

ENGINEERING GEOLOGY

CE1301

Lecture #3 Igneous Rocks

Muayad A. Al-Sharrad

Ph.D. Geotechnical Engineering

Assist Prof.- Department of Civil Engineering

University of Anbar

Room 012

Civil Engineering Building

Ramadi 31001

Iraq

Email: muayad.alsharrad@uoanbar.edu.iq



WHAT ARE IGNEOUS ROCKS?

- A **rock**: is a naturally occurring solid aggregate of one or more minerals or amorphous solids.
- **Magma**: is generated by local heating and melting of rocks within the Earth's crust, mostly at depths between 10 and around 100 km.

Most compositions of rock melt at temperatures of 800–1200°C.

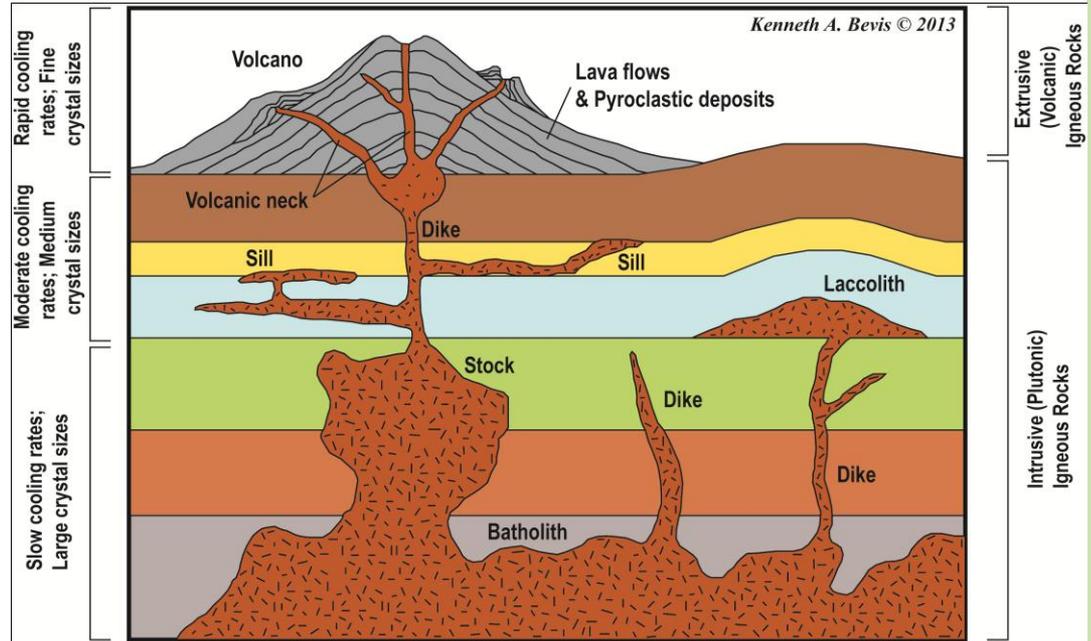
- **Lava**: is the name for both molten rock on the surface, and also the solid rock formed when it cools.
- **Igneous Rocks**: are formed by cooling magma or lava (*lava is a magma which cools on earth's surface*).
- **1- Intrusive or plutonic rocks**: formed from magma forced into older rocks at depths within the Earth's crust, which then slowly solidifies below the Earth's surface, though it may later be exposed by erosion. Igneous intrusions form a variety of rock types.

Large visible crystals are formed due to the relatively slow rate of cooling of magma.

- **2- Extrusive or volcanic rock**: formed from lava that was poured out or ejected at the Earth's surface.

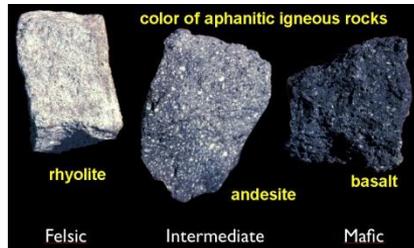
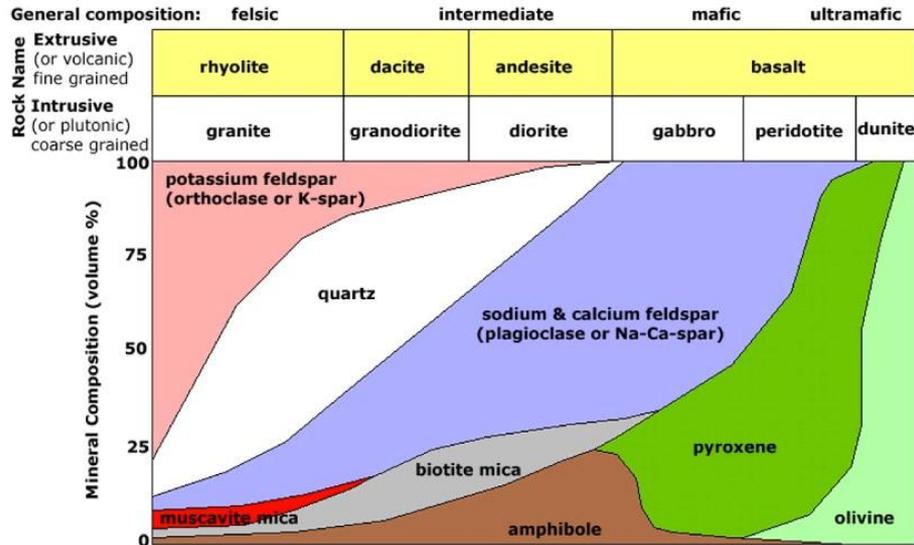
No visible crystals are formed because lava crystallizes very quickly.

Source: <http://intheplaygroundofgiants.com>



- **Batholiths**: are large blob-shaped intrusions, roughly equi-dimensional and commonly 5–50 km in diameter. Most are of granite.
- **Dykes** are smaller sheet intrusions formed where magma has flowed into a fissure, Mostly 1–50 m wide; may extend for many Kilometres.
- **Sills**: are sheet intrusions parallel to the bedding of the country rocks into which the magma was intruded.
- **Pyroclastic rocks** (meaning fire fragmental) are formed of material, collectively known as tephra, thrown into the air from an explosive volcano. Most tephra is cooled in flight, and lands to form various types of ash, tuff and agglomerate, all with the properties of sedimentary rocks.
- **Laccolith** – dome-shaped magma formed by intruding layered sedimentary rocks.

CLASSIFICATION OF IGNEOUS ROCKS



- Igneous rocks classification is based on combinations of their: 1) mineral composition, 2) grain size, 3) color, and 4) texture.
- General composition is of little significance in the context of most engineering.

Texture and composition

- Degree of crystallinity** (commonly reflects speed of cooling)
 - Holocrystalline = entirely composed of crystals (cooled slowly)
 - Hypocrystalline = composed of crystals and glass
 - Hyalocrystalline = no crystals, i.e. glassy (cooled quickly)
- Visible crystallinity** (commonly reflects speed of cooling)
 - Phaneritic = individual crystals can be distinguished (cooled slowly)
 - Aphanitic = granularity from the presence of crystals can be seen, but individual crystals cannot be distinguished
 - Glassy = entirely glass-like, or some crystals set in glass (cooled quickly)
- Crystal size** (commonly reflects speed of cooling)
 - Coarse = > 2 mm
 - Medium = 2-0.06 mm
 - Fine = <0.06mm
 - (Microcrystalline = must be observed using a microscope)
- Relative crystal size** (commonly reflects abundance of ions and uniformity of cooling history)
 - Equigranular = all crystals are approximately of equal size
 - Inequigranular = some crystals are clearly larger than others
 - Porphyritic = large crystals surrounded by much smaller crystals
- Crystal shape** (commonly reflects sequence of crystallization)
 - Euhedral = well defined regular shape (crystallized early from melt) (= idiomorphic)
 - Anhedral = poorly defined and irregular outlines (crystallized late from melt)

Source:
<http://geologycafe.com/>

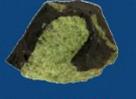
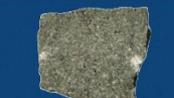
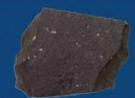


A CLASSIFICATION OF IGNEOUS ROCKS

Grain size by diameter/mm

- COARSE** > 5 mm
- MEDIUM** 1-5 mm
- FINE** < 1 mm
- GLASSY**



	Felsic		Intermediate		Mafic	Ultramafic
	> 69% SiO ₂		63-69% SiO ₂		45-52% SiO ₂	<45% SiO ₂
COARSE	 granite	 granodiorite	 syenite	 diorite/diabase	 gabbro	 peridotite
MEDIUM	 microgranite	 microgranodiorite	 microsyenite	 microdiorite	 dolerite	 lamproite
FINE	 rhyolite	 dacite	 trachyte	 andesite	 basalt	 komatite/picrite
GLASSY	 obsidian				 tachylite	

plutonic / intrusive
minor intrusion
hypabyssal
volcanic / extrusive

main minerals
(approximate %)

quartz 30 orthoclase 45 plagioclase 15 mica + hornblende 10	quartz 20 orthoclase 20 plagioclase 50 biotite + hornblende 10	orthoclase 55 plagioclase 25 quartz 5 biotite + hornblende + pyroxene 15	plagioclase 70 biotite + hornblende + pyroxene 30	plagioclase 60 pyroxene 40	pyroxene 50 olivine 50
--	---	--	---	-------------------------------	---------------------------

Source: <http://alexandriadarcy.com/tag/igneous-rocks/>

SOME ENGINEERING CONSIDERATIONS

- The use of igneous rocks in Portland cement as aggregates can cause problems related to volume expansion due to the alkali-silica reaction.
- Coarse grained igneous rocks are undesirable for use as aggregates for construction due the reduction of abrasion resistance with increasing aggregate size. The rock is less suitable for use as base coarse (in roads) or riprap (for slope protection along rivers and seacoasts).
- Weathered igneous rocks are to be avoided in dams, bridge piers.
- Igneous rocks are commonly used as dimension stone due to their resistance to weathering.