Metamorphic Rocks

Rocks Under Stress

Metamorphism

- Recrystallization
- Solid-State Chemical Reactions
- No Melting

Factors that affect Metamorphism

- Parent Rock (aka protolith) Composition
- Temperature
- Pressure
- Fluids

Factors that affect Metamorphism

- Parent Rock Composition
- Temperature
- Pressure
- Fluids

Directed Pressure Results in:

Lithostatic pressure

Directional pressure

Foliation
Factors that affect Metamorphism

- Parent Rock Composition
- Temperature
- Pressure
- Fluids

Types of Metamorphism

High T, Low P conditions…

Increase of T and P Together

Regional Metamorphism
Regional Metamorphism

Hydrothermal Metamorphism

Metamorphic Rocks - Identification

Metamorphic Textures (All Crystalline)

Foliation

Composition - Minerals

Lots of Hot Fluids

Foliation

Regional Metamorphism Changes Rock Texture

Garnets are an index mineral
Metamorphic Rocks - Interpretation

Metamorphic Rock "Translations"

- Chemical Composition
- Parent Rock (Protolith)
- Mineral Composition
- T & P of Formation (Depth, Type, & Facies)
- Texture: Foliation
- T & P of Formation (Depth, Type, & Facies)

Chemical Composition - Parent Rock (Protolith)
Overall chemical composition of the protolith is the same as the metamorphic rock created.

<table>
<thead>
<tr>
<th>Protolith</th>
<th>Metamorphic Rock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Felsic</td>
<td>Felsic</td>
</tr>
<tr>
<td>Mafic</td>
<td>Mafic</td>
</tr>
<tr>
<td>All Quartz</td>
<td>Quartz</td>
</tr>
<tr>
<td>All Calcite</td>
<td>Calcite</td>
</tr>
</tbody>
</table>

Nonfoliated Rocks

Equant-shaped or blocky minerals like quartz or calcite
Parent Rock: Limestone
Marble (Low to High Grade)

Nonfoliated Rocks (cont.)

Parent Rocks
- Sandstone
- Conglomerate
Quartzite
Metacoglomerate
Mineral Composition - Index Minerals

Felsic Protolith

Mineral Composition - Mineral Assemblages

Index minerals

Mineral Composition - Geothermometers

Staurolite - Forms 500-750°C
Garnet - Forms 450-700°C
Muscovite - Forms 300-550°C

Rock Forms: 500-550°C

Metamorphic Environments

Metamorphic Facies

Metamorphic Facies

INDEX MINERALS, GRADE, AND FACIES DESCRIBE METAMORPHISM
**Foliated Metamorphic Rocks**

- Parent Rock - Shale
  - Slate (Low Grade)
  - Phyllite (Low Grade)

**Foliated Rocks (cont.)**

- Schist (Medium Grade)
- Migmatite (Very High Grade)

**Foliated Rocks (cont.)**

- Felsic Parent Rock
  - Gneiss (High Grade)
  - Migmatite (Very High Grade)

**Metamorphic Facies**

- Temperature, °C
- Pressure (kilobars)

**Intermission: Quiz**

**What Can you say about the history of this rock?**

**Schist**

Metamorphism of a shale parent rock under medium grade metamorphic conditions. (Specific index minerals would tell you specific T & P.)

**Marble**

Metamorphism of a limestone parent rock. Grade could be low, medium or high.

Parent rock formed in a shallow tropical ocean.