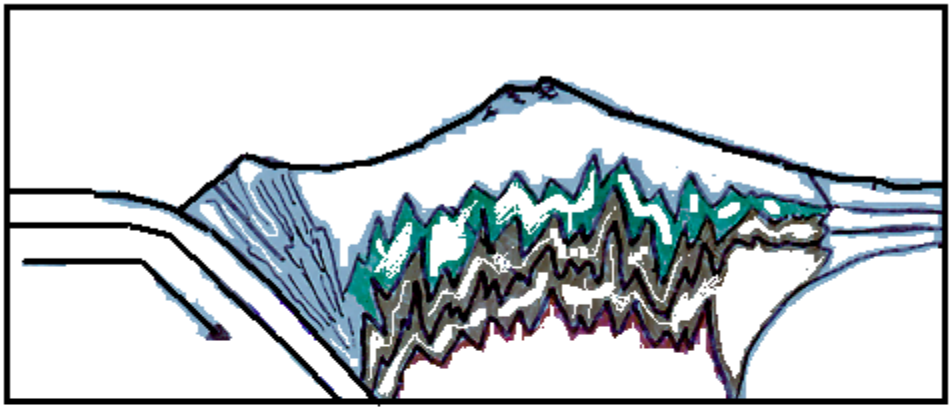
METAMORPHIC ROCKS

Metamorphic Rocks are formed by the alteration of PRE-EXISTING ROCKS in response of changes in HEAT (TEMPERATURE), PRESSURE, SHEAR STRESS and CHEMICAL EFFECTS of FLUIDS or GASES.
SOLID STATE PROCESS

PRE-EXISTING ROCKS	
PROTOLITH **PRECURSOR or** **PARENTAL ROCK**	**IGNEOUS** **SEDIMENTARY = more prone to be affected by metamorphism.** **METAMORPHIC ROCKS**

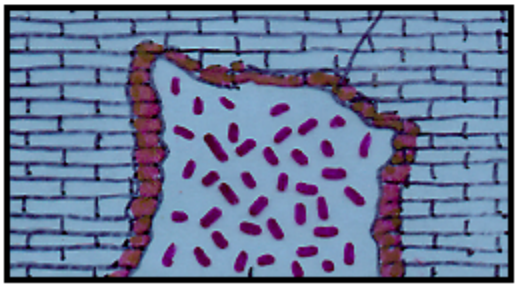
TYPES OF METAMORPHISM

REGIONAL METAMORPHISM



Produced by large-scale deformation, during periods of mountain building and / or burial,. Usually occurs in extensive belts hundred of miles x thousands of miles.
<u>High P</u>; variable T

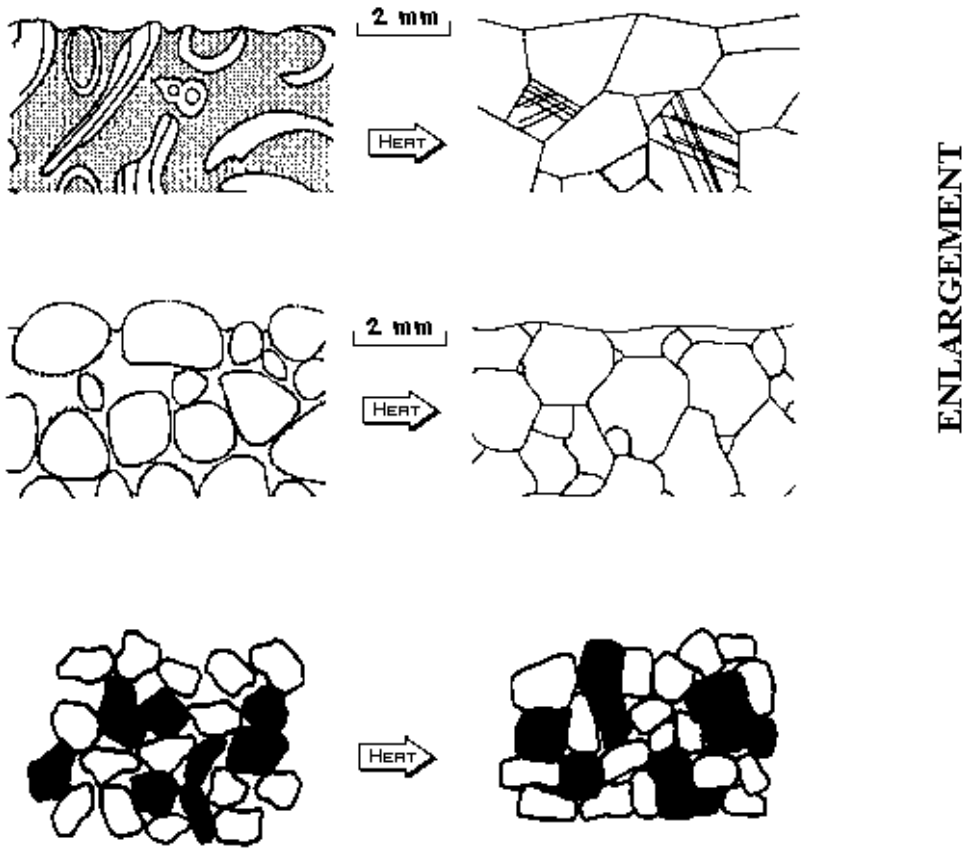
CONTACT METAMORPHISM



Produced by magmatic intrusions. It only affects the surrounding rocks masses (host rocks). It is more intense near or at the zone of contact.
Low P; <u>High T</u>

METAMORPHIC PROCESSES	**RECRYSTALLIZATION**	**Growth of new crystals. No changes in overall chemistry. New crystals grow from the minerals already present. Enlargement of original crystals**
	CRYSTALLIZATION	**Chemical breakdown of unstable minerals and growth of new crystals.**
	ROTATION (DEFORMATION)	**Reorientation of minerals due to directed pressures.**

RECRYSTALLIZATION



(Schematic) Effects of recrystallization during metamorphism. The grains become tightly interlocking, and porosity (empty space) decreases

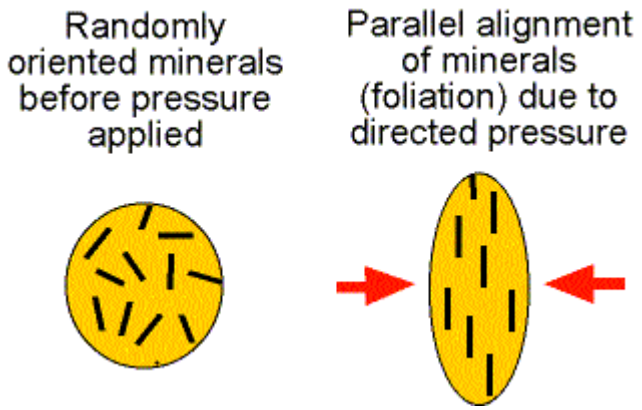
CRYSTALLIZATION

$(Mg, Fe)_7 Si_8O_{22}(OH)_2$ → $7 (Mg, Fe)SiO_3$ + SiO_2 + H_2O
Amphibole → pyroxene + quartz + water

$(Mg, Fe)_3 Si_2O_5(OH)_4$ + $KAlSi_3O_8$ → $K(Mg, Fe)_3 AlSi_3O_{10}(OH)_2$ + $2SiO_2$ + H_2O
Chlorite + orthoclase → biotite + quartz + water

$3(Mg, Fe)_3 (Al,Si)2Si_5(OH)_4$ + Fe_3O_4 + $6SiO_2$ → $3(Mg, Fe)_3(Fe, Al)_2Si_3O_{12}$ + H_2O + $^1/_2$ O_2
Chlorite + magnetite + quartz → garnet + water + oxygen

ROTATION (DEFORMATION)



A preferred orientation of minerals commonly develops under applied pressure. Platy or sheet-like minerals such as muscovite and biotite become oriented perpendicular to the direction of force. This preferred orientation is called foliation. Foliated metamorphic rocks are generally associated with regional metamorphism.

METAMORPHIC MINERALS	
QUARTZ	Also present in igneous rocks
PLAGIOCLASE	
ORTHOCLASE	
MUSCOVITE	
BIOTITE	
HORNBLENDE	
CHLORITE	Diagnostic
GARNET	
STAUROLITE*	
KYANITE*	
SILLIMANITE*	

FOLIATED ROCKS / TEXTURES

GRADE	GRAIN SIZE	TYPE OF FOLIATION	TEXTURAL FEATURES	MINERAL / SIZE	ROCK NAME	CHARACTER-ISTICS	
↓	↓	**SLATY CLEAVAGE**	**Parallel arrangement of microscopic platy minerals.**	**Microscopic platy minerals (CHL, MUS) +/- qtz, Na-plag.**	**SLATE**	**The rock tends to split in thin layers**	**Resembles shale "Rings" when you strike it**
		PHYLLITIC TEXTURE	**Parallel arrangement of barely microscopic platy minerals.**	**Fine grained MUS, BIO, +/- qtz, Na-plag.**	**PHYLLITE**	**Has lustrous sheen (resembles frosted eye shadow). Surfaces might by slightly contorted,**	
		SCHISTOCITY	**Parallel arrangement of macroscopic platy minerals.**	**Macroscopic MUS, BIO, CHL, Talc +/- hornblende, quartz**	**SCHIST**	**Abundant obvious micas (Mica-rich)** Talc-rich Chlorite-rich	
				Micas	**MICA-SCHIST**		
				Micas + garnet	**GARNET-MICA-SCHIST**		
		GNEISSIC LAYERING	**Alternating layers of macroscopic dark and light colored minerals.**	**Macroscopic Dark layers = BIO, HORN Light layers =ORTH, PLAG, QTZ**	**GNEISS (pronounced "nice")**	**Banded or striped appearance**	

NON-FOLIATED ROCKS
Appear massive or structurless, except for elongated grains or other linear features

	APPEARANCE	TEXTURE	MINERALOGY	ROCK NAME
WITH LINEATION	May appear weakly foliated	COARSELY CRYSTALLINE	MOSTLY AMPHIBOLES +/- other minerals	AMPHIBOLITE
	Stretched pebbles in some cases or recrystallized matrix. Breaks across the grains, rather than around them	Pebble-grained	Composition of pebbles variable as in conglomerate	META-CONGLOMERATE 
GRANOBLASTIC GRANULAR CRYSTALLINE	Looks like sandstone, but breaks across the grains, rather than around them	Finely to coarsely crystalline	Quartz	QUARTZITE
	Sugary sparkle imparted by cleavage of calcite and dolomite	Finely to coarsely crystalline	Calcite or dolomite	MARBLE