

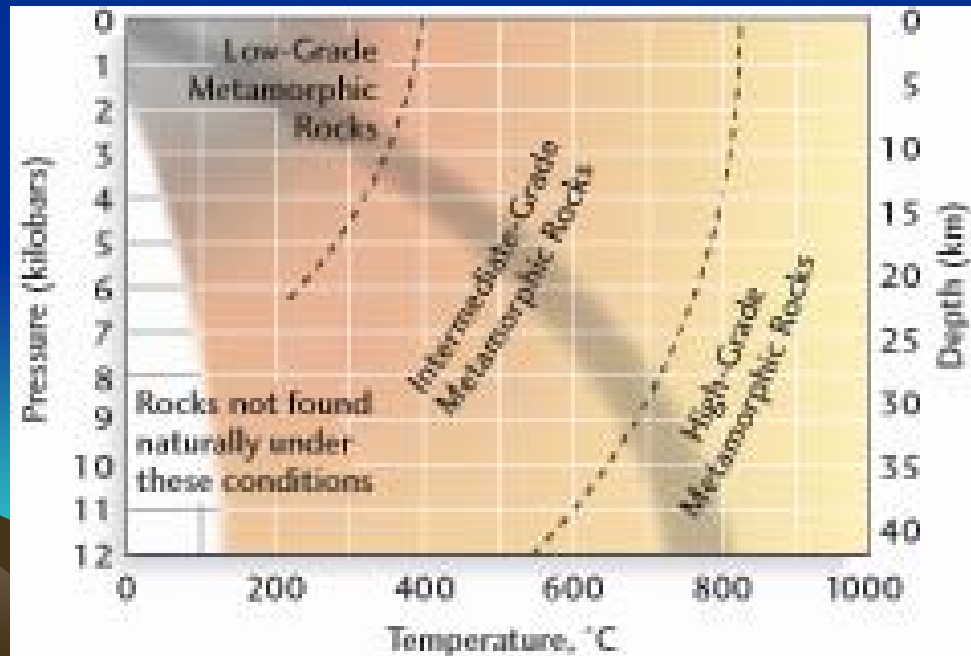
GY111 Earth Materials

Lecture 7: Metamorphic Rocks



Metamorphism

- Causes of Metamorphism
 - Elevated T & P
 - Fluids (H₂O, CO₂, CH₄, etc.)
 - Directed Stress

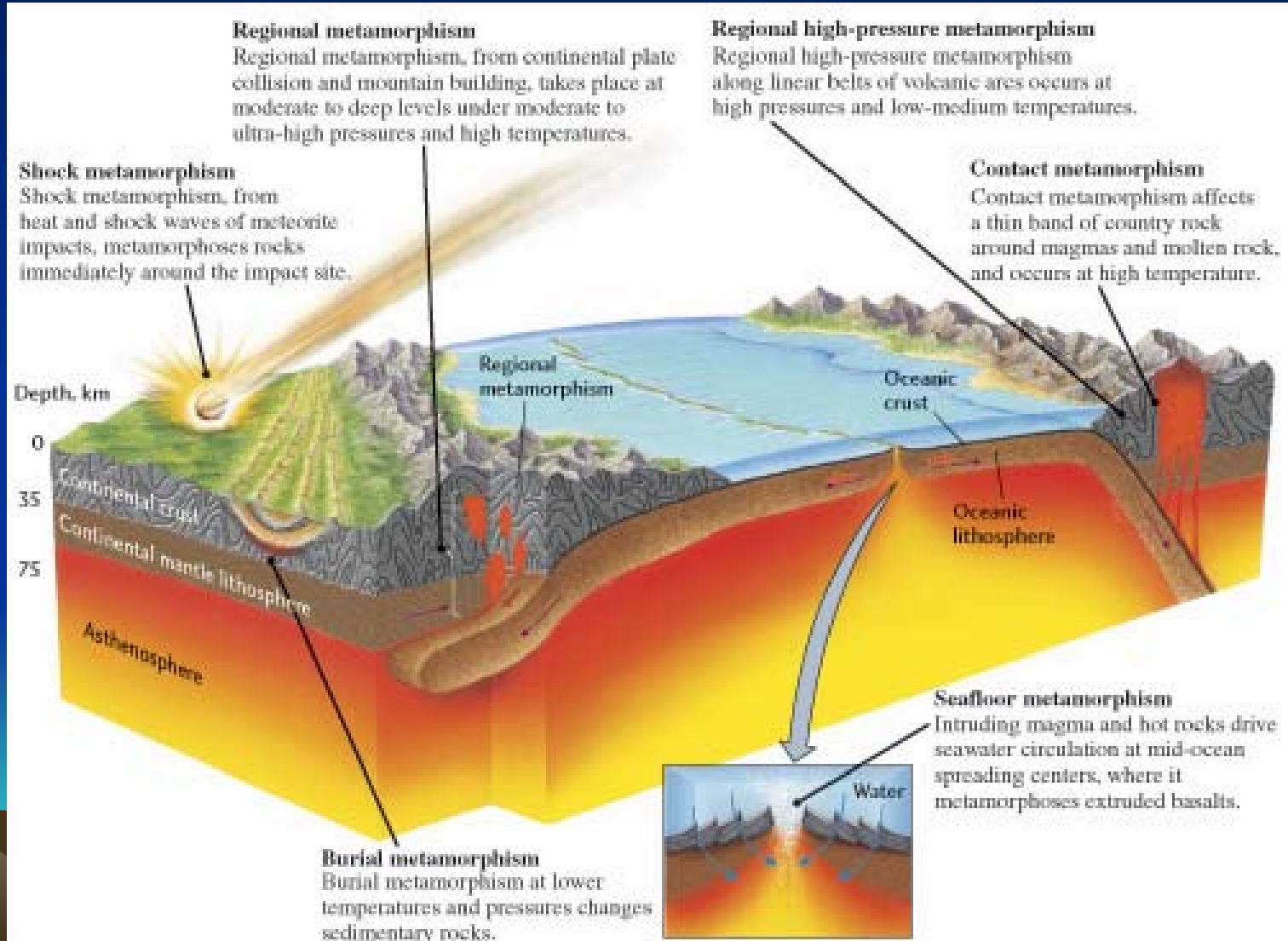


Types of Metamorphism

- Regional: occur along convergent plate boundaries
- Contact: occurs along margin of a magma intrusion
- Seafloor: associated with circulating hydrothermal fluids at divergent ocean ridge systems
- Shock: meteorite impact



Types of Metamorphism: Tectonic Environments

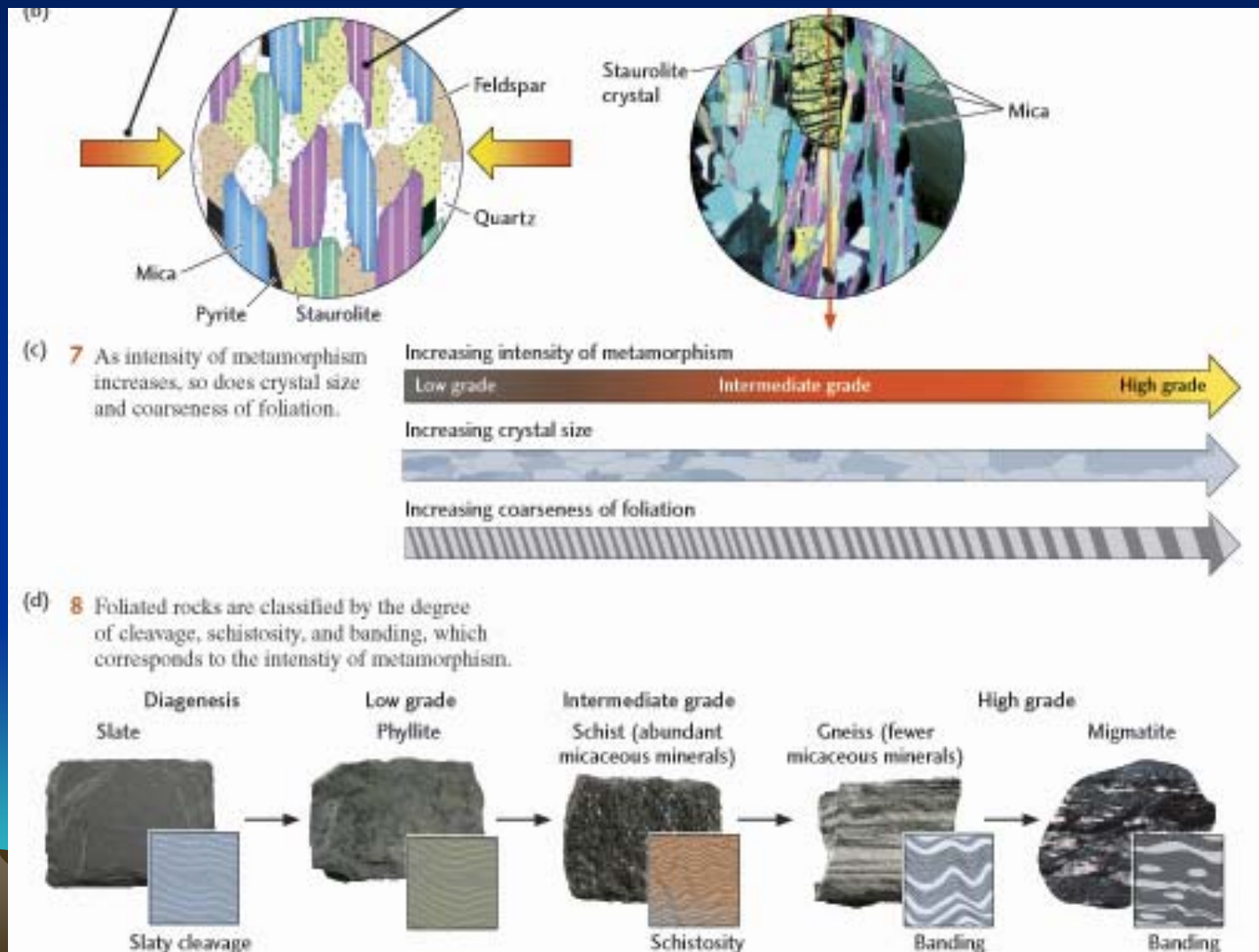


Metamorphic Textures

- Cleavage: tendency of a rock to break along smooth even planes
- Foliation: preferred alignment of platy grains (i.e. mica)
- Lineation: preferred alignment of elongated minerals (i.e. amphibole)



Metamorphic Texture: Foliation



Foliation vs. Cleavage

- All regional metamorphic rocks contain a foliation- in low grade (Low T) rocks the grains are microscopic so you can't "see" the foliation
- Cleavage in rocks is the tendency to split along smooth planes. Rocks with microscopic foliation tend to have excellent rock cleavage

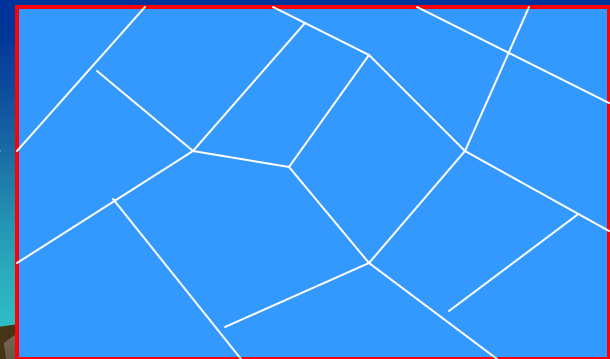


Granoblastic Metamorphic Rocks

- Granoblastic metamorphic textures are produced when the constituent grains of the rock are equidimensional- i.e. the grains have the same diameter in any direction.
- Granoblastic rocks therefore do not develop foliation
- Examples: marble, quartzite, greenstone, amphibolite*, hornfels, granulite



quartzite



Granulites

- Granulites, as their name implies, have a granular texture composed of pyroxene, plagioclase and garnet
- Granulites form at the highest grades of metamorphism when portions of the protolith melt and exit the rock leaving behind a “restite” that is devoid of H₂O or other fluids



Protoliths

- Protolith: original rock that becomes metamorphosed
- Common Protolith/metamorphic rock relationships

<u>Protolith</u>	<u>Low</u>	<u>Med</u>	<u>High</u>
Shale	slate, phyllite	schist	gneiss
Basalt	greenstone	amph.	amph.
Sandstone	quartzite	quartzite	quartzite
Limestone	marble	marble	marble



Large Crystal Textures

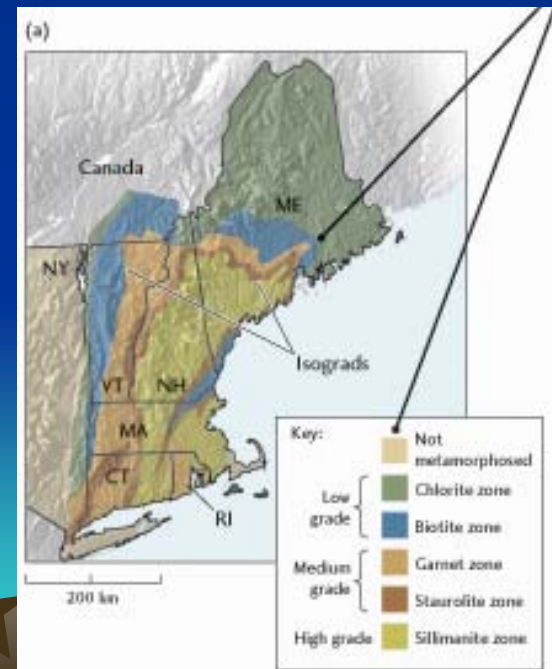
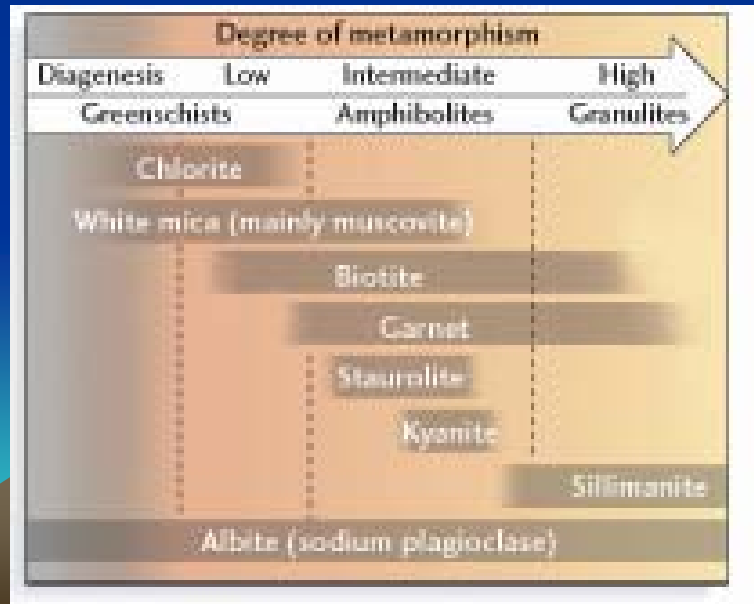
- Large metamorphic crystals are termed porphyroblasts
- Common porphyroblast forming minerals include: Garnet, Andalusite, Staurolite, Kyanite, Plagioclase, Amphibole



Garnet porphyroblast

Metamorphic Isograds

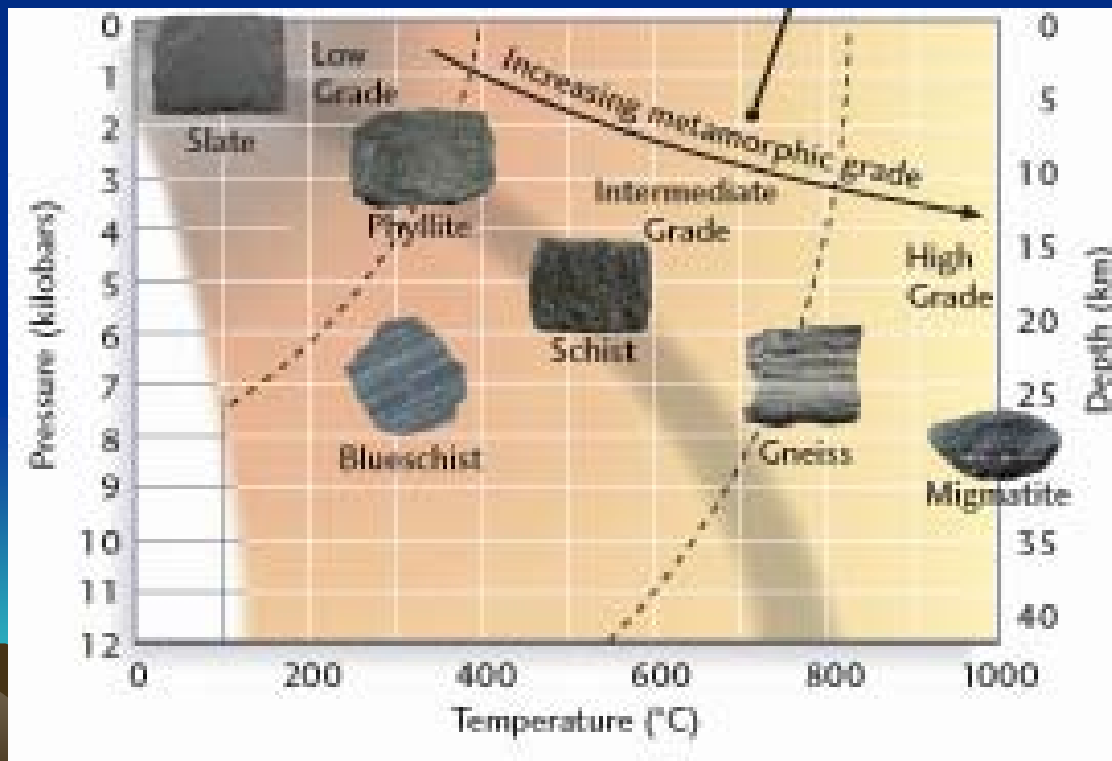
- Isograd: this first appearance of an index metamorphic mineral
- Minerals: Chlorite, Muscovite, Biotite, Garnet, Staurolite, Kyanite, Sillimanite



Relationship of Texture and Grade

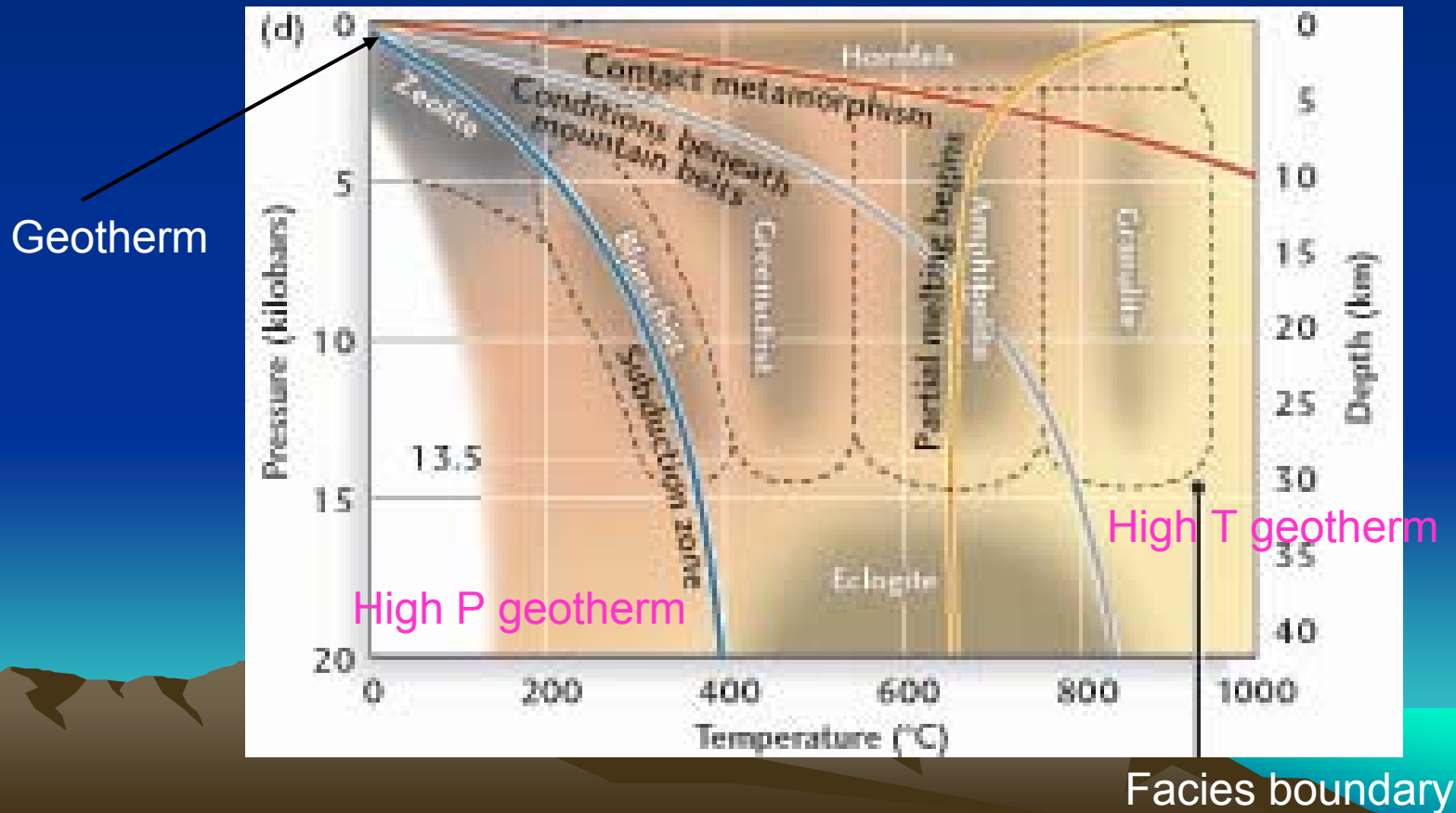
- Increasing metamorphic grade results in larger grain size

Increase in grain size



Metamorphic Facies Concept

- Metamorphic Facies: regions on a T vs. P graph



Geotherms and Plate Tectonics

- Subduction zones have unusually low geotherms- High P geotherm (Blue schist > Eclogite)
- Volcanic/Magmatic Arcs have unusually high geotherms- High T geotherm (Slate>Phyllite>Schist>Gneiss>Granulite)

