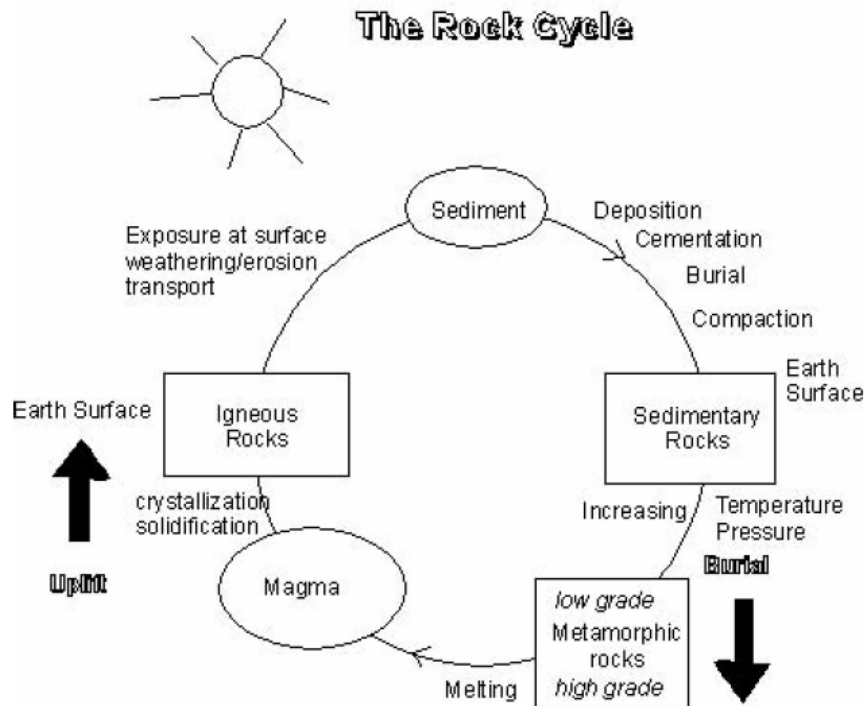


MODULE2
GEO 003 (Engineering Geology)



Melting

At one time the surface of the earth probably was entirely molten. Therefore it can be said that all crystal materials were ultimately derived from **magma** (molten rock). For this reason, discussion of the rock cycle begins with the cooling of magma. As liquids are cooled, they begin to form a solid, with the temperature of solidification depending on the composition of the liquid. Magma begins to solidify at between ~800-1200 °C, depending on the exact composition and conditions of cooling (e.g. water content, pressure, etc). This cooling usually produces mineral grains (crystals) and is therefore called **crystallization**.

Magma that flows out onto the earth's surface (**lava**) cools very rapidly to form rocks with small (microscopic) crystals or a glass (non-crystalline). These rapidly cooled rocks are called **volcanic igneous rocks** (Vulcan = Greek God of Fire). If magma does not reach the earth's surface, but cools and solidifies in the upper reaches of the crust, we call the result a **plutonic igneous rock** (Pluto = Greek God of the Underworld). The rock layers surrounding and overlying plutonic rocks act as an insulating blanket, causing this type of rock to cool and solidify very slowly. This allows crystals in plutonic rocks to grow much larger than their volcanic counterparts, and it is not unusual for plutonic rocks to consist entirely of large (megascopic) crystals.

Weathering

When rocks are exposed at the earth's surface (by volcanism, uplift of mountains, etc) they are placed in an environment that is inherently different than the environment in which they formed, or in which they were derived. Consequently, rocks exposed at the earth's surface begin to break down under a process called **weathering**. Weathering can be classified in two broad categories. **Mechanical weathering** is the physical breakdown of rocks (i.e. breaking of big rocks into little rocks). This may happen through rock fall, landslides, wedging & cracking by tree roots, water freezing and expanding, etc. **Chemical weathering** is the chemical breakdown of minerals (the primary constituents of rocks) to form minerals that are more stable on the earth's surface. For example, metallic iron, when exposed to air and water, will change to rust, a substance of quite a different chemistry (a combination of oxygen, iron and water).

Erosion & transport

As weather breaks rocks down, they are eventually removed from their place of origin by **erosion**. The weathered material (sediment), can be transported by:

1. **Water** - In the form of rivers & streams, wave action on the beach, ocean currents, etc
2. **Air** - As wind blows dust, sand, etc.
3. **Ice** - Flowing down slope as glaciers
4. **Mass Movement** - Simply the down slope movement of material driven by its own weight (e.g. landslides, mudflows, etc).

Sediment includes things like sand, gravel and clay, as well as bones, shells, and other organically-derived remains.

Deposition & lithification

Transported sediment is eventually deposited at some location, called the **depositional environment**. Sand dunes, beaches, river floodplains, lake bottoms and gravel bars are all examples of specific sedimentary environments. As sediment is buried deeper and deeper under newer sediment, it begins to undergo compaction, and eventually solidifies, forming a true sedimentary rock. Solidification of a sedimentary rock is called **lithification**, and most commonly occurs through a process of **cementation**, caused by precipitation of minerals between the sediment particles, which binds the rock together. Any material within a sedimentary rock that is an indication of past life is called a **fossil**; nearly all fossils occur in sedimentary rocks.

Metamorphism

If burial of rock continues to greater depths, the rock becomes subjected to increasingly high temperatures and pressures. Very often, these conditions cause the mineralogical composition of the rock to change through solid-state recrystallization. This process is called **metamorphism**, and produces metamorphic rock. These “changed rocks” which have been effected by relatively low pressures and temperatures are **low-grade** metamorphic rocks, while the most strongly altered metamorphic rocks are **high-grade** metamorphic rocks. Very often high-grade metamorphic rocks show evidence of flowage or partial melting, attesting to the extreme geologic conditions they have experienced.

Completing the cycle

When rocks are exposed to extremely high temperatures, they eventually melt and form magma, thus completing the rock cycle. There are several ways in which the complete rock cycle can be interrupted, however. For example, a metamorphic rock may be uplifted and eroded, without ever melting to form an igneous rock. Other “shortcuts” are also possible.

SOURCE: <http://pasadena.wr.usgs.gov/>

Identification of Igneous Rocks

Grain Size	Usual Color	Other	Composition	Rock Type
fine	dark	glassy appearance	lava glass	<u>Obsidian</u>
fine	light	many small bubbles	lava froth from sticky lava	<u>Pumice</u>
fine	dark	many large bubbles	lava froth from fluid lava	<u>Scoria</u>
fine or mixed	light	contains <u>quartz</u>	high-silica lava	<u>Felsite</u>
fine or mixed	medium	between felsite and basalt	medium-silica lava	<u>Andesite</u>
fine or mixed	dark	has no quartz	low-silica lava	<u>Basalt</u>
mixed	any color	large grains in fine-grained matrix	large grains of feldspar, <u>quartz</u> , pyroxene or <u>olivine</u>	<u>Porphyry</u>
coarse	light	wide range of color and grain size	feldspar and quartz with minor mica, amphibole or pyroxene	<u>Granite</u>
coarse	light	like granite but without quartz	feldspar with minor mica, amphibole or pyroxene	<u>Syenite</u>
coarse	light to medium	little or no <u>alkali feldspar</u>	<u>plagioclase</u> and quartz with dark minerals	<u>Tonalite</u>
coarse	medium to dark	little or no quartz	low-calcium plagioclase and dark minerals	<u>Diorite</u>
coarse	medium to dark	no quartz; may have <u>olivine</u>	high-calcium plagioclase and dark minerals	<u>Gabbro</u>
coarse	dark	dense; always has <u>olivine</u>	olivine with amphibole and/or pyroxene	<u>Peridotite</u>
coarse	dark	dense	mostly pyroxene with olivine and amphibole	<u>Pyroxenite</u>
coarse	green	dense	at least 90% olivine	<u>Dunite</u>
very coarse	any color	usually in small intrusive bodies	typically granitic	<u>Pegmatite</u>

Identification of Sedimentary Rocks

Hardness	Grain Size	Composition	Other	Rock Type
hard	coarse	clean <u>quartz</u>	white to brown	<u>Sandstone</u>
hard	coarse	<u>quartz</u> and <u>feldspar</u>	usually very coarse	<u>Arkose</u>
hard or soft	mixed	mixed sediment with rock grains and clay	gray or dark and "dirty"	<u>Wacke/</u> <u>Graywacke</u>
hard or soft	mixed	mixed rocks and sediment	round rocks in finer sediment matrix	<u>Conglomerate</u>
hard or soft	mixed	mixed rocks and sediment	sharp pieces in finer sediment matrix	<u>Breccia</u>
hard	fine	very fine sand; no clay	feels gritty on teeth	<u>Siltstone</u>
hard	fine	<u>chalcedony</u>	no fizzing with acid	<u>Chert</u>
soft	fine	clay minerals	splits in layers	<u>Shale</u>
soft	fine	carbon	black; burns with tarry smoke	<u>Coal</u>
soft	fine	<u>calcite</u>	<u>fizzes with acid</u>	<u>Limestone</u>
soft	coarse or fine	<u>dolomite</u>	<u>no fizzing with acid unless powdered</u>	<u>Dolomite rock</u>
soft	coarse	fossil shells	mostly pieces	<u>Coquina</u>
very soft	coarse	<u>halite</u>	salt taste	<u>Rock Salt</u>
very soft	coarse	<u>gypsum</u>	white, tan or pink	<u>Rock Gypsum</u>

Identification of Metamorphic Rocks

Foliation	Grain Size	Hardness	Usual Color	Other	Rock Type
foliated	fine	very soft	light	greasy feel	<u>Soapstone</u>
foliated	fine	soft	dark	"tink" when struck	<u>Slate</u>
foliated	fine	soft	dark	shiny; crinkly foliation	<u>Phyllite</u>
foliated	coarse	hard	mixed dark and light	crushed and stretched fabric; deformed large crystals	<u>Mylonite</u>
foliated	coarse	hard	mixed dark and light	wrinkled foliation; often has large crystals	<u>Schist</u>
foliated	coarse	hard	mixed	banded	<u>Gneiss</u>
foliated	coarse	hard	mixed	distorted "melted" layers	<u>Migmatite</u>
foliated	coarse	hard	dark	mostly hornblende	<u>Amphibolite</u>
nonfoliated	fine	soft	greenish	shiny, mottled surface	<u>Serpentinite</u>
nonfoliated	fine or coarse	hard	dark	dull and opaque colors, found near intrusions	<u>Hornfels</u>
nonfoliated	coarse	hard	red and green	dense; garnet and pyroxene	<u>Eclogite</u>
nonfoliated	coarse	soft	light	<u>calcite</u> or <u>dolomite</u> by the <u>acid test</u>	<u>Marble</u>
nonfoliated	coarse	hard	light	<u>quartz</u> (no fizzing with acid)	<u>Quartzite</u>

SOURCE: *geology.about.com*

STUDY:

1. Minerals
2. Moh's hardness scale
3. Bowen's reaction series