrusive structures –dykes, sills, batholiths, etc.**
* Rocks are forming !!!!!!!!!!!!
* So what exactly is rock?
* 1. It is an aggregate or assemblages of minerals
* 2. A solid substance that occurs naturally because of the effects of three basic geological processes:

1. Magma solidification;

* b. Sedimentation of weathered rock debris;
* c. Metamorphism of the products of the above geological processes
* Classification based on Texture
* **IGNEOUS ROCKS**

By

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* ***Formation of Igneous Rocks***

***WHEN MAGMA*** **FREEZES** **And** **SOLIDIFIES**

* **CLASSIFICATION**
* **IGNEOUS ROCKS**
* **CLASSIFICATION**
* **CLASSIFICATION**
* **IS BASED ON**
* ***TEXTURE***
* ***MINERAL CONTENT***

But

* **TEXTURE IS EASILY RECOGNIZABLE**
* CLASSIFICATION of IGNEOUS ROCKS
* DON’T FORGET THESE
* **Most dark-coloured minerals are mafic and are rich in plagioclase and ferromagnessiun minerals**
* **Light-coloured inerals are felsic and contain potassium feldspar, sodium plagioclase and quartz and only minor amounts of other minerals**
* **Intermediate ıgneous rocks are neither dark nor light and generally contai light colourd minerals (feldpar, and some quartz) and dark minerals such as hornblende or biotıte.**
* ***COMMON IGNEOUS TEXTURES***
* **If crystals are not visible or visible with hand lens**
  + *The rock looks like glass, the* *texture is glassy*
  + *But if texture has grain size similar to fine or medium sandpaper, the texture probably is fine grained.*
  + *If rock consists of fragments, the texture is pyroclastic.*
* If crystals are visible without hand lens
* If Crystals are of two sizes, texture is Porphyritic
* If the groundmass is fine grained, the texture is fine grained and porphyritic
* If the groundmass is course grained, the texture is coarse grained and porphyritic
* Intrusive structures
* Definition of intrusive structures
* **Phacolith** is an igneous intrusion in folded sedimentary rocks that is convex.
* **Laccolith** is a sheet intrusion that has been injected between two layers of sedimentary rocks.
* **Sill** is a tabular sheet intrusion that has intruded between older layers of sedimentary rocks, beds of volcanic lava.
* Definition cont’d
* Dyke/dike: a type of sheet intrusion that cuts discordantly across planer wall rock structure.
* Batholith: a large emplacement of igneous intrusive rock that forms from cooled magma.
* Diagram of intrusive structures
* **THANKS FOR BEING PART OF THE CLASS**
* ***BEFORE I FORGET***
* ***ANY QUESTIONS***
* ***REMEMBER EARTH SCIENCE OR GEOLOGY IS PRACTICAL COURSE, THE EARLIER YOU DEVELOP AN INTEREST FOR IT THE BETTER***
* ***SEE YOU SOON.***
* **SEDIMENTARY ROCKS**

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* LEARNING OBJECTIVES
* How sediments forms
* Process of sedimentary formation
* Common sedimentary structures
* Differences between clastic, chemical and organic sedimentary rocks
* Classification of sedimentary rocks
* SEDIMENTARY ROCKS
* LAYERED ROCKS
* FROM CONSOLIDATED SEDIMENTS
* HAVE SEDIMENTARY STRUCTURES
* LITHIFICATION
* IS THE CONVERSION OF SEDIMENTS TO SEDIMENTARY ROCKS
* Accomplished by:
  + - Compaction
    - Cementation
    - Crystallization
* SEDIMENTARY STRUCTURES
* **SIGNIFICANCE OF SEDIMENTARY STRUCTURES**
* they provide
  + Evidence of transporting agent
  + And the environment of deposition
* **SEDIMENTARY STRUCTURES**
* STRATIFICATION – BEDDING OR LAYERING
* MUD CRACKS
* RIPPLE MARKS
* **STRATIFICATIONS**
* Is the arrangement of the rock units in strata.
* Common term used is BEDDING
* There are two types of layering in sedimentary rocks:
  + - * + CROSS BEDDING
        + GRADED BEDDING
* **STRATIFICATION, BEDDING OR LAYERING**
* **CROSS BEDDING**
* Sediments are transported by either water current or by wind
* Direction of current can be observed from the nature of stratification
* **GRADED BEDDING**
* Has got larger grains of the depositing sediments at the bottom with finer ones on top
* Formed when sediment –laden current slows down
* **MUD CRACK**
* FORMED WHEN FINE GRAINED SEDIMENTS DRIES AND SHRINKS
* CRACKS ARE WIDER AT TOP AND
* TAPERS AT BOTTOM
* **RIPPLE MARK**
* IS A SMALL SCALE SUB PARALLEL RIDGES AND TROUGHS
* FORMED IN LOOSE SAND BY WIND, WATER CURRENTS OR WAVES
* **CLASSIFICATION OF SEDIMENTARY ROCKS**
* **TYPES OF SEDIMENTARY ROCKS**
* Detrital Sediments are those made of solid particles derived from outside the basin of deposition
* Chemical Sediment are those formed by precipitation of ions or accumulations of organic materials within the basin of deposition.
* **CLASSIFICATION IS BASED ON**
  + - ***TEXTURES*** 
      * + ***and***
    - ***MINERAL COMPOSITION***
* **Classification**
* Sedimentary rocks are siliceous rocks (> 90% silica) and are classified based on grain size and mineral composition.
* In terms of grain size; they can be
  + - * Fine
      * Medium and
      * coarse
* **ANY QUESTION(S)**
* **HOPE ITS WELL WITH YOU**
* **KEEP WATCHING**
* **KEEP OBSERVING**
* **APPLY WHAT YOU HAVE LEARNT**
* **AND YOU WILL UNDERSTAND THE SCIENCE OF THE EARTH CRUST**
* **REMEMBER; YOURS IS TO APPLY THEM TO SOLVE PROBLEMS THAT WILL BRING DEVELOPMENT**
* **SEE YOU**
* **METAMORPHIC ROCKS; WHAT ARE THEY? UP NEXT**
* **METAMORPHIC ROCKS**

*BY*

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* Metamorphic rocks
* Introduction
  + - Rocks (Igneous, Sedimentary or metamorphic rocks) do change in appearance if subjected to
      * + Heat
        + Pressure
* WHY CHANGE IN APPEARANCE
* ***BECAUSE THE TEXTURE AND MINERALOGY OF THE ROCKS CHANGE***
* ***This process is***
* ***METAMORPHISM***
* **Metamorphism, what does it do?**
* Now that we know the Effects of Metamorphism
* *WHAT ARE THE CONDITIONS NECESSARY TO CAUSE THESE CHANGES IN TEXTURE AND MINERALOGY?*
* These are:
* *EXTREME TEMPERATURES*

*and*

* *EXTREME*

*PRESSURES*

*However, remember that different rocks melt at different temperatures and pressures*

* **IF SO, WHAT ARE THE TYPES OF METAMORPHISM**
* ***REGIONAL METAMORPHISM***

***AND***

* ***CONTACT METAMORPHISM***
* Contact metamorphism
* Contact metamorphism occurs locally, at and near the contacts between intrusions and the surrounding country or host rock. The heat introduced by the intrusion controls the metamorphism.
* Regional metamorphism
* Regional metamorphism is metamorphism that occurs over broad areas of the crust. Most regionally metamorphosed rocks occur in areas that have undergone deformation during an orogenic event resulting in mountain belts that have since been eroded to expose the metamorphic rocks.
* **Metamorphic Textures**
* ***Subdivided into two. These are:***
* ***Non foliated and***
* ***Foliated***
  + - ***WHAT IS FOLIATION, IN ANYCASE?***
* ***Foliation is the arrangement of mineral crystals in parallel or nearly parallel planes***
* **GEOLOGICAL STRUCTURES**

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* **What is Structural Geology?**
* Study of the form, arrangement and internal structure of rocks.
* Stresses within the earth bend and break rocks
* The effects from the stress result in the formation of *folds, faults and other geologic structures*
* STRUCTURAL GEOLOGY

**Is therefore concern with the DEFORMATION OF ROCKS**

* DEFORMATION OF ROCKS – How do they occur?
* Caused by the Stress Regimes in the earth crust
* The Stress - is the force that acts at an area of a rock
* It thus tends to change its size and shape.

Mathematically

* STRESS = Force/ Unit area
* DEFORMATION OF ROCKS
* TYPES OF STRESS
* COMPRESSIVE STRESS
* Compressive stress or compression causes
* **shortening**
* is an important type of stress at ***convergent tectonic plate boundaries***
* **TENSIONAL STRESS**
* Tensional stress or tension is the stress that causes
* **stretching**.
* This type of stress principally occurs at ***divergent boundaries***
* **SHEAR STRESS**
* **This type of stress causes**
* **one side of a body to slide past the other.**
* **This is the principal type of stress along transform fault plate boundaries**.
* **TYPES OF DEFORMATION**
* ***Brittle Deformation***
* ***Ductile Deformation***
* **WHAT IS BRITTLE DEFORMATION**
* ***Rocks that break while undergoing elastic strain, with little or no plastic strain.***
* ***Examples of brittle rocks are rhyolites, basalts, tuffs, and sandstones.***
* ***Deformations that are associated with these rocks are BRITTLE DEFORMATION***
* DUCTILE DEFORMATION

Rocks that undergo plastic strain without rupturing or breaking are said to be **Ductile.**

Examples of such rocks are phyllites, schists etc. Deformations associated with this type of rocks are DUCTILE DEFORMATION

* **HOW TO RECOGNIZE AND DESCRIBE THESE GEOLOGIC STRUCTURES**
* ***Examine the rock at the outcrop site***
* ***Measure their orientation or attitude i.e. strike, dip and dip direction***
* ***Plot these data on a map and then***
* ***Visualize the structure of the rocks in three dimensions***
* **WHAT IS STRIKE OF A ROCK?**
* ***is the compass direction of the line formed by the intersection of the surface and a horizontal plane.***

***OR***

* ***is the compass direction of any horizontal line on the surface of interest.***
* ***This is the direction taken at a structural surface e.g. bedding or fault plane, as it intersects the horizontal.***
* **STRIKE**
* **WHAT IS DIP?**
* **is the angle of inclination of the surface as measured downward from a horizontal plane to the surface.**
* **It is always measured in a vertical plane that is perpendicular to the strike.**
* How are they presented on a map?
* Some Terminologies

**CONTACTS:**

These are surfaces ***separating adjacent bodies*** of ***rock of different types or ages.***

* Some Terminologies
* *Unconformity*

This is a boundary that exists between two series of strata. It indicates that the first deposit has been partly eroded before the deposition of the second deposition. There two types of unconformity and these are non conformity and disconformity.

* Non-conformity; this is when the upper series of beds lie over the eroded surface of tilted or folded strata of non-stratified rocks.
* Disconformity; this is when the upper as well as the lower series of beds are practically parallel but the contact or junction between the two series in as uneven.
* **FOLD STRUCTURES**
* **Fold is a bend in a layer of rock due to ductile strain (deformation).**
* **They consist of limbs, hinge line and axial surface.**
* **The flanks of folds are called the limbs and they**
* **join at the hinge line.**
* **COMMON FOLD STRUCTURES**
* **ANTICLINE- UPFOLD**
* **SYNCLINE - DOWNFOLD**
* OTHER FOLD SYSTEMS
* **RECUMBENT FOLD**
* **OVERTURNED FOLDS**
* **FAULTS**

Are breaks or fractures in the earth’s crust along which movement has occurred.

The rocks on one side of the discontinuity or break in the earths crust generally move relative to those on the other side.

These relative movements may be up and down, sideways or a combination of the two.

* **TYPE OF FAULTS**

Classified on the basis of relative movements. These are;

* **Normal Fault**
* **Reverse Fault**
* **Thrust Fault**
* **Vertical fault**
* **Graben fault**
* **NORMAL FAULT**
* Rocks above the fault plane have moved downward relative to the rocks below the fault plane.
* **REVERSE FAULT**
* The hanging wall moved upward relative to the footwall.
* In this form of fracturing, the dip of the fault plane or fracturing plane is usually greater than 45O
* **THRUST FAULT**
* This is similar to reverse fault.
* Occur in shallow dipping bodies.
* The hanging wall moved upward relative to the footwall,
* and the dip of the fault plane dip at less than 45O.
* **STRIKE SLIP FAULT**
* *Are faults whose relative movement is sideways or essentially horizontal, and often parallel to strike of the fault.*
* **END OF LECTURE**
* ***HOPE TO SEE ALL IN GOOD SPIRIT TOMORROW 4 THE NEXT LECTURE***
* ***WE HOWEVER, HAVE MORE TO DISCUSS AND MORE TO LEARN***
* ***THANK YOU***