**Metamorphism and Metamorphic Rocks**

In biology, we use "metamorphism" to talk about major change through time in individual organisms (as from caterpillars to butterflies). Rocks can likewise undergo change to the extent that their nature and appearance are completely transformed. Thus the three fundamental kinds of rocks are igneous, sedimentary, and metamorphic.

**Change in mineralogy and texture of a rock because of increased temperature and pressure**

(and perhaps because of chemical substances gained or lost to passing fluids).

- **New minerals**
  - Coarser crystals
  - Crystals with preferred orientation

- **Regional metamorphism:**
  - caused by high pressure and temperature with deep burial within the continents, and thus commonly covering entire regions when exposed by erosion.

- **Contact metamorphism:**
  - caused by high temperature near an igneous intrusion, and thus at the contact between the surrounding host rock and the intrusive rock.

Lack of significant and/or sustained pressure results in no preferred orientation of crystals.

- **Shale**
  - Clay minerals with little preferred orientation

- **Slate**
  - Small but foliated crystals

- **Phyllite**
  - Larger, but still essentially microscopic, foliated metamorphic crystals

- **Schist**
  - Foliated crystals visible to the naked eye

**The process of metamorphism:**

"recrystallization"

**The immediate products of metamorphism:**

**A very schematic model of metamorphism**

**Regional metamorphism due to temperature and pressure**

- Newly-formed minerals, perhaps micas (e.g., muscovite) after incipient metamorphism

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**Railsback's Some Fundamentals of Mineralogy and Geochemistry**

**Change in mineralogy and texture of a rock because of increased temperature and pressure**

- Less hydrous minerals
- More dense minerals

**New minerals**

- Coarser crystals
- Crystals with preferred orientation

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**Conditions not found in nature**

- Some melting of granite in presence of water
- Some melting of basalt in presence of water
- Dry melting

**Earth-surface conditions**

**Pressure (kbars)**

<table>
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<th>0</th>
<th>2</th>
<th>4</th>
<th>6</th>
<th>8</th>
<th>10</th>
</tr>
</thead>
<tbody>
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<td>Pressure (kbars)</td>
<td>0</td>
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</tr>
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</table>

**Temperature (°C)**

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
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<th>200</th>
<th>400</th>
<th>600</th>
<th>800</th>
<th>1000</th>
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</thead>
<tbody>
<tr>
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<td>10</td>
<td>20</td>
<td>30</td>
<td>40</td>
<td>50</td>
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