ROCKS

Three Major Types of Rock

- The material that makes up the solid parts of Earth is known as *rock*.
- Based on the processes that form and change the rocks of Earth's crust, geologists classify rocks into three major types by the way the rocks form.

1. Igneous rock forms when magma, or molten rock, cools and hardens.

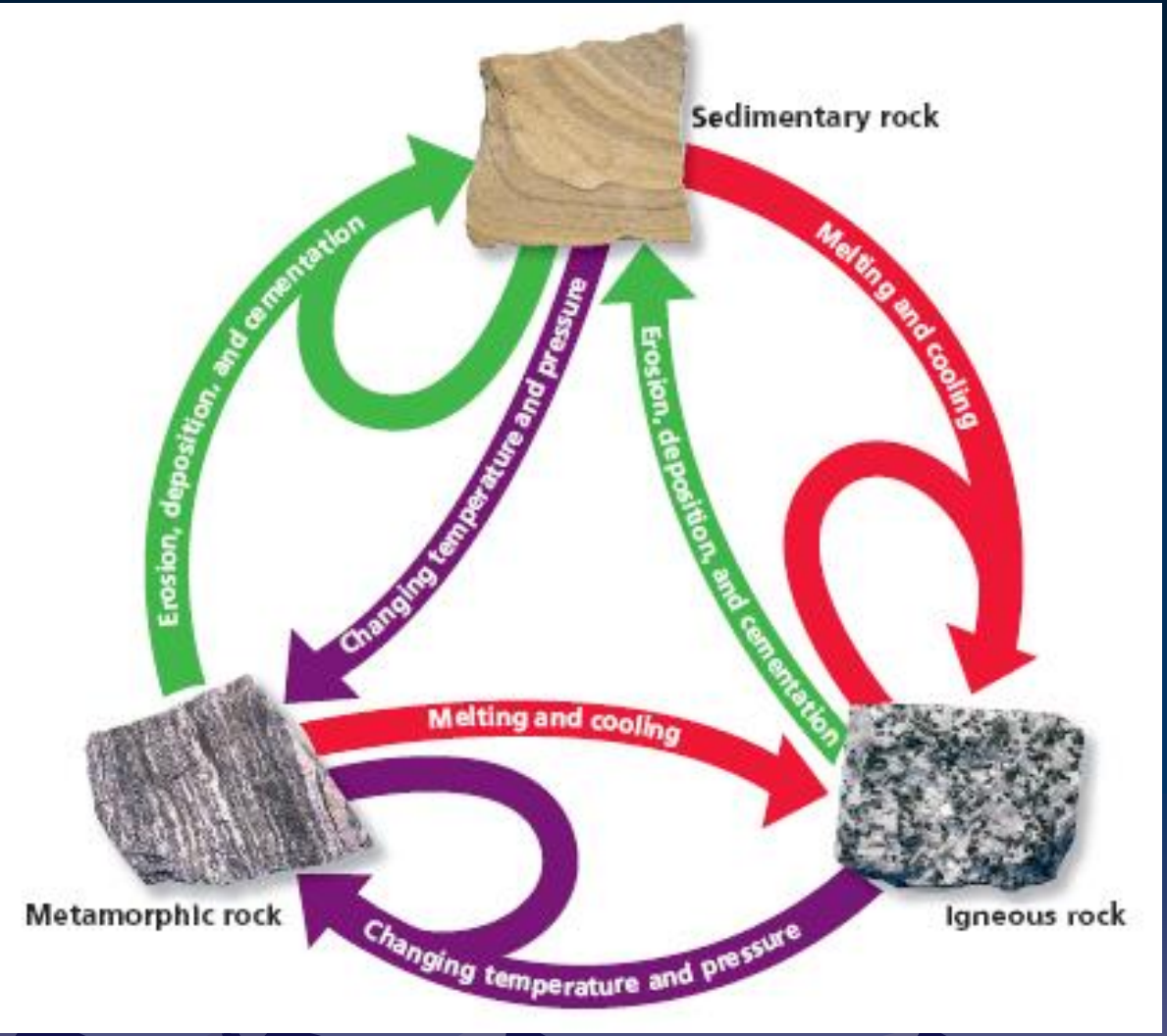
Three Major Types of Rock

2. Sedimentary rock forms when sediment deposits that form when rocks, mineral crystals, and organic matter have been broken into fragments, called *sediments*, are compressed or cemented together.
3. Metamorphic rock forms when existing rock is altered by changes in temperature, by changes in pressure, or by chemical processes.

The Rock Cycle

- Any of the three major types of rock can be changed into another of the three types.
- Geologic forces and processes cause rock to change from one type to another.
- **rock cycle** the series of processes in which rock forms, changes from one form to another, is destroyed, and forms again by geological processes

The Rock Cycle



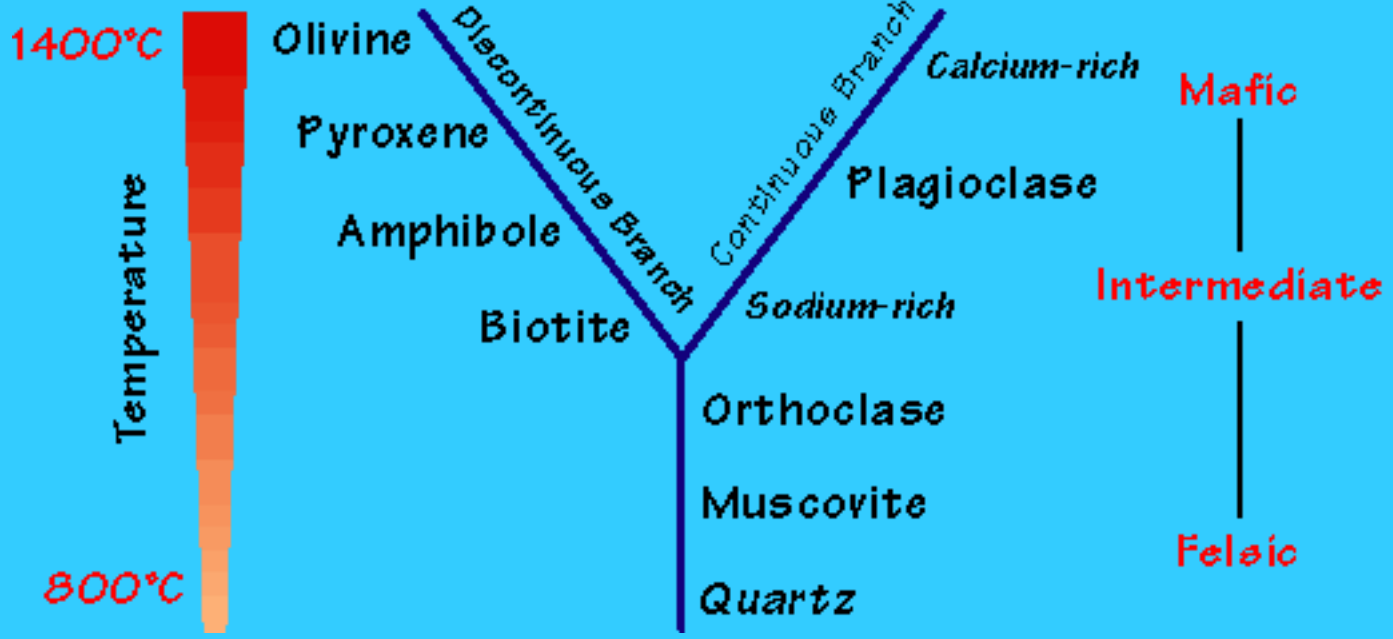
Properties of Rocks

The rate at which rock weathers and the way that rock breaks apart are determined by the chemical stability of the minerals in the rock.

Bowen's Reaction Series

- **Bowen's reaction series** the simplified pattern that illustrates the order in which minerals crystallize from cooling magma according to their chemical composition and melting point

Bowen's Reaction Series



Rock Cycle

- Play rock cycle
- Interactive rock cycle
- Rock cycle interactive
- Show how rocks are made

Properties of Rocks

Chemical Stability of Minerals

- *Chemical stability* is a measure of the tendency of a chemical compound to maintain its original chemical composition rather than break down to form a different chemical.

- The chemical stability of minerals is dependent on the strength of the chemical bonds between atoms in the mineral.

Physical Stability of Rocks

- Rocks have natural zones of weakness that are determined by how and where the rocks form.
- When rock that formed under intense pressure is uplifted to Earth's surface, decreased pressure allows the joints or fractures to open.
- Once these weaknesses are exposed to air and water, the processes of chemical and mechanical weathering begin.

IGNEOUS ROCK

Igneous rock forms when *magma* cools and hardens (*ignis-Latin)*: born of fire)

- The three factors that affect whether rock melts include temperature, pressure, and the presence of fluids in the rock.

- Rock melts when the temperature of the rock increases to above the melting point of minerals in the rock.

Igneous Rock, cont.

- Rock melts when excess pressure is removed from rock that is hotter than its melting point.
- Rock may melt when fluids, such as water, are added. The addition of fluids generally decreases the melting point of certain minerals in the rock.

Textures of Igneous Rocks

Igneous rocks are classified according to where magma cools and hardens.

- **intrusive igneous rock** forms from the slow cooling and solidification of magma beneath Earth's surface (larger crystals result)

- **extrusive igneous** rock forms from the quick cooling and solidification of *lava* at Earth's surface

Textures of Igneous Rocks

- The texture of igneous rock is determined by the size of the crystals in the rock. The size of the crystals in determined mainly by the cooling rate of the magma.

Coarse-Grained Igneous Rock:

- intrusive igneous rocks that cool slowly- commonly compose of large mineral crystals.

Fine-Grained Igneous Rock:

- extrusive igneous rocks that cool rapidly- commonly composed of small mineral grains.

Textures of Igneous Rocks

- ***porphyritic* texture**: When magma cools slowly at first, but then cools more rapidly as the magma nears or reaches Earth's surface, the igneous rock that forms may have large crystals embedded within a mass of smaller crystals.

- ***vesicular texture**:* When highly viscous magma cools very rapidly, few crystals will grow. When the magma contains a small amount of dissolved gases, a *glassy texture* will result. When the magma contains a large percentage of dissolved gases, the gases are trapped as bubbles in the rock.

Composition of Igneous Rock

Felsic Rock

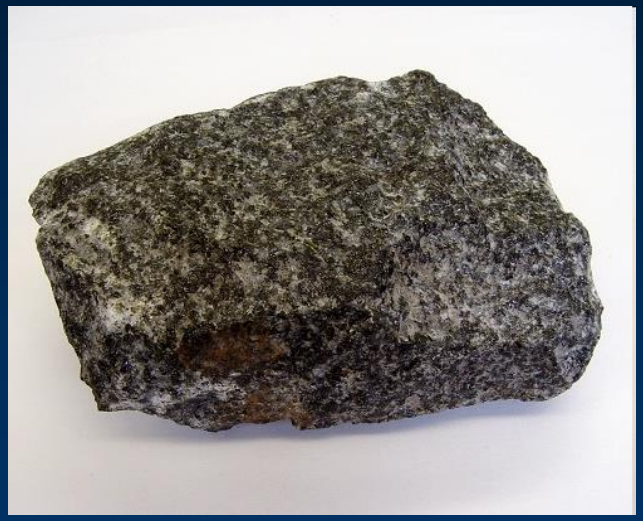
- **felsic** describes magma or igneous rock that is rich in feldspars and silica and that is generally light in color

- Common minerals in felsic rocks include potassium feldspar and quartz.

- The felsic family includes many common rocks, such as granite, rhyolite, obsidian, and pumice.

Composition of Igneous Rock

Mafic Rock



- **mafic** describes magma or igneous rock that is rich in magnesium and iron and that is generally dark in color
- Common minerals in mafic rocks include plagioclase feldspar and pyroxenes.
- The mafic family includes the common rocks basalt and gabbro.

Intermediate Rocks

- Rocks in the intermediate family contain lower proportions of silica than rocks in the felsic family do but contain higher proportions of silica than rocks in the mafic family do.
- Rocks in the intermediate family include diorite and andesite.

Practice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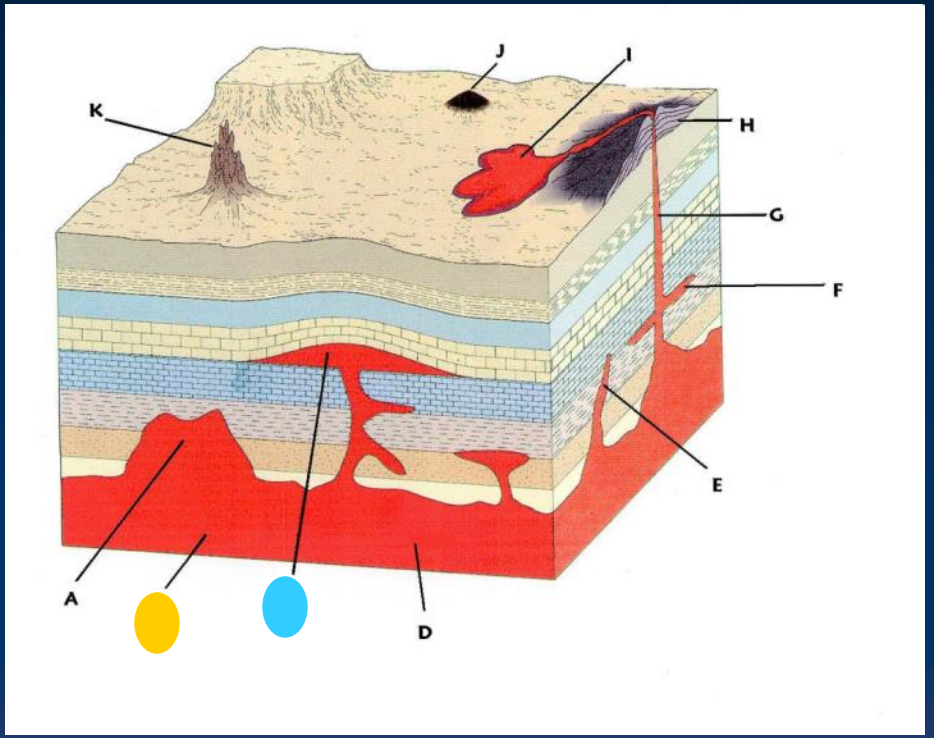
Igneous rock

- Play
- What the rocks are made of
- Formation and crystals

Intrusive Igneous Rock Structures

- **Batholiths** are intrusive formations that spread over at least 100 km^2 when they are exposed on Earth's surface.
- **Stocks** are similar to batholiths but cover less than 100 km^2 at the surface.

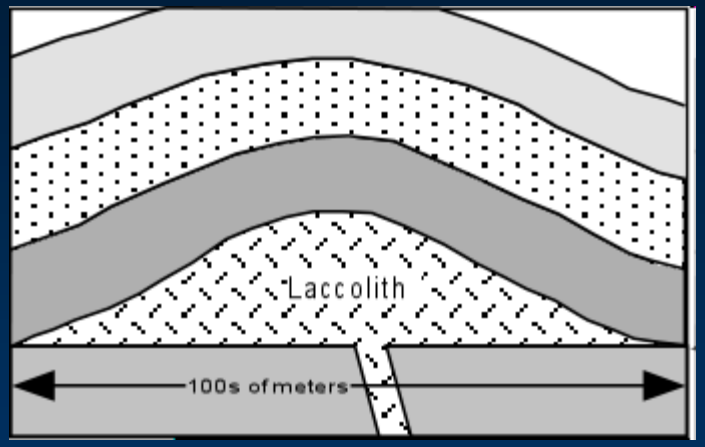


Sierra Nevada Batholith, CA

Intrusive Igneous Rock Structures

Laccoliths

- A laccolith is an intrusive formation that forms when magma flows between rock layers and pushes the overlying rock layers into a dome.



Intrusive Igneous Rock Structures

Sills and Dikes

- When magma flows between layers of rock and hardens to form a body of rock that is parallel to the layers of rock that surround it, a *sill* forms.
- When magma forces its way through rock layers by following existing fractures or by creating new fractures, a *dike* forms. Dikes cut across layers rather than lying parallel to the rock layers.
- Sills and dikes vary in thickness from a few centimeters to hundreds of meters.

Dike

Sill

Extrusive Igneous Rock Structures

- Igneous rock masses that form on Earth's surface are called *extrusions*.
- A *volcano* is a vent through which magma, gases, or volcanic ash is expelled. Volcanic cones and volcanic necks are common examples of extrusive igneous structures.
- Lava flows, lava plateaus, and tuff layers are other common extrusions.

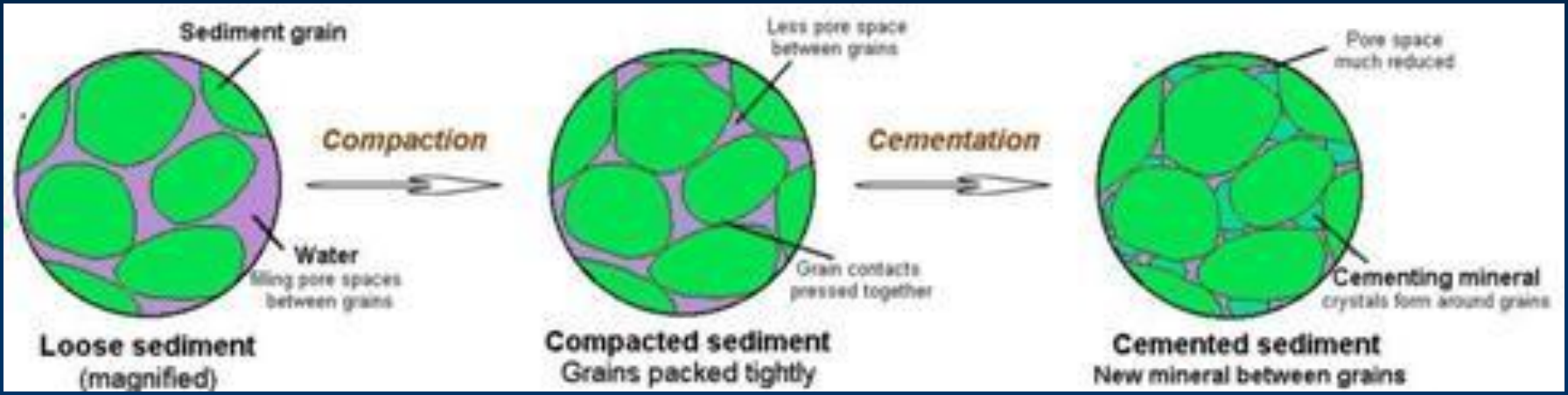
SEDIMENTARY ROCKS

- Most sedimentary rock is made up of combinations of different types of sediment, which is loose fragments of rock, minerals, and organic materials.

- Two main processes convert loose sediment into sedimentary rock:

1. **compaction** the process in which the volume and porosity of a sediment is decreased by the weight of overlying sediments as a result of burial beneath other sediments

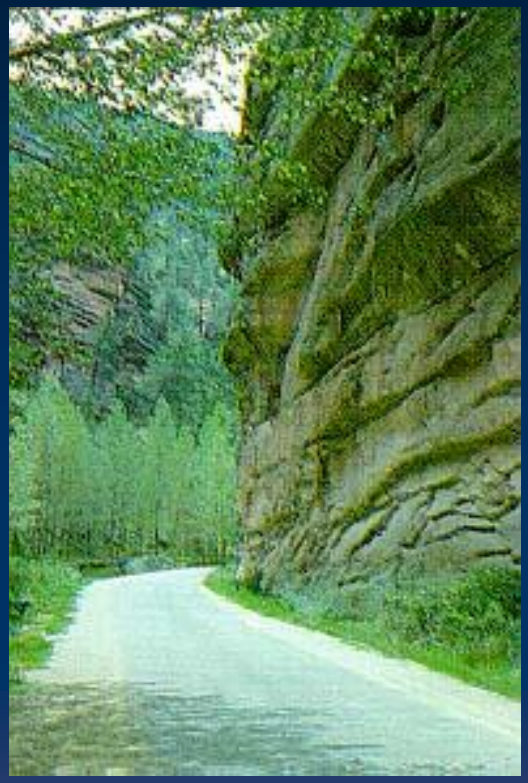
2. **cementation** the process in which minerals precipitate into pore spaces between sediment grains and bind sediments together to form rock



Formation of Sedimentary Rocks

- Geologists classify sedimentary rocks by the processes by which the rocks form and by the composition of the rocks.

- There are three main classes of sedimentary rocks—chemical, organic, and clastic, which is based on the shape, size, and composition of the sediments that form the rocks.



Chemical Sedimentary Rock

- **chemical sedimentary rock** forms when minerals precipitate from a solution or settle from a suspension
- When water evaporates, the minerals that were dissolved in the water are left behind. Eventually, the concentration of minerals in the remaining water becomes high enough to cause minerals to precipitate out of the water.
- Rocks that form through evaporation are called *evaporites*. Gypsum and halite are common evaporites.

Rock salt (mineral: halite)

Death Valley, CA

Bonneville Salt Flats, UT

Chapter me

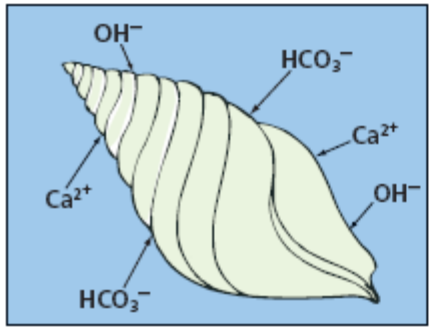
Organic Sedimentary Rocks

- **organic sedimentary rock** forms from the remains of plants or animals

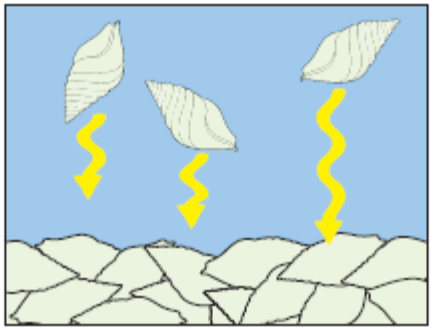
- Ex: Coal and some limestones
- Organic limestones form when marine organisms, such as coral, clams, oysters, and plankton, remove the chemical components of the minerals calcite and aragonite from sea water.

Organic Sedimentary Rocks

The organisms make their shells from these minerals, and when the organisms die, their shells settle to the bottom of the ocean, accumulate, and are compacted to form limestone.



Organisms that live in lakes or oceans take chemicals from the water and produce the mineral calcium carbonate, $CaCO_3$. They use the $CaCO_3$ to build their shells or skeletons.



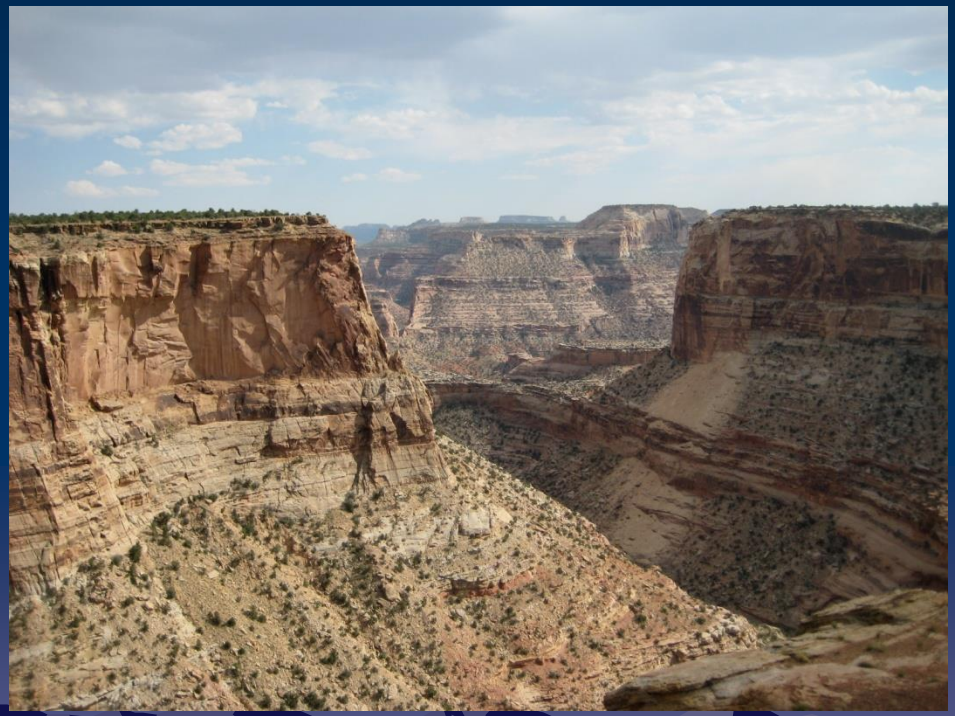
When the organisms die, the hard remains that are made of $CaCO_3$ settle to the lake or ocean floor.

The shells of the dead organisms pile up. Eventually, the layers are compacted and cemented to form limestone.

Limestone and Coral Fossils from Ireland

Clastic Sedimentary Rock

- **clastic sedimentary rock:** forms when fragments of preexisting rocks are compacted or cemented together



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Resources

- Rock that contains large, rounded pieces is called *conglomerate*. Rock that contains large, angular pieces is called *breccia*.

- Rock that is composed of sand-sized grains is called *sandstone*. Rock that is composed of clay-sized particles is called shale.

Characteristics of Clastic Sediments

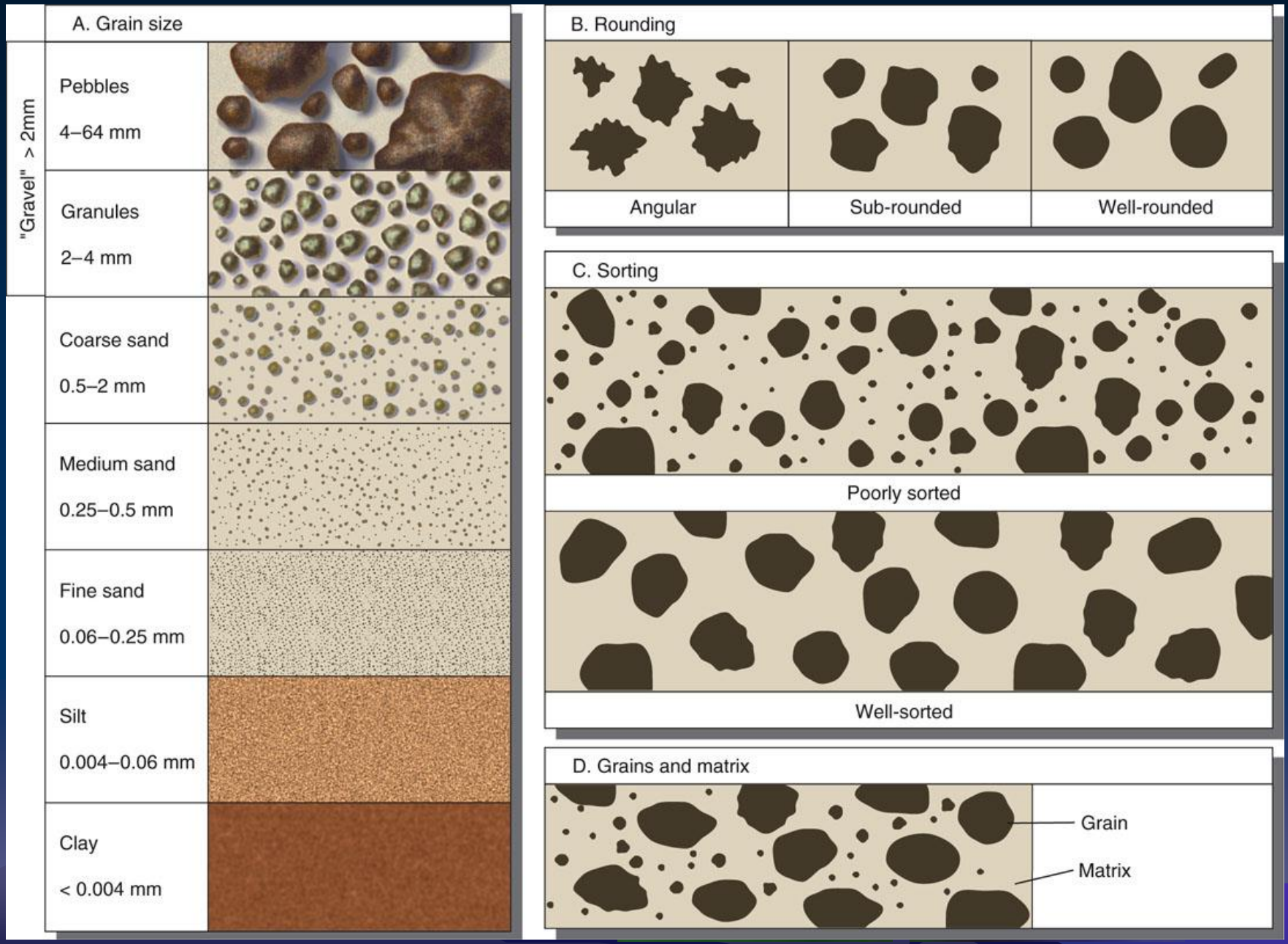
- The physical characteristics of sediments are determined mainly by the way sediments were transported to the place where they are deposited.

- four main transportation agents: water, ice, wind, and the effects of gravity.

Characteristics of Clastic Sediments

Sorting: The tendency for currents of air or water to separate sediments according to size is called sorting.

- When particles first break from the source, they tend to be angular and uneven. Particles that have moved long distances from the source tend to be rounded and smooth. In general, the farther sediment travels from its source, the finer and smoother the particles of sediment become.



Sedimentary Rock Features

- The setting in which sediment is deposited is called a *depositional environment*.

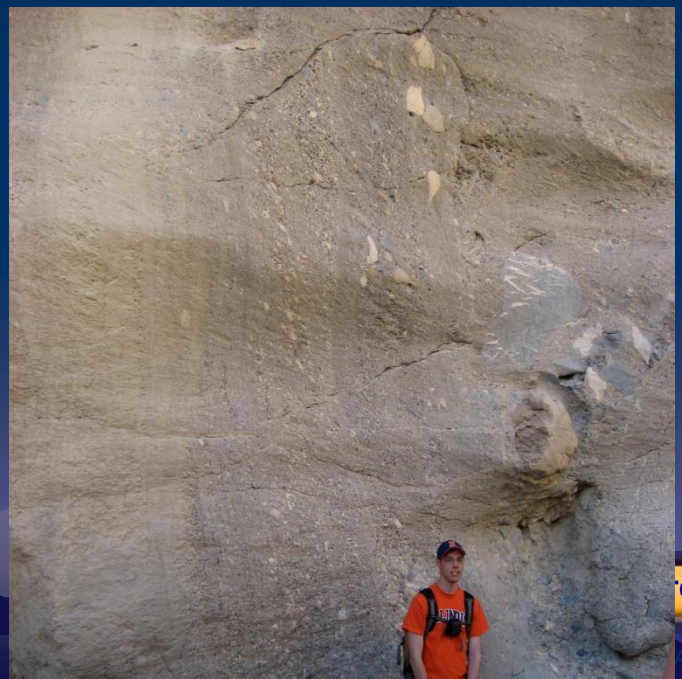
Stratification: Layering of sedimentary rock. Stratified layers, also called *beds*, vary in thickness and composition.

Sedimentary Rock Features

Cross-Beds and Graded Bedding

- Cross-beds, or slanting layers within rock strata, commonly form in sand dunes or river beds.

- Graded bedding is a feature in which various sizes and kinds of materials are deposited in one layer, with the largest grains at the bottom and finest grains at the top.



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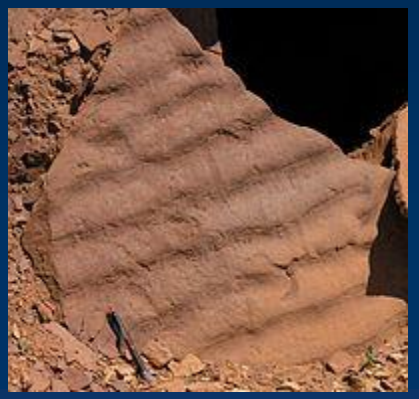
Sedimentary Rock Features

- **Ripple Marks:** formed from the agitation of water or wind, and the ripples are preserved in the rock.
- Ex: water or wind currents



Sedimentary Rock Features

- **Mud Cracks:** form when muddy deposits dry and shrink. The shrinking causes the drying mud to crack.

- Mud cracks form on river floodplains or on dry lake beds.

- **Fossils:** the remains of once living organisms that are preserved in rock.

- Concretions are lumps of minerals that precipitate from fluids and build up around a nucleus or in a cavity in existing rock.

Sedimentary Rock

- Play formation of sedimentary rock
- Unconformity of sedimentary rock
- Formation of coal, natural gas …

METAMORPHIC ROCKS

- **Metamorphism:** the process in which one type of rock changes into metamorphic rock because of chemical processes or changes in temperature and pressure

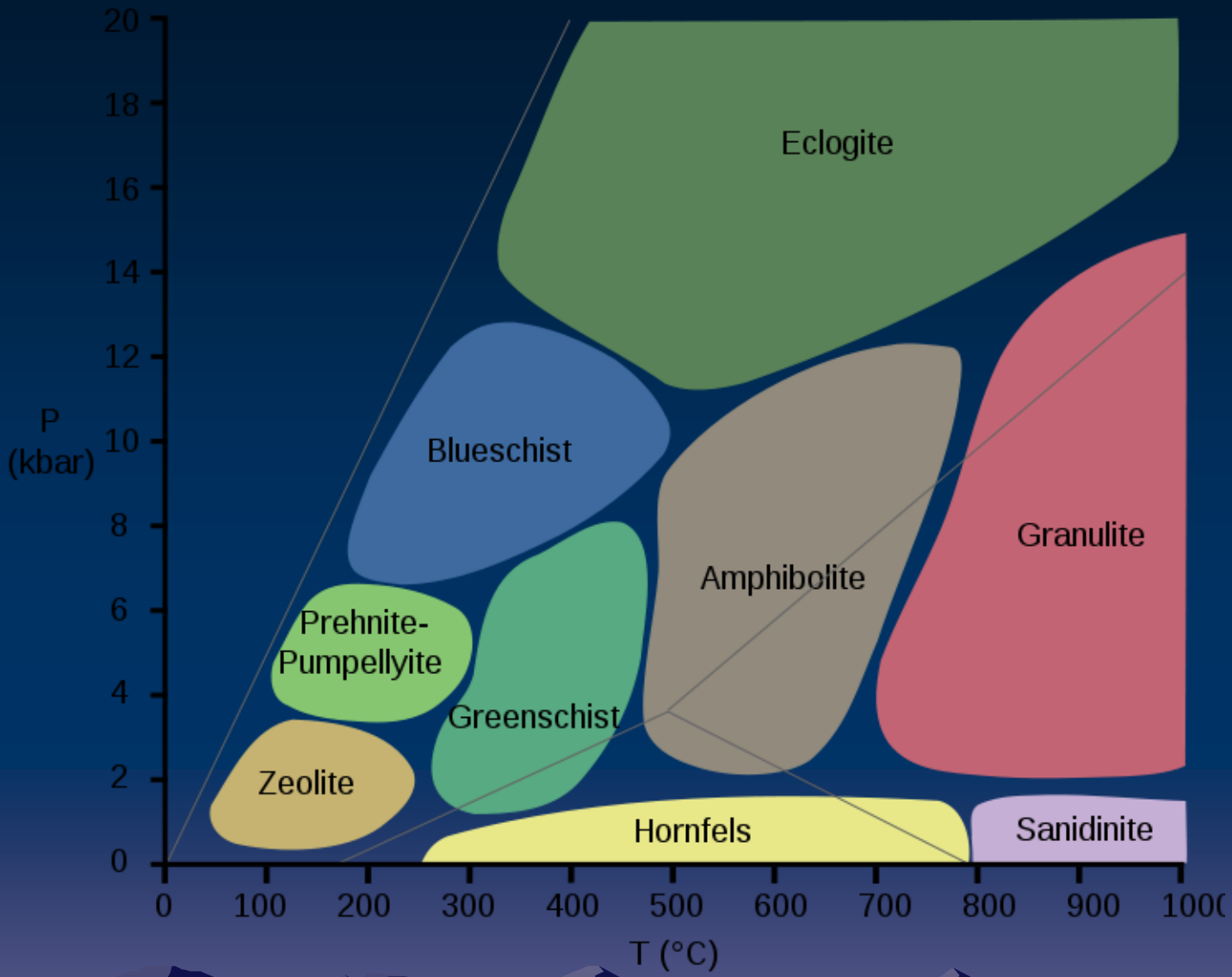
- During metamorphism, heat, pressure, and hot fluids cause some minerals to change into other minerals.

- Minerals may also change in size or shape, or they may separate into parallel bands that give the rock a layered appearance.

- Hot fluids may circulate through the rock and change the mineral composition of the rock by dissolving some materials and by adding others.

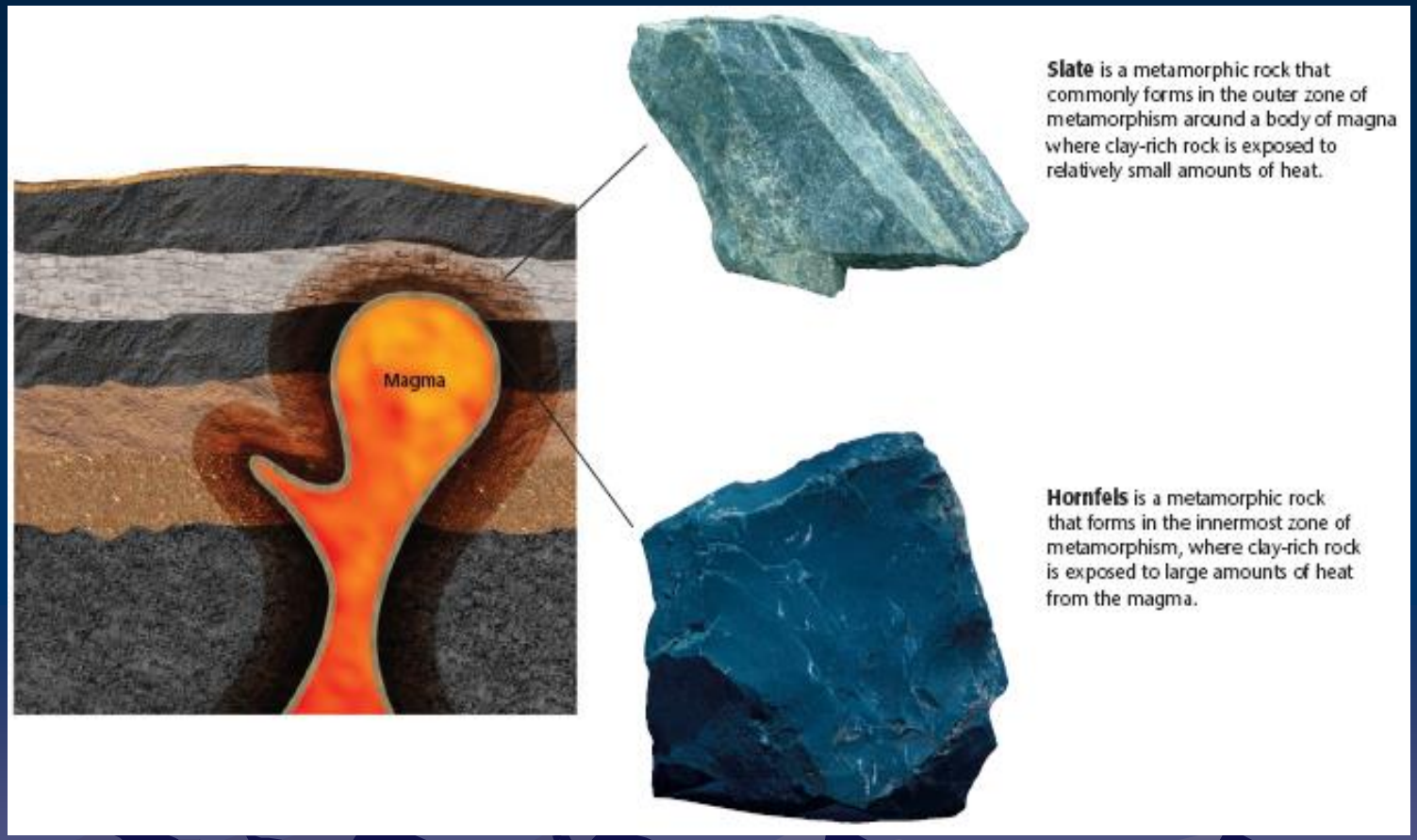
Formation of Metamorphic Rocks

- The type of rock that forms because of metamorphism can indicate the conditions under which the original rock changed.
- The composition of the rock being metamorphosed, the amount and direction of pressure, and the presence or absence of certain fluids cause different combinations of minerals to form.
- Two types of metamorphism occur in Earth's crust—contact metamorphism and regional metamorphism.



Formation of Metamorphic Rocks

The diagram below shows how the type of rock that forms during meta-morphism indicates the conditions under which the metamorphism occurred.



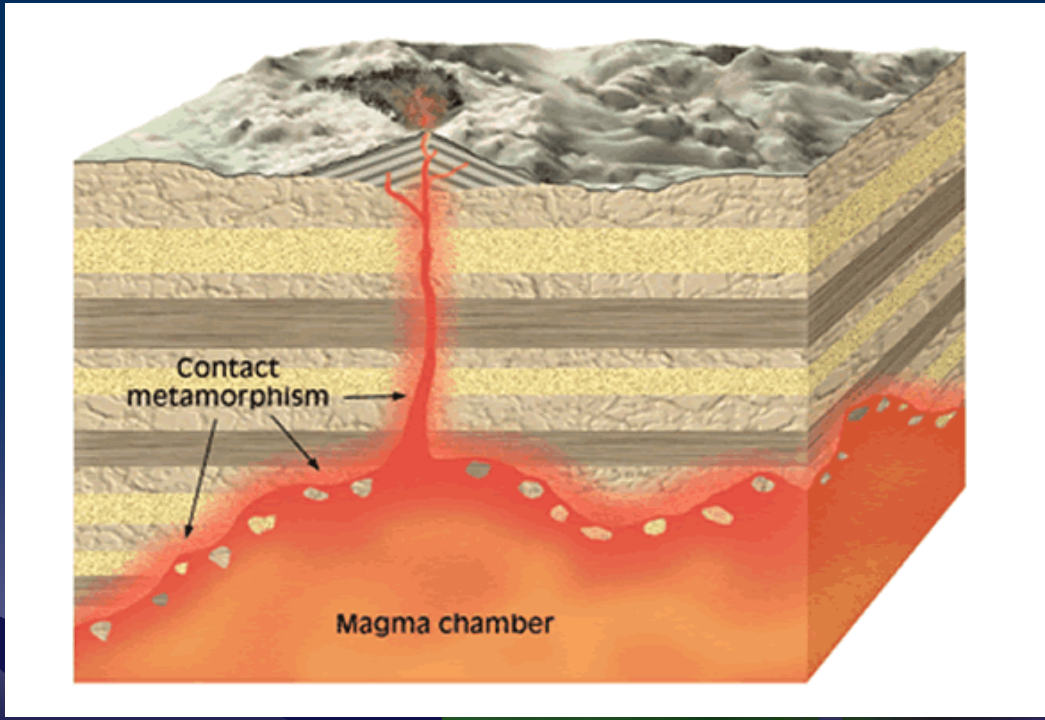
Slate: clay rich rock exposed to low heats

Hornfels: clay rich rock exposed to high heats

Formation of Metamorphic Rocks

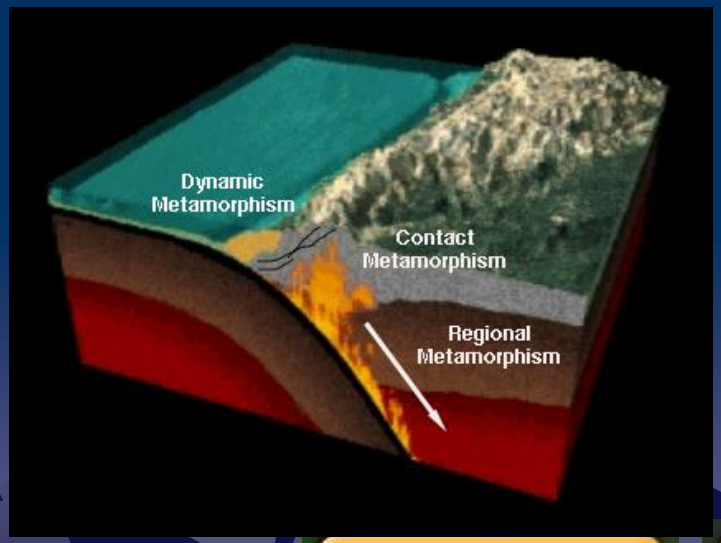
Contact Metamorphism

- **contact metamorphism** a change in the texture, structure, or chemical composition of a rock due to contact with magma



Regional Metamorphism

- **regional metamorphism** a change in the texture, structure, or chemical composition of a rock due to changes in temperature and pressure over a large area, generally are a result of tectonic forces



Foliated Rocks

- **foliation** the metamorphic rock texture in which minerals grains are arranged in planes or bands
- Extreme pressure may cause the mineral crystals in the rock to realign or regrow to form parallel bands.
- Foliation also occurs as minerals that have different compositions separate to produce a series of alternating dark and light bands.

Foliated Rocks

- Foliated metamorphic rocks include the common rocks slate, schist, and gneiss.

These rocks form from igneous rocks or clay rocks like shale.

Nonfoliated Rocks

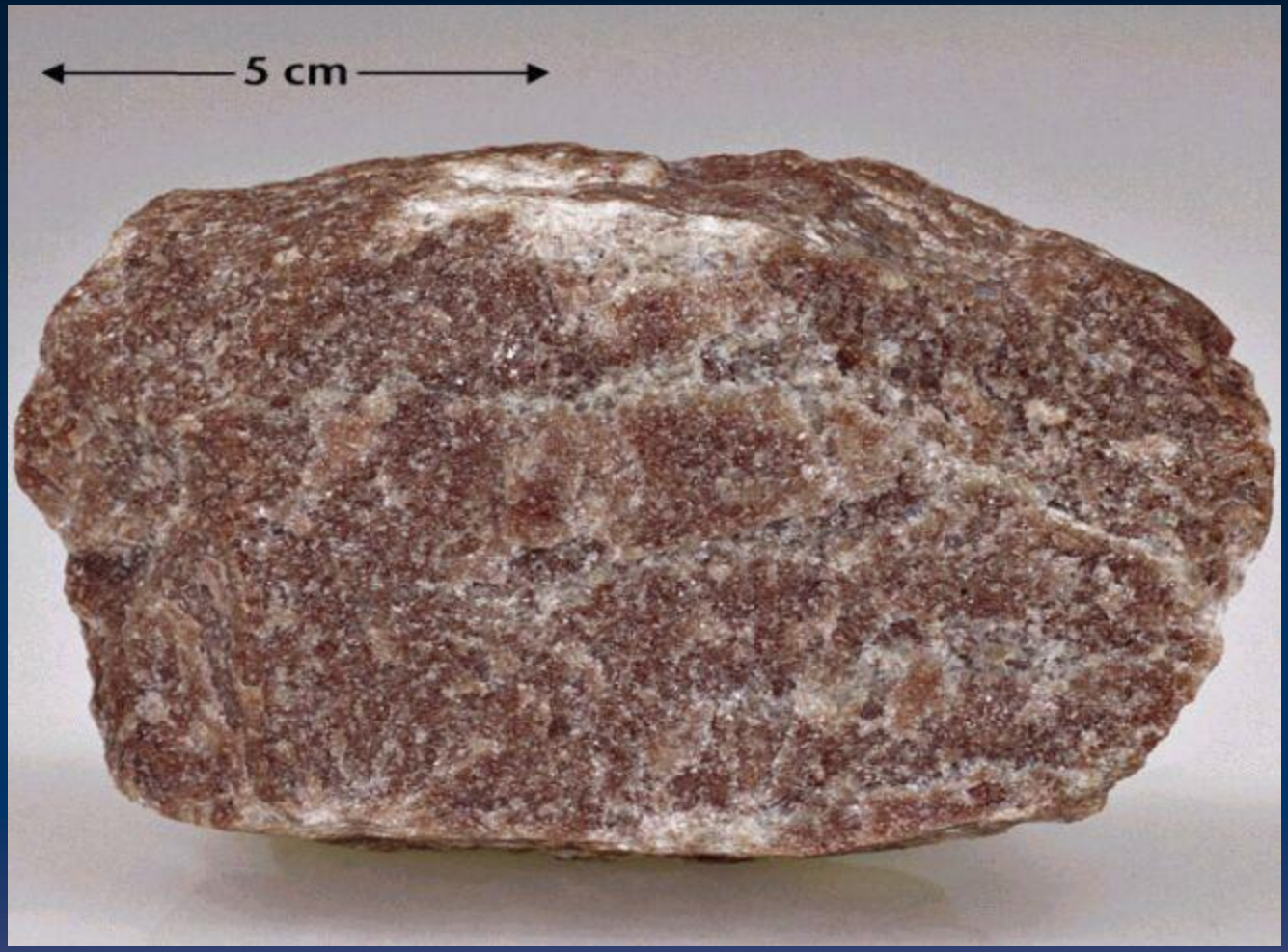
- **nonfoliated** the metamorphic rock texture in which minerals grains are not arranged in planes or bands

- Many nonfoliated metamorphic rocks contain grains of only one mineral or contain very small amounts of other minerals. Thus, the rock does not form bands of different minerals.

- Other nonfoliated metamorphic rocks contain grains that are round or square. These grains are unlikely to change shape or position when exposed to directed pressure.

Nonfoliated Rocks

- Nonfoliated metamorphic rocks include the common rocks marble and quartzite.



Chapter menu

Resources

Quick review of Metamorphic rock

- Metamorphic rocks are rocks that have changed from one form to another.
- These rocks form deep in the earth where the it is very hot and there is a lot of pressure.
- If a rock is heated and squeezed for millions of years, it can turn into a new kind of rock.
- Metamorphic rocks begin to form at 12-16 kilometers (7.5 - 10 miles) beneath the surface of the earth.

Quick review of Meta rock

- They begin changing at temperatures of 100 - 800 degrees Celsius (212 - 1472 degrees Fahrenheit)
- The heat in the earth comes from Magma and the pressure comes from layers of rock piled onto layers of rock.
- The layers on the bottom get squeezed and the thicker the layers the more pressure or the more they get squeezed.

Metamorphic rocks

- Play
- More meta rocks

How all 3 rocks are made?

- Play