First year of Geomatics Department
Engineering Geology 2018
Lecture 5

# IGNEOUS ROCKS AND VOLCANOS



Dr. Eng. Hassan Mohamed

# IGNEOUS ROCKS

**Igneous rocks** (from the Greek word for **fire**) form from when hot, molten rock crystallizes and solidifies. The melt originates deep within the Earth near active plate boundaries or hot spots, then rises toward the surface.

Igneous rocks are produced this way but most igneous rocks are ***produced deep underground by the cooling and hardening of magma***. **Magma** is molten (melted) rock under the surface of the Earth. It is produced in **the upper reaches of the mantle** or in **the lowest areas of the crust** usually at a depth of **50 to 200** kilometers.

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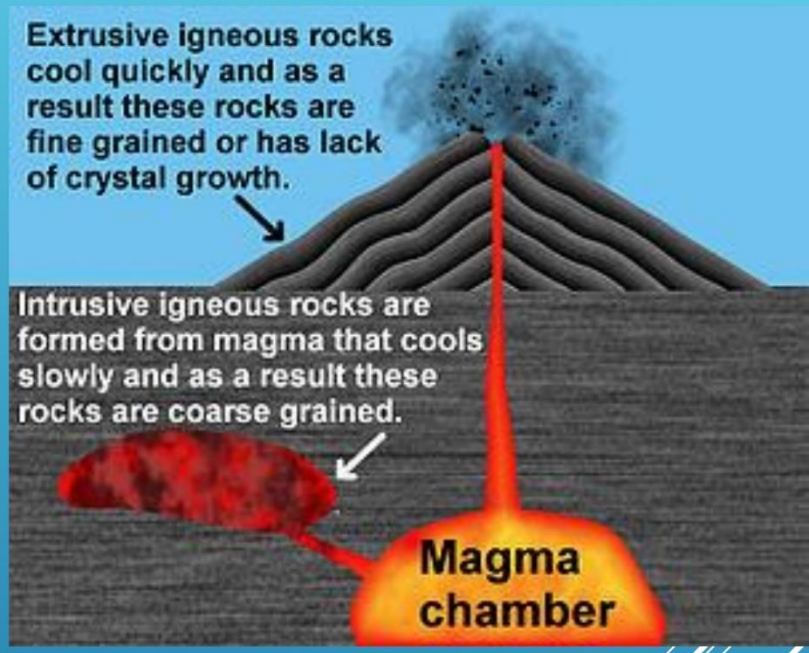
# IGNEOUS ROCKS

The magma can be derived from partial melts of existing rocks in either a planet's mantle or crust. Typically, the melting is caused by one or more of three processes: an ***increase in temperature, a decrease in pressure, or a change in composition***. Solidification into rock occurs either **below** the surface as **intrusive** rocks or **on** the surface as **extrusive** rocks.

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# INTRUSIVE IGNEOUS ROCKS:

Intrusive, or plutonic, igneous rock forms when magma **is trapped deep inside** the Earth. Great globs of molten rock rise toward the surface. Some of the magma may feed volcanoes on the Earth's surface, but most remains **trapped below**, where it cools very slowly over many thousands or millions of years until it **solidifies**.

Slow cooling means the individual mineral grains have a very long time to grow, so they grow to a relatively **large** size. Intrusive rocks have a **coarse grained texture**.

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# EXTRUSIVE IGNEOUS ROCKS:

**Extrusive**, or volcanic, igneous rock is produced when magma exits and **cools above** (or very near) the Earth's surface. These are the rocks that form at **erupting volcanoes and oozing fissures**.

The magma, called **lava** when molten rock erupts on the surface, cools and solidifies almost instantly when it is exposed to the relatively cool temperature of the atmosphere.

Quick cooling means that mineral crystals **don't have much time to grow,** so these rocks have a **very fine-grained or even glassy texture**. Hot gas bubbles are often trapped in the quenched lava, forming a bubbly, vesicular texture.

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# GEOLOGICAL SIGNIFICANCE

1. their minerals and global chemistry give information about the **composition** of the **mantle**, from which some igneous rocks are extracted, and the temperature and pressure conditions that allowed this extraction, and/or of other pre-existing rock that melted.
2. their **absolute ages** can be obtained from various forms of radiometric dating.
3. their features are usually characteristic of a specific **tectonic environment**, allowing tectonic **reconstitutions**.
4. in some special circumstances they host important mineral deposits (ores): for example, **tungsten** and **uranium** are commonly associated with **granites** and diorites, whereas ores of **chromium** and **platinum** are commonly associated with **gabbro**.

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# IGNEOUS ROCKS CLASSIFICATION

Igneous rocks are classified according to mode of occurrence, texture, mineralogy, chemical composition, and the geometry of the igneous body.

The classification of the many types of different igneous rocks can provide us with important information about the conditions under which they formed. Two important variables used for the classification of igneous rocks are particle size, which largely depends on the cooling history, and the mineral composition of the rock.

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# IGNEOUS ROCKS CLASSIFICATION

Feldspars, quartz or feldspathoids, olivines, pyroxenes, amphiboles, and micas are all important minerals in the formation of almost all igneous rocks, and they are basic to the classification of these rocks. All other minerals present are regarded as nonessential in almost all igneous rocks and are called accessory minerals. Types of igneous rocks with other essential minerals are very rare, and these rare rocks include those with essential carbonates.

Igneous rocks that have crystals large enough to be seen by the naked eye are called phaneritic; those with crystals too small to be seen are called aphanitic. Generally speaking, phaneritic implies an intrusive origin; aphanitic an extrusive one.

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# CHEMICAL CLASSIFICATION

Chemical: total alkali-silica content (TAS diagram) for volcanic rock classification used when modal or mineralogic data is unavailable:

1. felsic igneous rocks containing a high silica content, greater than 63% $SiO_2$ (examples granite and rhyolite),
2. intermediate igneous rocks containing between 52–63% $SiO_2$ (example andesite and dacite),
3. mafic igneous rocks have low silica 45–52% and typically high iron – magnesium content (example gabbro and basalt),
4. ultramafic rock igneous rocks with less than 45% silica (examples picrite, komatiite and peridotite),
5. alkalic igneous rocks with 5–15% alkali ($K_2O$ + $Na_2O$) content or with a molar ratio of alkali to silica greater than 1:6 (examples phonolite and trachyte).

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# MINERALOGICAL CLASSIFICATION

Mineralogic contents – felsic versus mafic:

1. felsic rock, highest content of silicon, with predominance of quartz, alkali feldspar and/or feldspathoids: the felsic minerals; these rocks (e.g., granite, rhyolite) are usually light coloured, and have low density.
2. mafic rock, lesser content of silicon relative to felsic rocks, with predominance of mafic minerals pyroxenes, olivines and calcic plagioclase; these rocks (example, basalt, gabbro) are usually dark coloured, and have a higher density than felsic rocks.
3. ultramafic rock, lowest content of silicon, with more than 90% of mafic minerals (e.g., dunite).

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# MINERALOGICAL CLASSIFICATION

The following table is a simple subdivision of igneous rocks according to both their composition and mode of occurrence.

| | Composition | | | |
|---|---|---|---|---|
| **Mode of occurrence** | Felsic | Intermediate | Mafic | Ultramafic |
| Intrusive | Granite | Diorite | Gabbro | Peridotite |
| Extrusive | Rhyolite | Andesite | Basalt | Komatiite |

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# BASALT

Basalt is made of **fine-grained** interlocking crystals (about **1mm** in size). It is **black** or **dark grey** in color, and often contains **bubbles** of **gas trapped** as the lava cooled.



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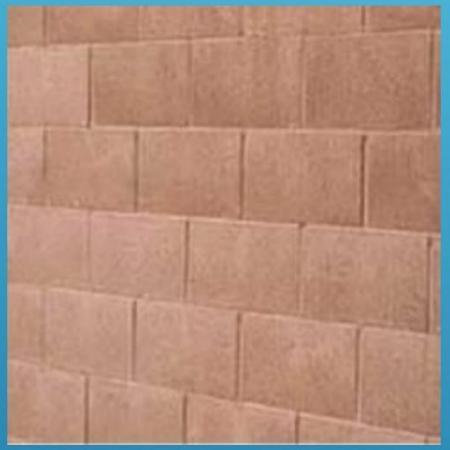
# PUMICE

**Pumice** is formed when **gas-rich magma** froths up to form a sort of "**mousse**". The lava is **glassy-looking** and is so full of **bubbles** that it floats on water.

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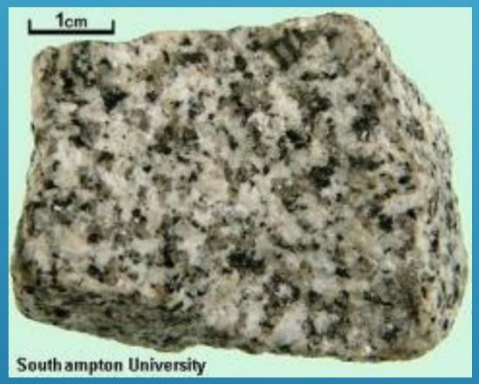
# GRANITE

**Granite** is made of **coarse-grained** (**5mm** or so) interlocking crystals. It has **more light colored** crystals than dark, usually of **white** or **pink** feldspar, glassy quartz, and shiny mica.



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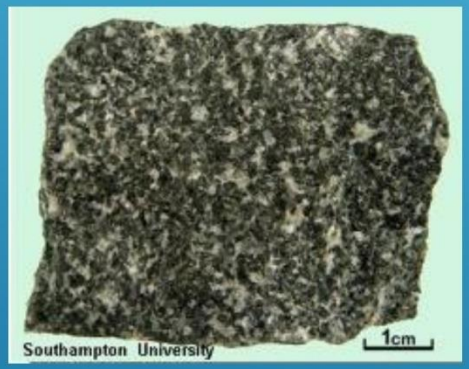
# GABBRO

Gabbro is made of **coarse-grained** (**5mm** or so) interlocking crystals. Its overall color **is dark grey** but it often contains **glassy** or pale-colored crystals of feldspar as well as dark minerals.





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# THANKS

Please visit the following links:

https://www.encyclopedia.com/earth-and-environment/geology-and-oceanography/geology-and-oceanography/igneous-rocks

https://en.wikipedia.org/wiki/QAPF_diagram

https://www.youtube.com/watch?v=PrN7jygu4cQ

https://www.youtube.com/watch?v=aCnAF1Opt8M

*https://www.youtube.com/watch?v=Zbz4e-9pjY4*



Dr. Eng. Hassan Mohamed