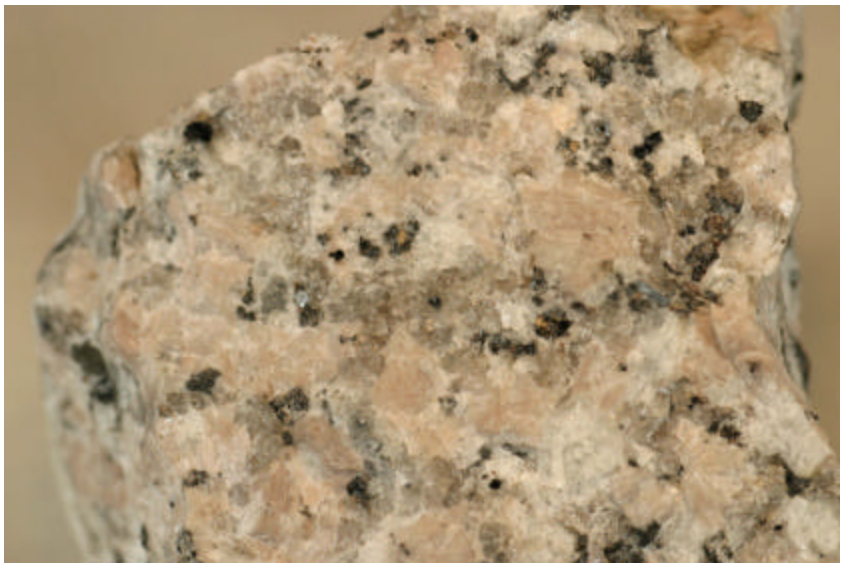
Geosciences 1030
Earthquakes and Volcanoes

Week 1 part 1

Introduction to Earth' materials:
Rocks and Minerals

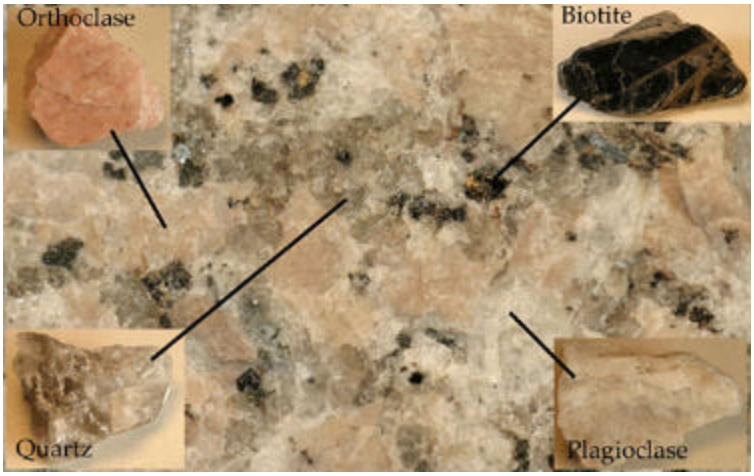
What is a rock? What is a mineral?
You see both in this slide. What are the definitions of a rock and a mineral? How are they different?



Rocks are made of minerals

Minerals- homogenous, solid, chemical compounds, with 3-D pattern to the arrangement of atoms, naturally occurring, inorganic

Minerals are not mixtures like most rocks. Examples of each of the four minerals in this rock are shown in the corners.

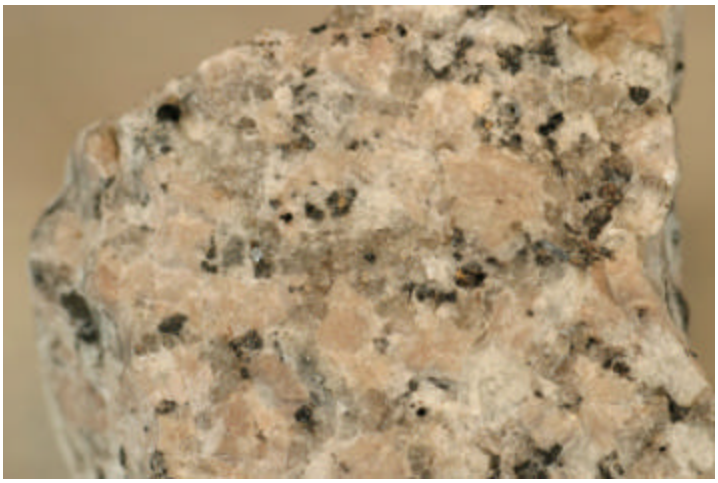


Minerals-

- **Homogenous** - they are the same throughout. They are not a mixture of different things as most rocks are. The minerals in the previous photograph are uniform in appearance compared to the rock
- **Solid-** no liquids or gases
- **Definate chemical composition-** each mineral species is a chemical compound that has its own chemical composition. For example, quartz is made of silicon and oxygen in the ratio of one silicon to two oxygens.
- **3-D pattern to the arrangement of atoms-** Some solids are a random mix of atoms with no pattern. Minerals have a definate pattern to the atomic structure.
- **Naturally occurring-** nothing made by humans is considered a mineral
- **Inorganic**- geological usage of term mineral varies from biological one. Minerals in a geological usage are created by processes that do not involve living organisms.

Rock- An aggregate of one or more minerals

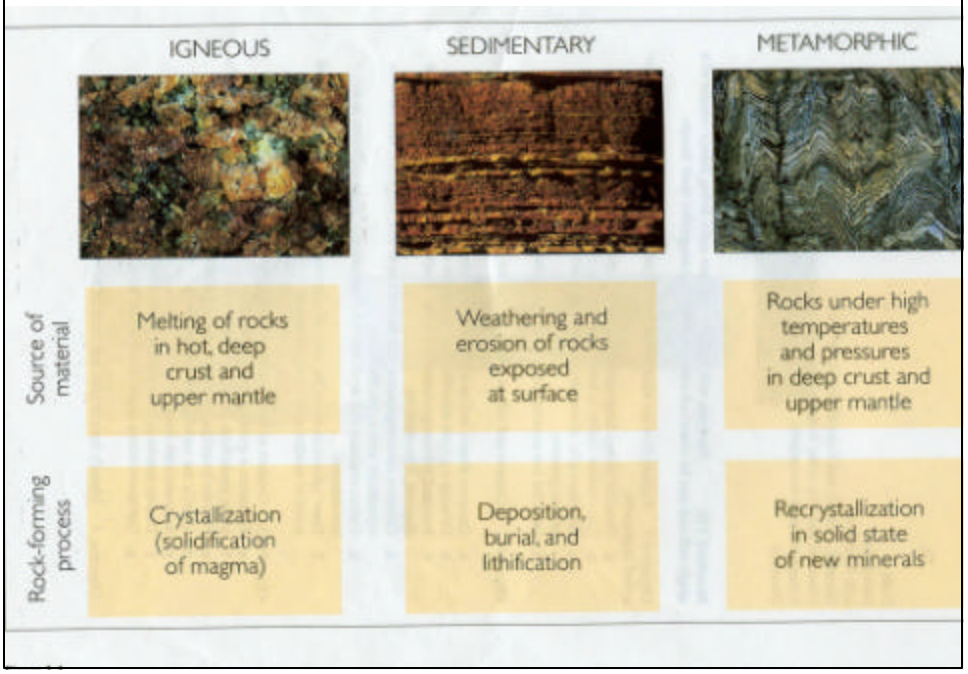
The Earth is made of rocks- different types of rocks in different parts of the Earth



Three types of Rocks

- Igneous
- Metamorphic
- Sedimentary

- Each of these types represents a different way that nature creates rocks within, or at the surface, of the Earth.



Process of crystallization
The formation of igneous rocks in more detail

1. Creation of interlocking textures between the mineral grains in igneous rocks. As the molten rock material cools it crystallizes or becomes solid. It is not an instantaneous process.

Note- We call molten rock material that is within the Earth a magma. If that material comes to the Earth's surface, we call it a lava.

Process of crystallization of magma or lava
is the formation of solid mineral grains growing from a liquid
a. atoms moving freely in the liquid begin to combine into solid compounds as they form bonds. These new solids are tiny grains of minerals
b. atoms are added layer-by-layer and the mineral grows
Note- figure is from your book

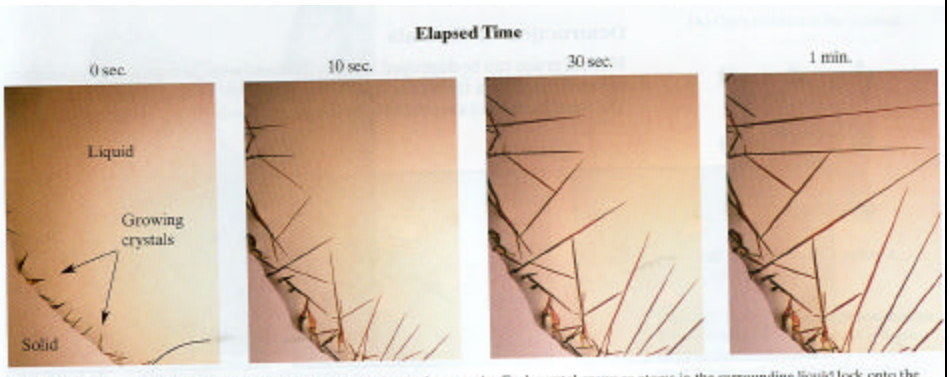


FIGURE 3.12 **Crystal growth** can be recorded by time-lapse photography. Each crystal grows as atoms in the surrounding liquid lock onto the outer faces of the crystal structure.

Minerals grow in geometric shapes unless their growth is inhibited by their surroundings
Figure from your text

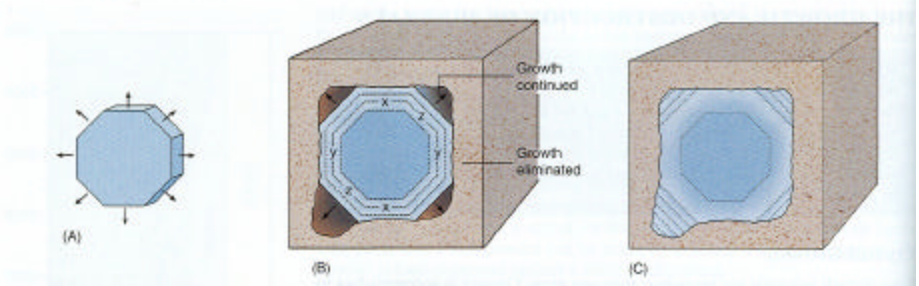


Figure 3.13 **Crystals growing in a restricted environment** do not develop perfect crystal faces. **(A)** Where growth is unrestricted, all crystal faces grow with equal facility. **(B)** In a restricted environment, growth on certain crystal faces, such as *x* and *y*, is terminated but growth on the faces labeled *z* continues. **(C)** The final shape of the crystal is determined by the geometry of the available space in which it grows.

In magmas/lavas many mineral grains are growing simultaneously. These grains grow into one another and form an interlocking texture.

At first there are very tiny solid grains that form, all floating in the liquid magma or lava. Many individual grains begin to grow, all separated by molten liquid. Over time, the grains grow larger as layer upon layer of new atoms bond to the initial tiny grain. Eventually, the grains grow so large that they start touching each other. This forms the interlocking texture of igneous rocks.

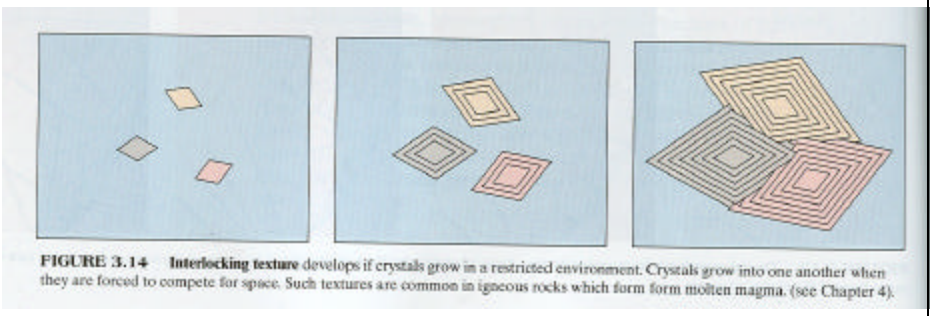
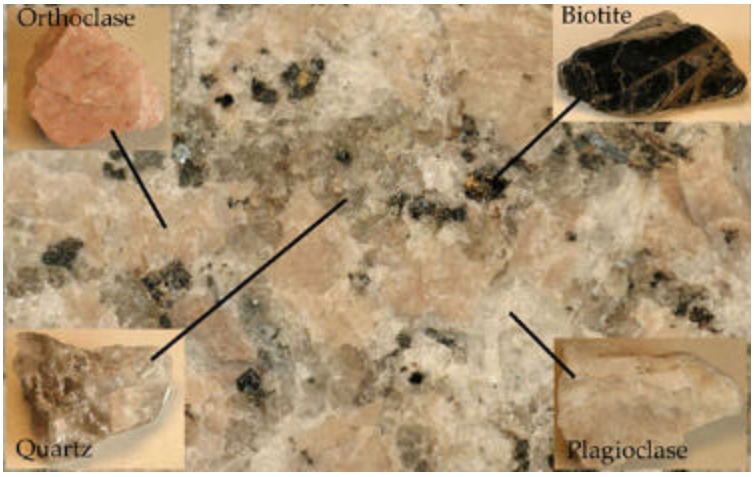


FIGURE 3.14 **Interlocking texture** develops if crystals grow in a restricted environment. Crystals grow into one another when they are forced to compete for space. Such textures are common in igneous rocks which form form molten magma. (see Chapter 4).

Interlocking texture in igneous rock. Mineral grains interlock like a 3-dimensional jigsaw puzzle.



Process of crystallization
The formation of igneous rocks in more detail

2. Cooling rate controls grain size

Sometimes the individual mineral grains are very large (see left side of next slide). Their large size comes from slow cooling and a lot of time for the individual mineral grains to grow. Coarse-grained rocks cool slowly within the Earth.

Fine-grained rocks (see right side of next slide) cool quickly, when lavas are erupted to Earth's surface. There is little time for the grains to grow before the rock solidifies.

The rock on the left is has very coarse mineral grains. The large pink grain in the center of the rock (with very straight edges) is just one individual mineral grain. The rock on the right is fine-grained. The photograph was taken with magnification (a penny would be about the size of the black area in the upper right corner). The grains are so tiny its hard to make them out.

In the case of igneous rocks, the mineral grains have an interlocking texture. But, it is important to determine if the rock is coarse-grained (cooled slowly) or fine-grained (cooled quickly).

Rocks that cooled from the same magma can have two different names. One name for the rock that cooled from magma in the Earth, another name for rock that cooled from the lava on Earth's surface.

Classification of 7 igneous rocks.
Classification is based on

- Texture- Size, shape, and arrangement of the mineral grains in the rock.

  For our purposes, we are most concerned about grain size (i.e. fine-grained versus coarse-grained).

- Chemical composition

More about chemical composition of igneous rocks

Almost all magmas (and resulting igneous rocks) are a mix of 8 chemical elements.

1) Silicon
2) Oxygen
3) Aluminum
4) Iron
5) Magnesium
6) Calcium
7) Potassium
8) Sodium

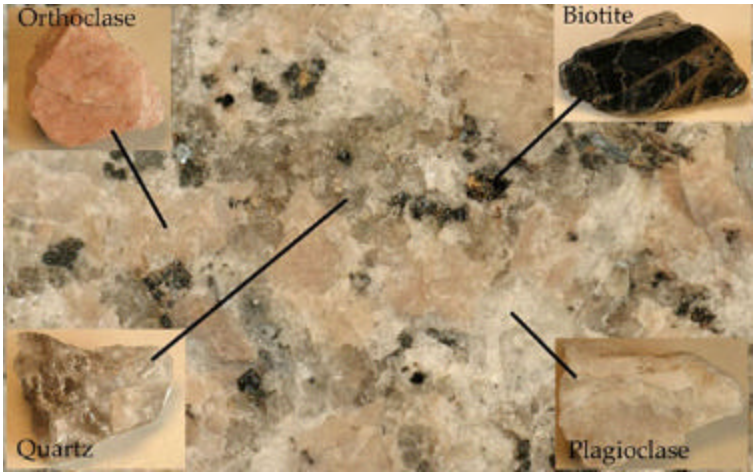
❖Silicon and oxygen bond together- we call this combination silica. ALL MAGMAS CONTAIN SILICA. Range from 33-75%

❖Different magmas contain different proportions of the 8 chemical elements. Magmas rich in silica are usually low in iron and magnesium. Magmas rich in iron and magnesium are low in silica.

❖Minerals rich in silica, aluminum, potassium and sodium are light in color. Igneous rocks that are rich in these minerals (and elements) are light in color.

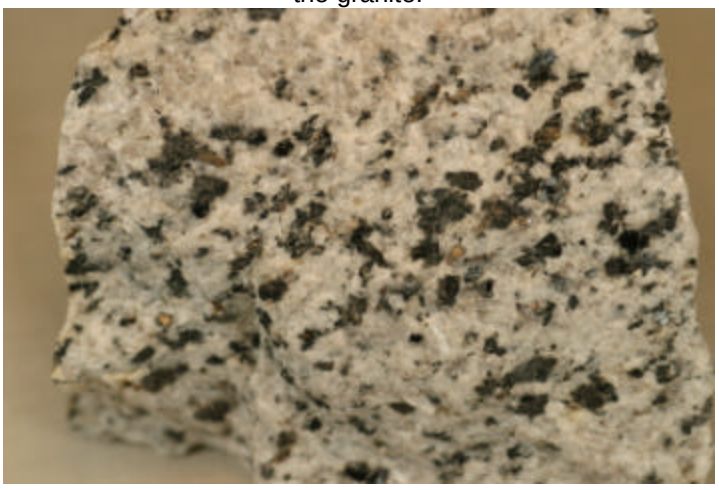
❖Minerals rich in iron and magnesium are dark in color. Igneous rocks that are rich in these minerals (and elements) are also dark in color.

Granite has abundance of light colored minerals and so is rich in silicon and oxygen (silica) and low in iron and magnesium



Diorite

A different rock from granite. Made from a different combination of minerals. This rock has more dark colored minerals. This rock is richer in iron and magnesium and poorer in silicon and oxygen (silica) than the granite.



Granite and Diorite
Both coarse-grained igneous rocks
The diorite contains more black minerals. It is richer in iron and magnesium and lower in silica.