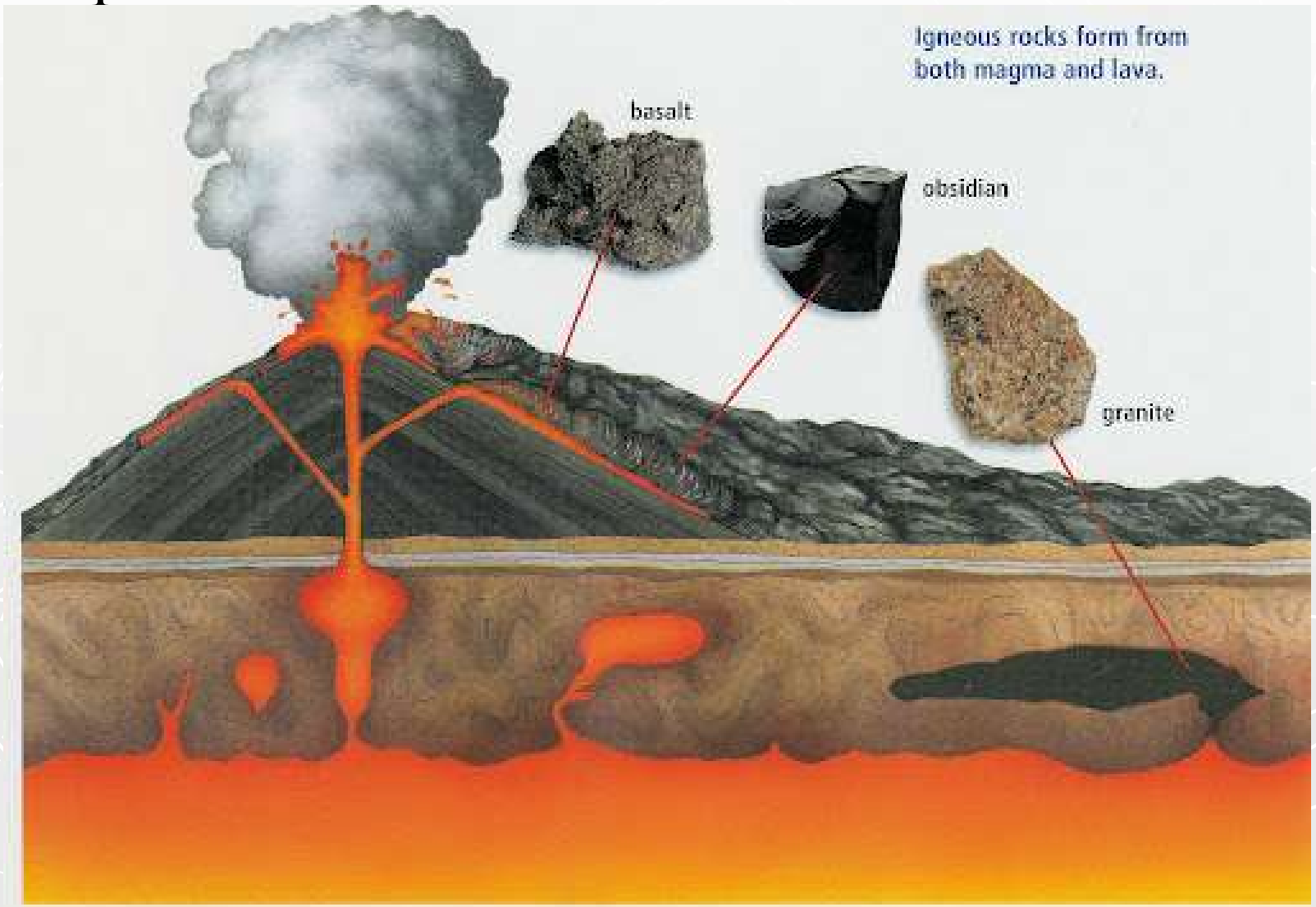
EWCE 203

Geology and Geomorphology

Igneous Rocks

What are Igneous Rocks?

Igneous rocks are **formed** from the **solidification** of molten rock material **below** the earth's surface and **extruded** through volcanic eruption.



What is Volcanoes?

- **Molten material** from deep within the earth, **escapes through the vents** of the earth's crust.

- Ejected solid and liquid matter **builds up landform around the vents are called volcanoes.**

- A **mountain** or hill, typically **conical**, having a **crater or vent** through which **lava, rock fragments**, **hot vapor**, and **gas** are or have been erupted from the earth's mantle.



Why volcanoes Remain Active?

- Between eruptions, a volcano's **vent may be chalked** with the rocks of past eruptions.
- Sometimes small **'jets of gas' come out** through cracks in rockplug.
- A volcano is **built by, and remains active** because of materials coming from a large deep seated reservoir of molten rocks.



Responsible for roughly **40 percent of all eruptions** in Africa.

Since 1882, the volcano has erupted **32 times** and it's lava lake consistently shows fluctuation in levels.

Eruption occurred about **500 feet underwater**.

Eruption of superheated molten rock caused **seawater to flash** explosively into steam.

A **plume** of water vapor, volcanic gases and ash reached an **altitude of 35 miles**.



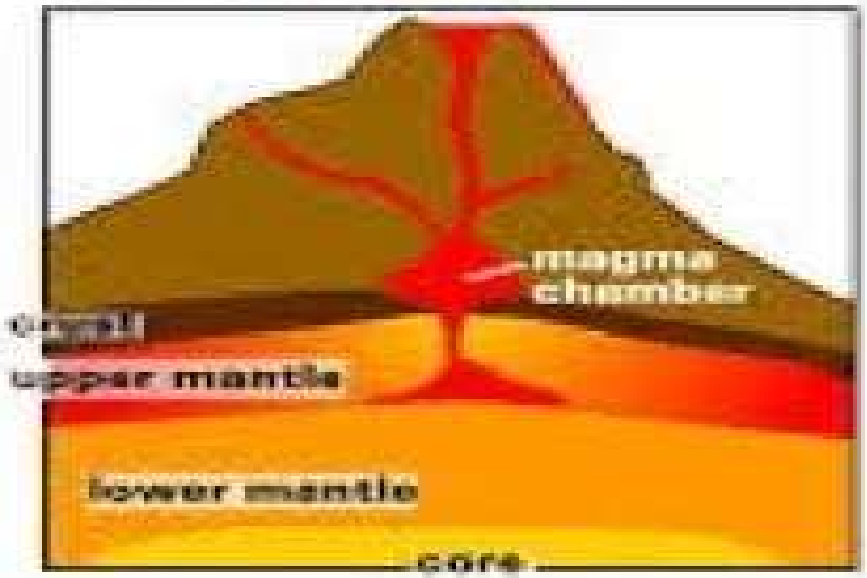
Eruption of the **Hunga Tonga–Hunga Ha‘apai** volcano in the Pacific Ocean, seen by a Japanese satellite on January 15, 2022

What is Magma and Lava?

- **Within** the ground, molten rock is called magma.
- When molten rocks **extruded** on the surface is called lava.

What is the difference between magma and lava?

Magma = molten rock below the earth's surface



Lava = molten rock flowing on the earth's surface



Volcanic Eruptions and Types:

Volatile component of magma, *play an important role in* ***igneous activity*** *and* ***produces volcanic eruptions***.

Volcanic eruptions are **different types**:

- relative **Quiet Outpouring of lava**,
- **Violent Explosions** accompanied by showers of volcanic debris.

Types of eruption depend to a great extent on:

- **the magma's composition**
- **the volatile contents.**

Lava rich in **ferromagnesian but low in silica**, tend to flow relatively quietly, where as those **high in silica** are viscous and explosive.



Indonesia's **volatile Mount Merapi Volcano** has unleashed a river of lava that flowed **1,400** meters (4,590 feet) down its slopes.

Volatile elements in magma, **drive explosive volcanic eruptions.**



Volcanic Debris and Gases:

- **Gases:**

  -mainly CO_2, N_2, S gases

  -Small amount of CO, H_2 and Cl_2 gases

- **Liquid:**

  -HCl.

  -H_2O content 1-8%



Volcanic-gas plume rises from Halema‘uma‘u Crater, Kīlauea Volcano, Hawai‘i.



Lava flowing from Maona Loa Volcano, Hawaii.

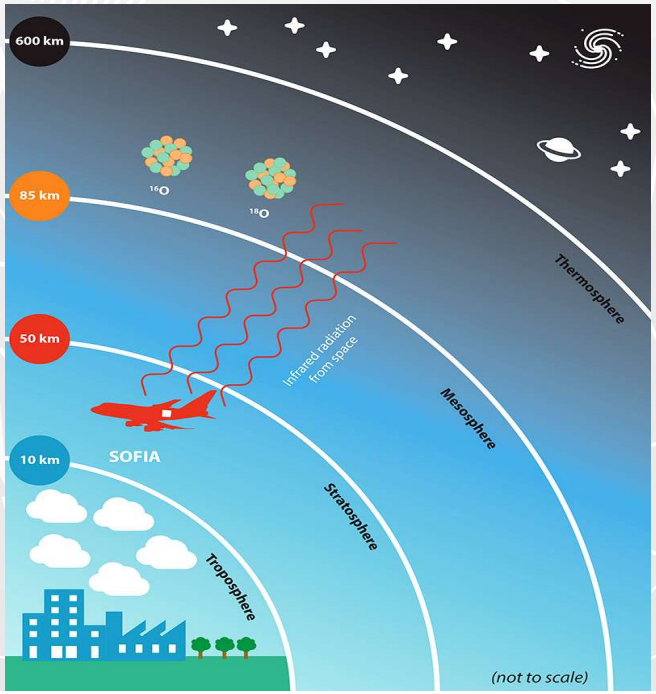
Pyroclastic Debris:

Fragments **blown out** by explosive eruptions and subsequently **deposited** on the ground is called pyroclastic debris.

Volcanic Dust:

- The **finest** **of pyroclastic debris** constitute is dust, which made up of pieces of the order of **10^{-4} cm in diameter**.

- When the volcanic **dust is blown into the upper atmosphere,** it can **remain** there for months, **travelling** a great distance.





Fragments settle around or near the volcanic craters

- **Ashes:** Fragments consisting of rock fragments, mineral crystals and **shapely angular glass particles,** smaller than cinders.



- At first glance, volcanic ash looks like a **soft, harmless powder**.
- Instead, volcanic ash is a rock material with a **hardness of about 5+** on the Mohs Hardness Scale.
- It is composed of **irregularly-shaped particles with sharp, jagged edge.**

Cinders:

- **Fragments of lava** that are ejected from a volcano and **cool** into coarse, irregularly-shaped pieces.
- **Size** 2mm to 64mm
- **Formed** when low-viscosity lava with lots of gas erupts from a volcano, often in the form of a liquid fountain
- **Accumulate around and downwind** from the volcano's vent



Lapilli: (Latin, 'little stone')

- **Small, stony or glassy fragments** of lava that are ejected from a volcano during an eruption and fall to the ground while still partially molten.
- **Formed** when liquid rock cools as it travels through the air.
- **Shaped** like spheres, teardrops, or buttons.



Volcanic Block:

- **Solid fragments of rock** that are **ejected from a volcano** and are more than 64 millimeters in diameter and remain solid during transportation.
- **Usually formed** when a new **vent opens explosively**, breaking older rocks.
- **Angular in shape** and can be **thrown as far as 20 miles** from the vent.



Volcanic Bombs:

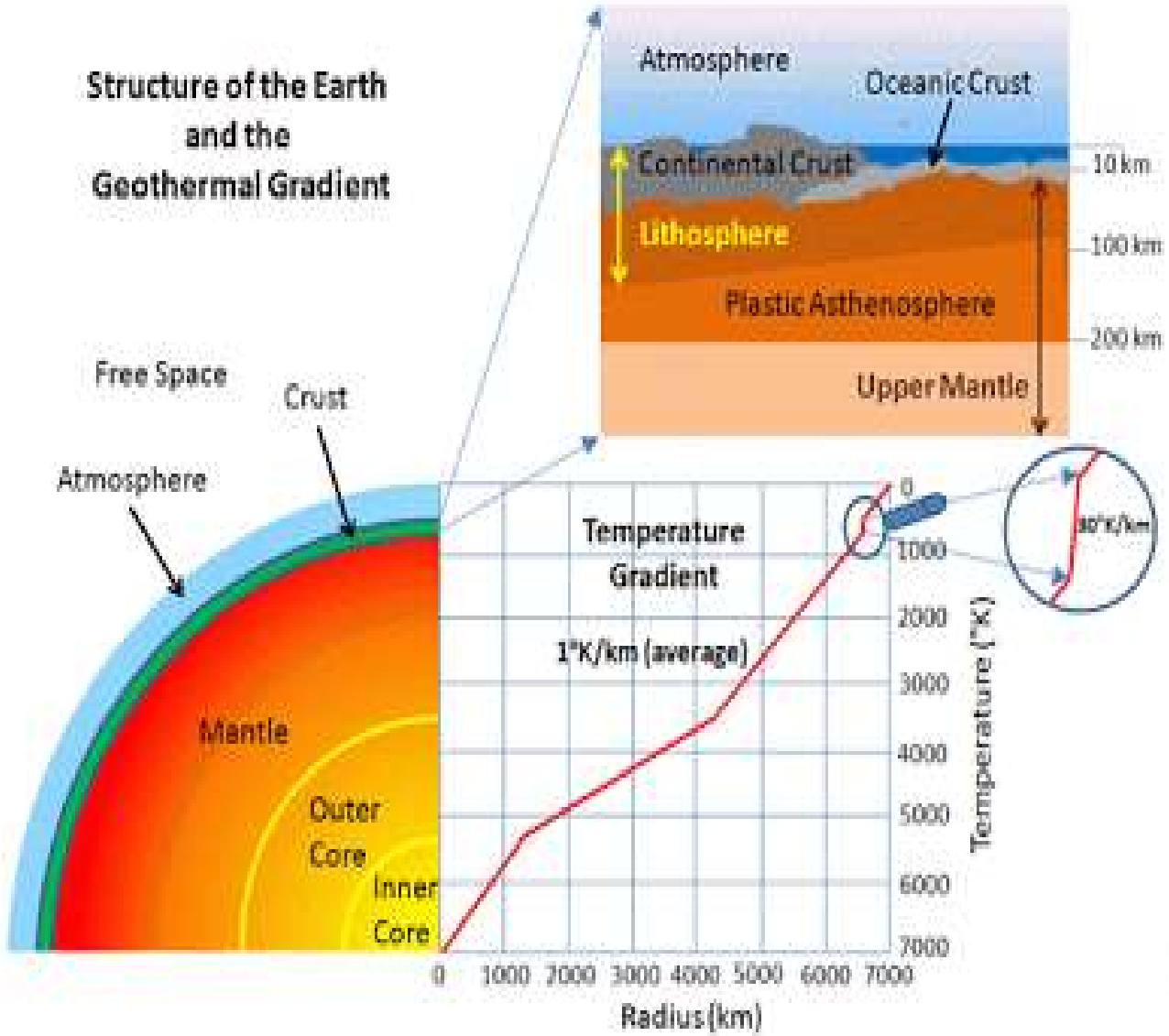
- **Rounded masses** that congeal from magma as **travel** through air.
- Was semi-molten (viscous) while ejected from a volcanic vent and is therefore **shaped while in flight.**
- **Sizes** are **larger than 64 mm** (2.5 inches) in diameter.
- **Cool into solid fragments** before they reach the ground.





What is Geothermal Gradient?

- Increase in temp with depth.
- Ranges vary from 10°C to 50° C/km
- Average 30°C/km



Causes of Igneous Activity:

- Igneous activity **requires magma** and **magma requires** rocks to be melted.

- Most of the magma comes from the **mantle**.

Heat to melt solid rocks is apparently produced in **two ways:**

- **Radio-active decay**: Generates heat energy as a product of transformation of one element into another.

- **Movement of rock masses**: when two rock masses pass one another, produces enormous frictional energy manifested as heat.

- **Heat from the Core of Earth.**

These mechanisms can account for the total heat **(1100°C) necessary to generate magma.**

Masses of Igneous Rocks:

- Formed from the solidification of magma.
- Rocks of igneous origin composes of about **95% of the outer 10 km of earth's crust.**
- During igneous activity, **extrusion of magma ie lava and pyroclastic debris form volcanoes and some land marks.**

Igneous Rock Formations

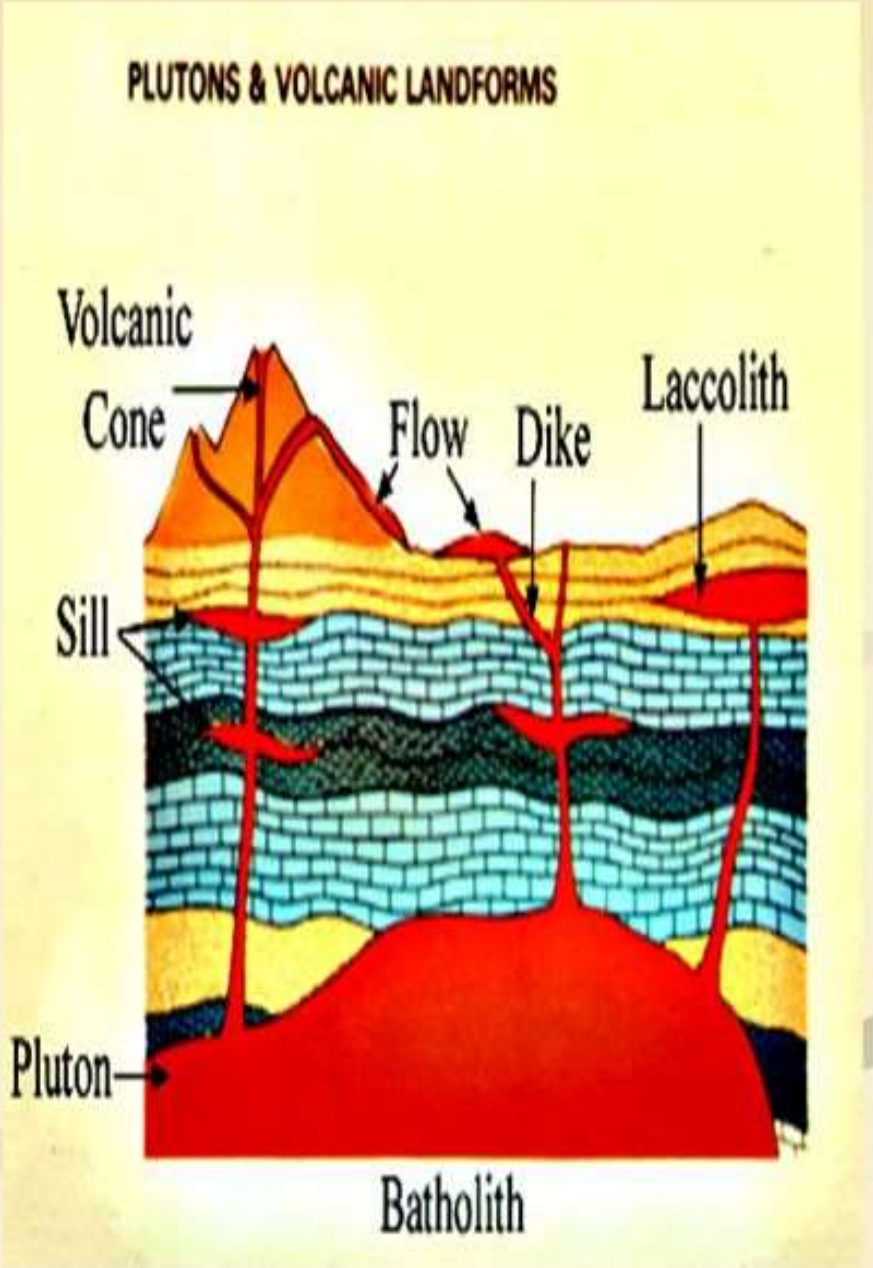
Extrusive Igneous Structues:

- volcanoes

Intrusive Igenous Structures:

- batholiths
- laccoliths
- sills
- dikes

- ❑ **Lopolith**
- ❑ **Stock**



Masses of Igneous Rocks:

Plutons:

When magma solidified **within the earth's crust**; rocks have **definite layers when magma invades** them:

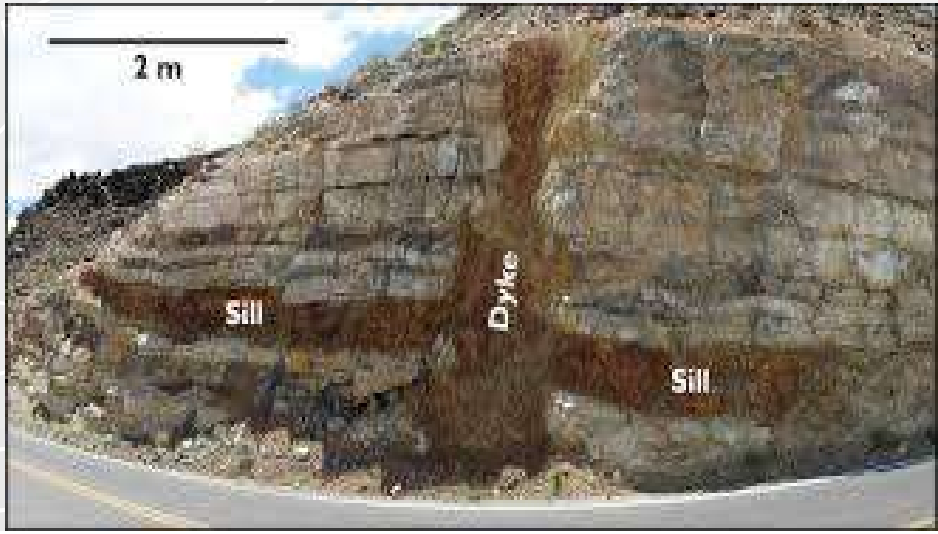
- **Concordant**: Rocks boundaries are **parallel to layering**.
- **Dis-concordant**: Rocks boundaries are **cut across the layering**.

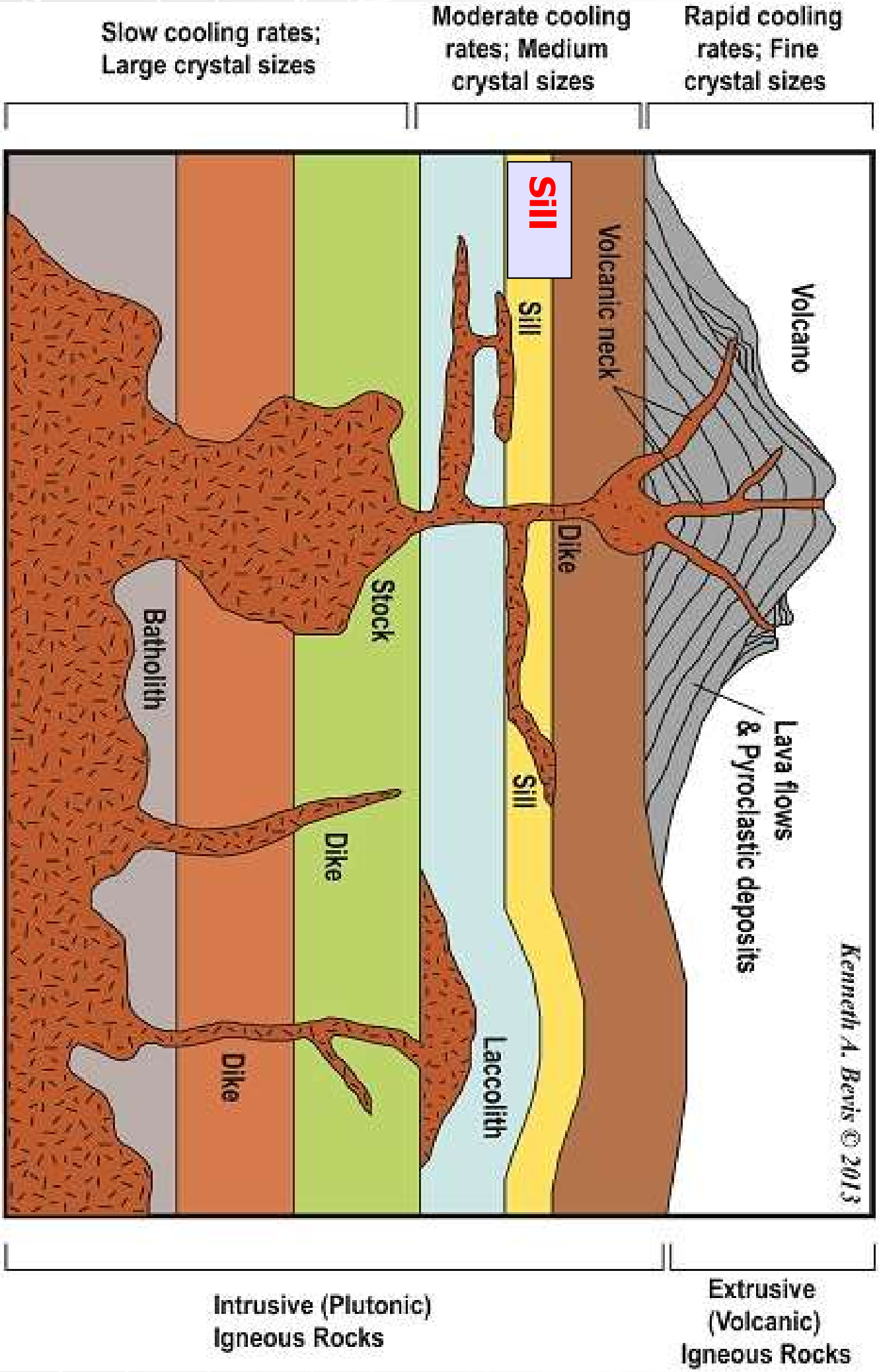
Types of Plutons: according to the **shape, size and relationship** of the surrounding layering rocks.

Tabular Plutons: A plutons with a **thickness that is small** to its other dimensions:

Sills:

- An intrusive form of rocks
- A **tabular concordant pluton**.
- May be **horizontal or inclined** depending on the attitude of rock structure with which it is concordant.
- **Younger** than the surrounding rocks.




Slow cooling rates; Large crystal sizes
Moderate cooling rates; Medium crystal sizes
Rapid cooling rates; Fine crystal sizes
Sill
Volcano
Volcanic neck
Sill
Dike
Stock
Batholith
Lava flows & Pyroclastic deposits
Sill
Dike
Laccolith
Dike
Kenneth A. Bevis © 2013
Intrusive (Plutonic) Igneous Rocks
Extrusive (Volcanic) Igneous Rocks

Dikes:(a few cm to many meters)

- **Tabular dis-concordant plutons**
- Originated when magma **forced its way through** the **fractures** of adjacent rocks.

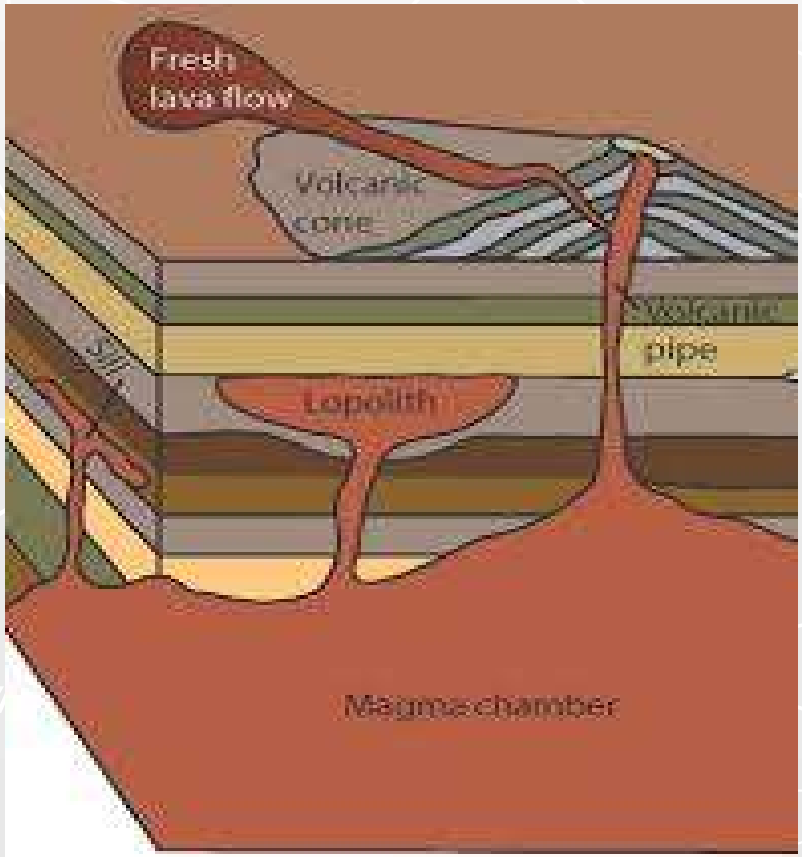
Ring Dike:

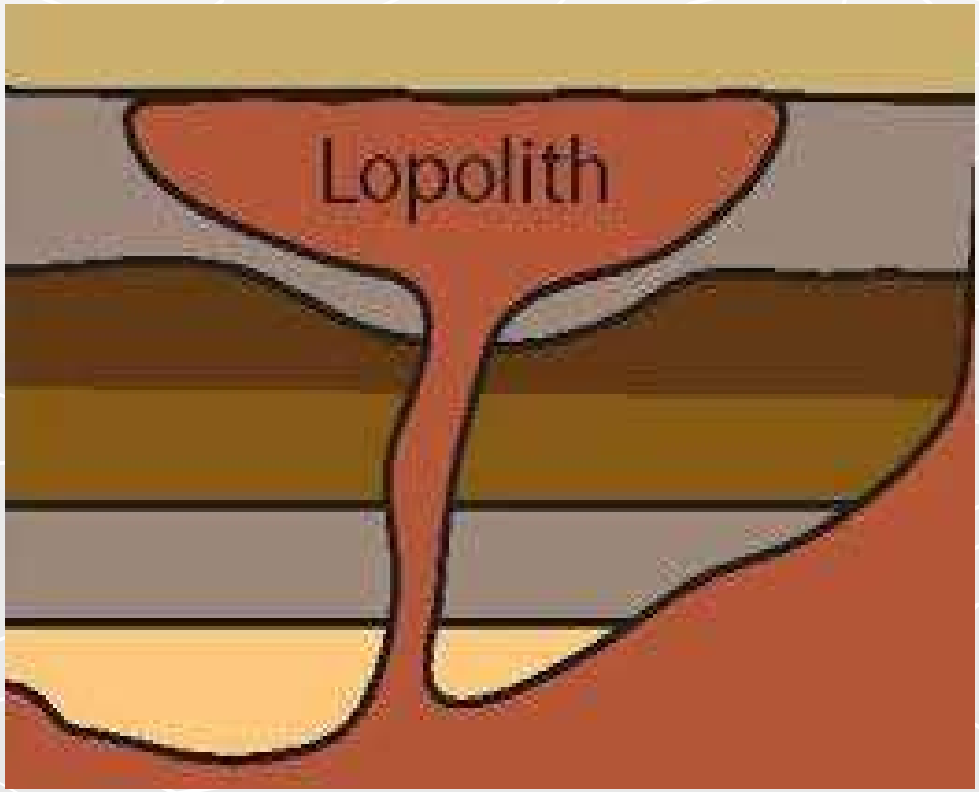
- Exposed surface **roughly circular or elliptical** masses of rocks that outline the cylindrical section of the crust.



Lopoliths:

- **Tabular concordant plutons** that shaped like **spoon**.
- Both roof and floor are **sagging downward**.
- Composed of **alternative layers of dark and light** colored minerals.

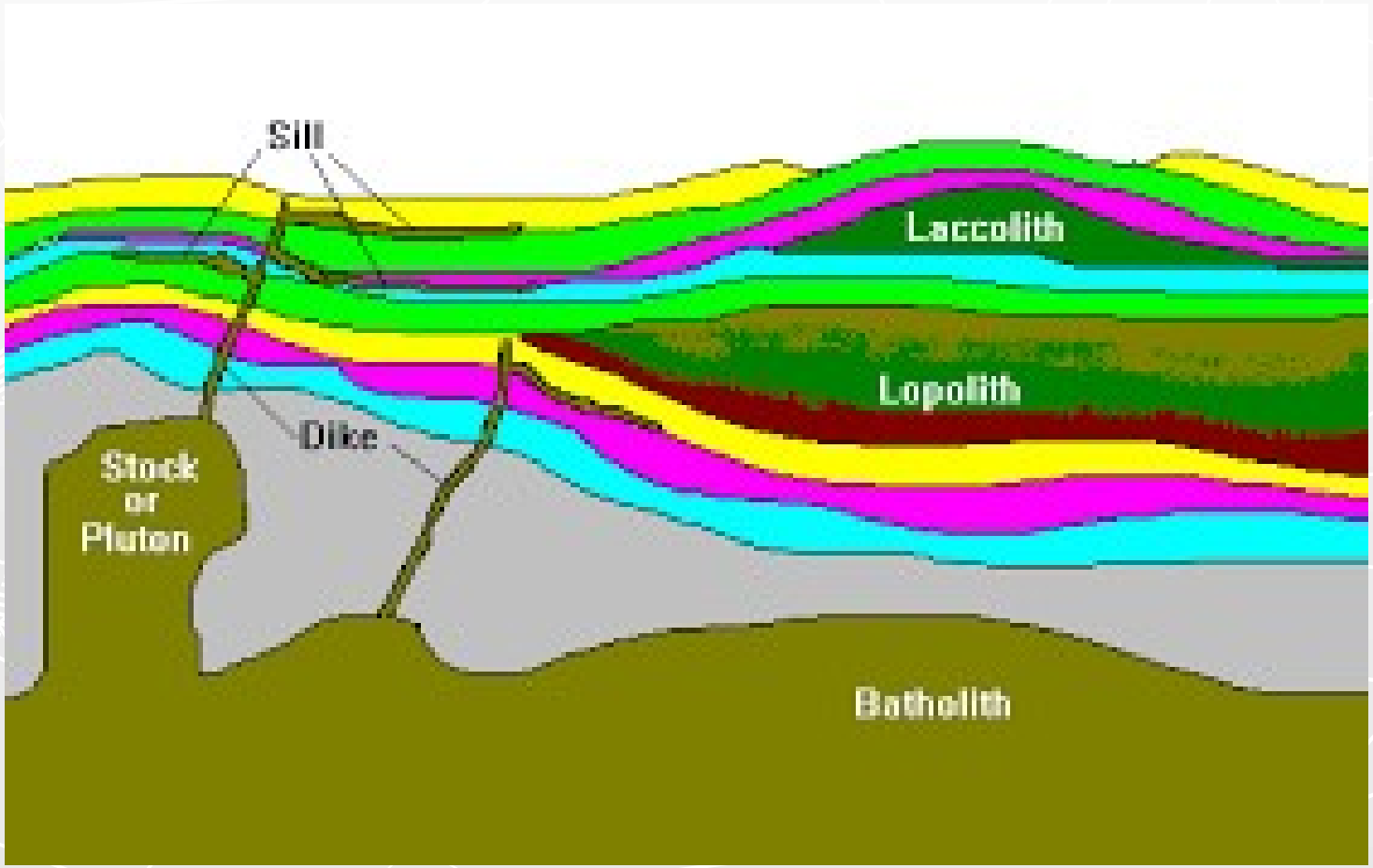




Laccoliths:

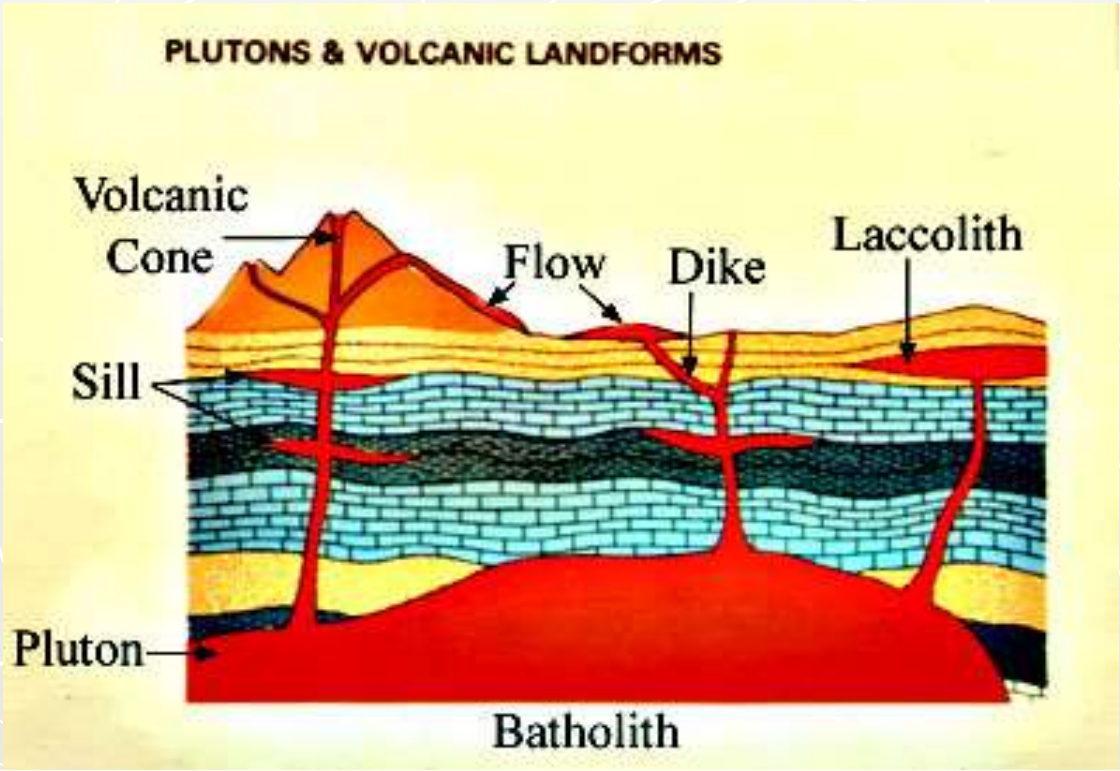
- Massive concordant plutons.

- Created when **magma pushed up the overlying** rocks structures in to a **doom.**



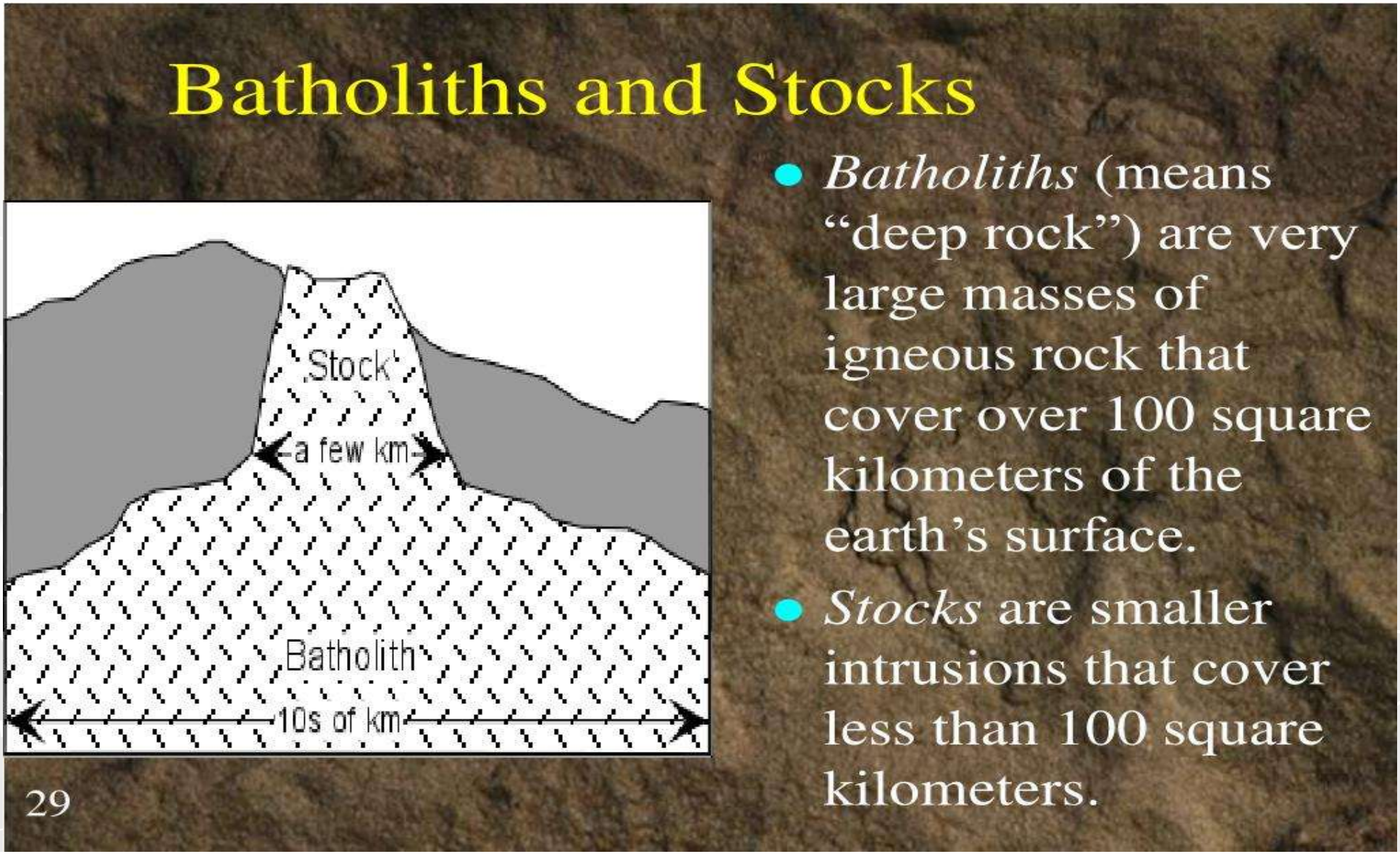
Batholiths:

- A **large pluton** (min 100 sq km) that **increases in size** as it extends downward.
- Located at mountain range.
- Run **parallel to the axes of mountain range**.
- Have **irregular dome shaped** roof.



Stock:

- A **batholiths that has smaller surface exposure.**
- other characteristics of batholiths remain.



Massive Plutons: A massive pluton that is **not tabular** in shape is called massive plutons.

Examples: Laccoliths and Batholiths.

Differences between Laccoliths and Batholiths.

- Batholiths are **formations of igneous rock that spread at least 100 sqkm** when they are exposed on earth's surface.
- Laccoliths is an intrusive rocks that forms when magma flows between rock layers and **pushes up the overlying rock layers in to a dome.**

Thanks