

A large, layered rock formation, possibly a natural rock arch or a similar geological feature, stands prominently in a desert landscape. The rock is composed of distinct horizontal layers, suggesting sedimentary deposition. The background shows a vast, open landscape with a blue sky and scattered white clouds. The foreground is a sandy, rocky terrain with some sparse vegetation.

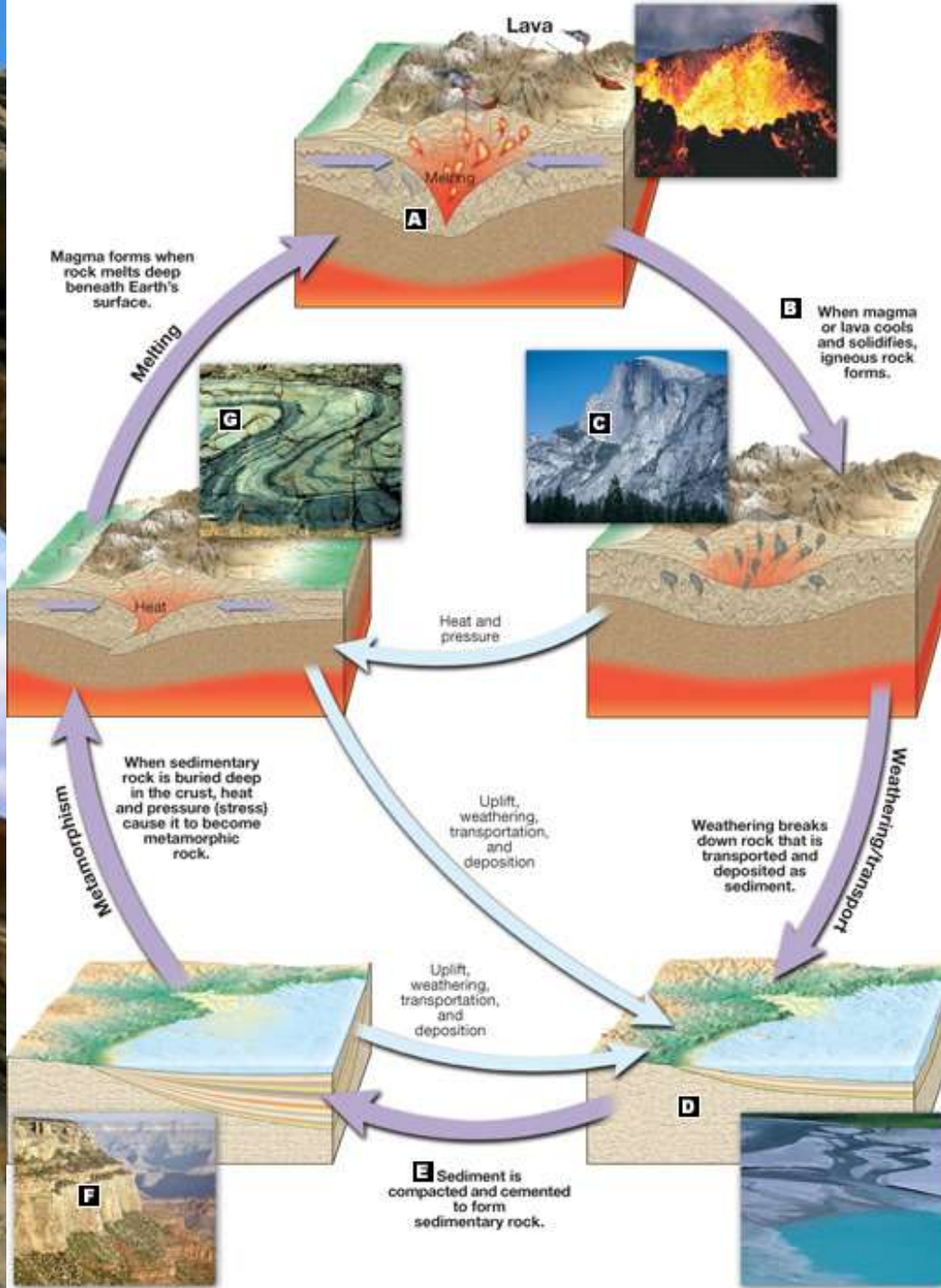
Earth & Space Science

Unit 3 Lecture 2 –
Rocks: Materials of the
Solid Earth (Ch. 3)

I. Rock Cycle

- A. Shows the relations among the three rock types
- B. Proposed by James Hutton in the late 1700s





I. Rock Cycle (cont.)

C. The cycle

1. Magma

a. Crystallization



I. Rock Cycle (cont.)

2. Igneous Rock
 - a. Weathering
 - b. Transportation
 - c. Deposition



I. Rock Cycle (cont.)

3. Sediment

a. Lithification



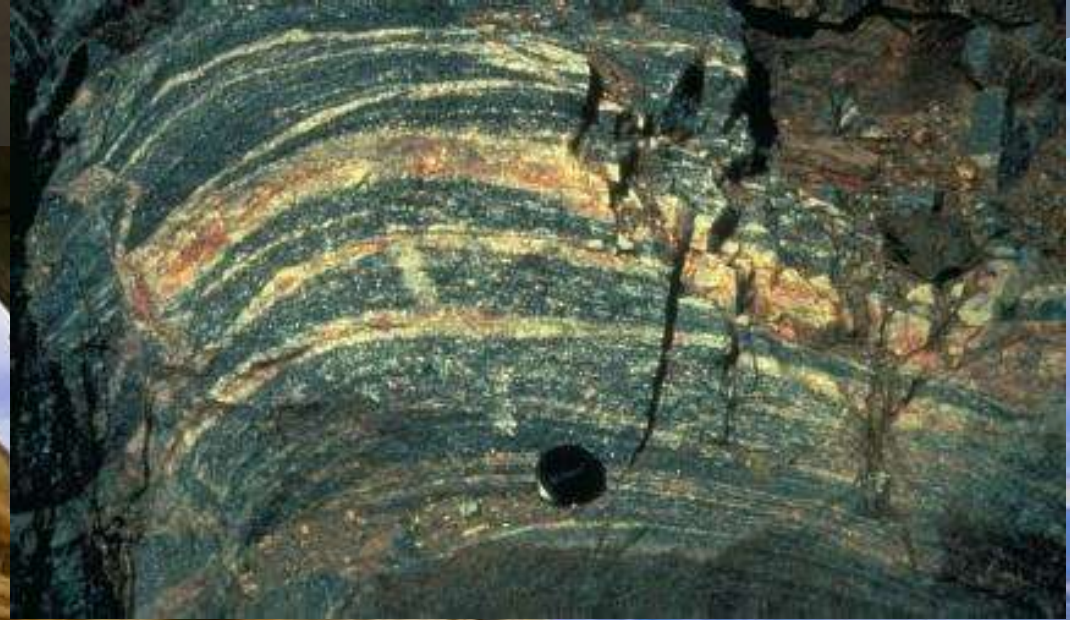
I. Rock Cycle (cont.)

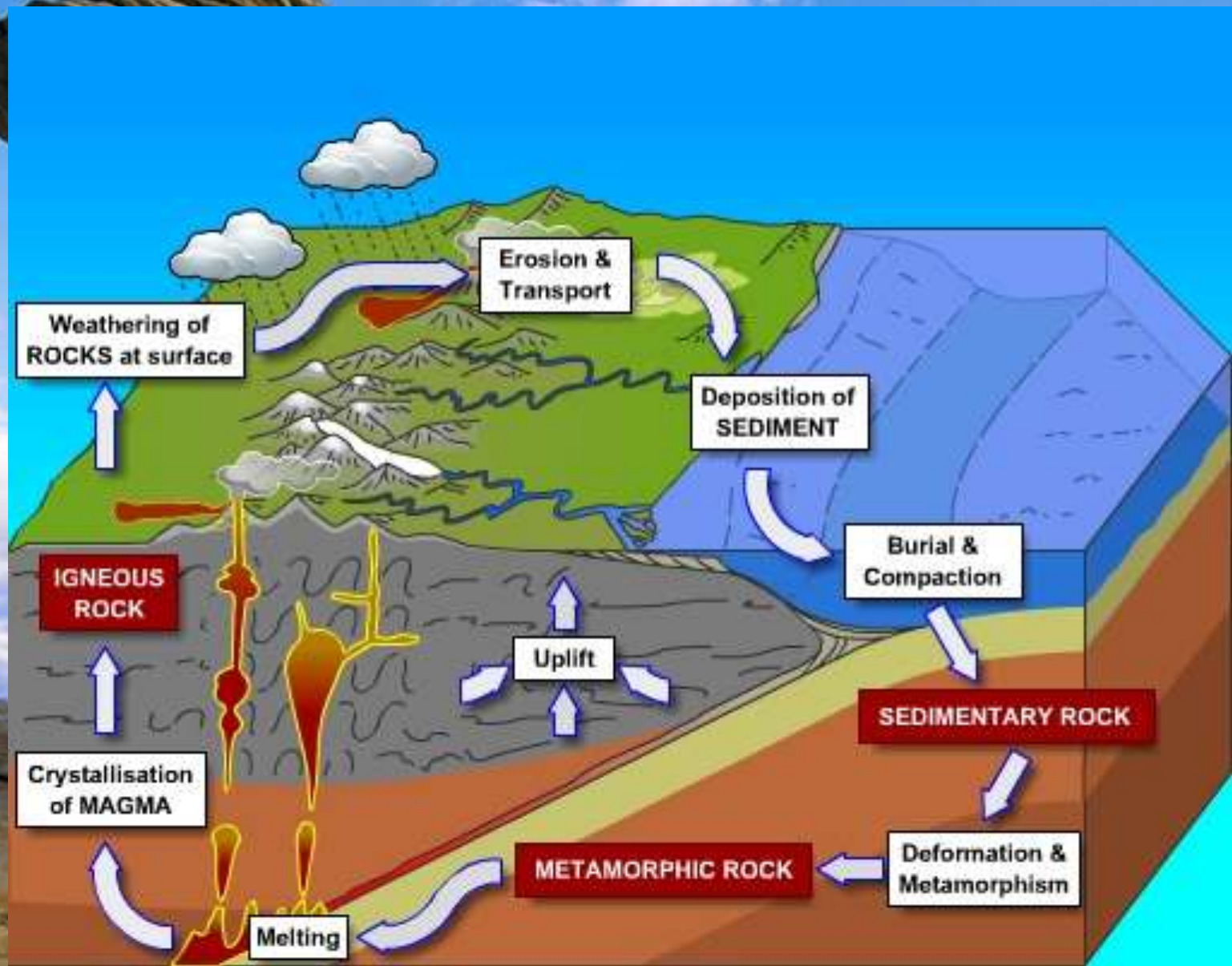
- 4. Sedimentary rock
 - a. Metamorphism



I. Rock Cycle (cont.)

- 5. Metamorphic rock
 - a. Melting
- 6. Magma

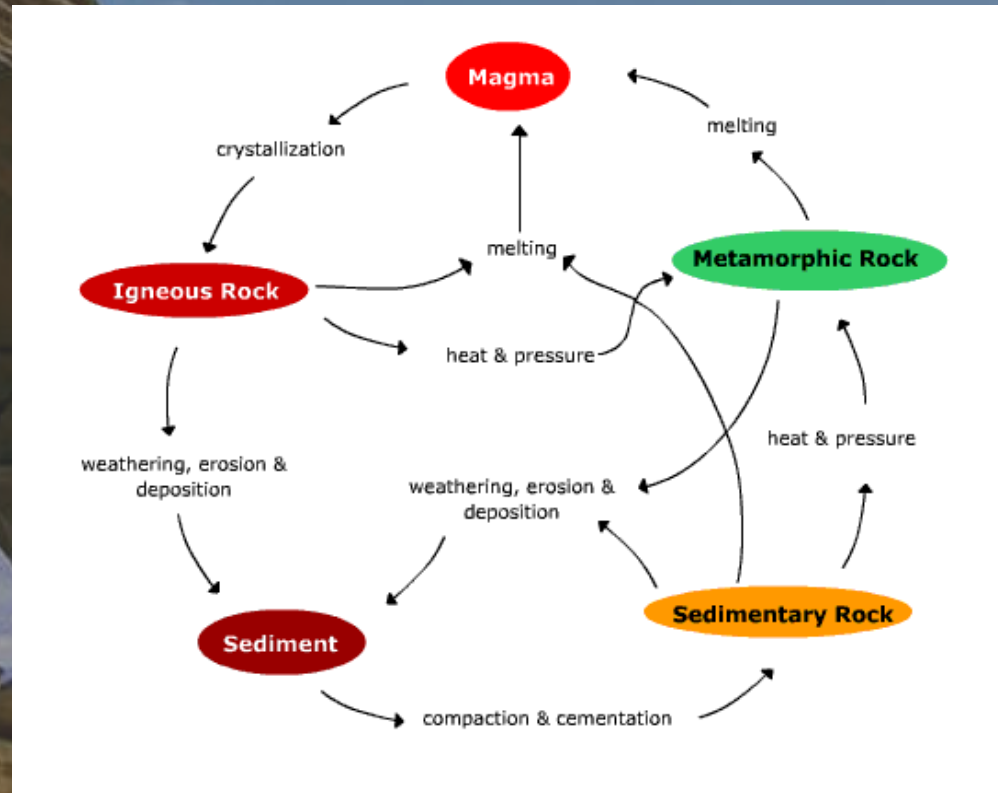


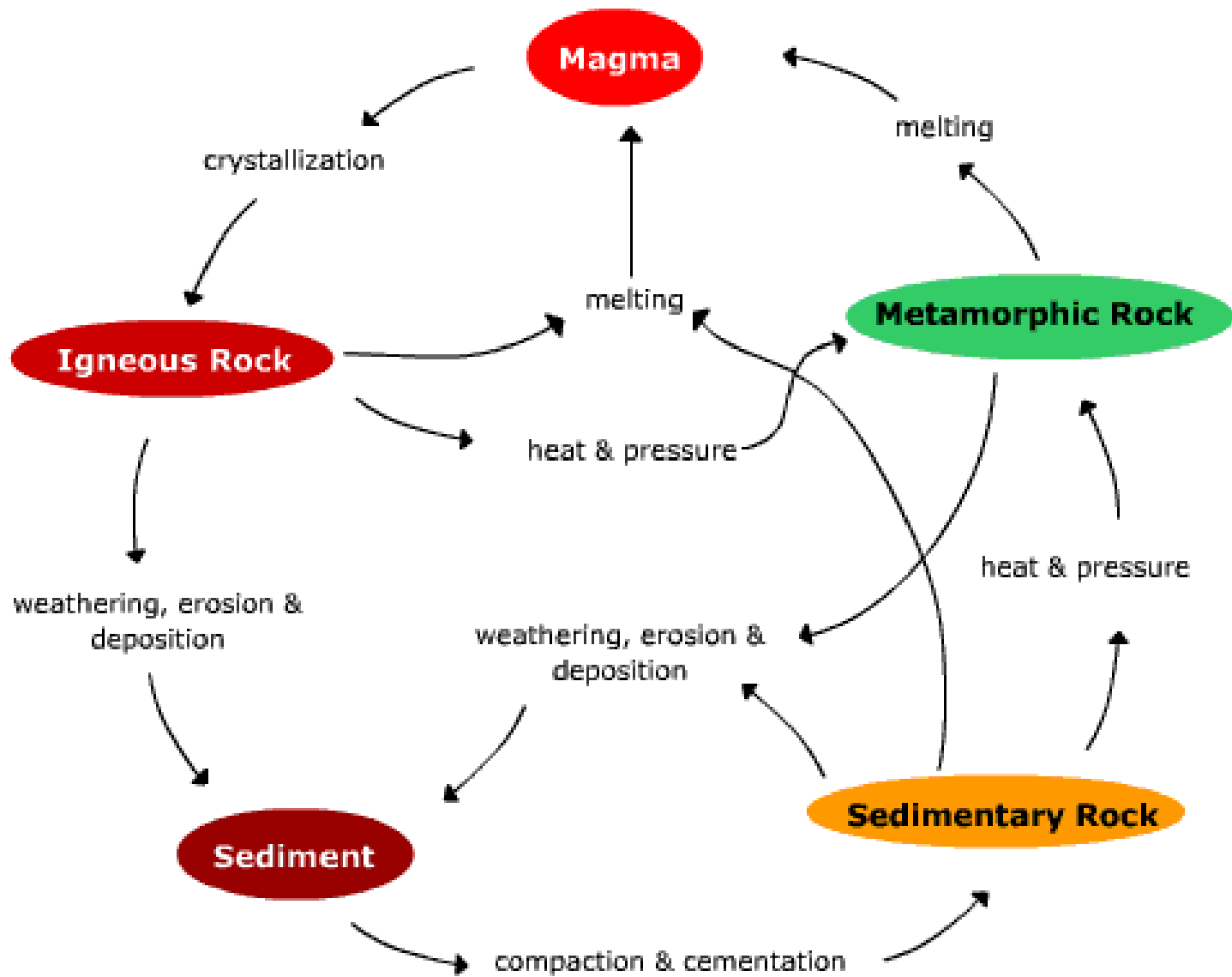


I. Rock Cycle (cont.)

D. Full cycle does not always take place due to “shortcuts” or interruptions

1. e.g., Sedimentary rock melts
2. e.g., Igneous rock is metamorphosed
3. e.g., Sedimentary rock weathers
4. e.g., Metamorphic rock weathers





II. Igneous Rocks

A. Form as magma cools and crystallizes

1. e.g., Sedimentary rock melts
2. e.g., Igneous rock is metamorphosed
3. e.g., Sedimentary rock weathers
4. e.g., Metamorphic rock weathers

II. Igneous Rocks (cont.)

B. Crystallization of magma

1. Ions are arranged into orderly patterns
2. Crystal size of the rock is determined by the rate of cooling
 - a. Slow rate forms large crystals
 - b. Fast rate forms microscopic crystals
 - c. Very fast rate forms glass

II. Igneous Rocks (cont.)

C. Classification is based on the rock's texture and mineral composition

1. Texture

a. Size and arrangement of crystals

b. Types

i. Fine-grained – fast rate of cooling

ii. Coarse-grained – slow rate of cooling

iii. Porphyritic (two crystal sizes) – two rates of cooling

iv. Glassy – very fast rate of cooling

II. Igneous Rocks (cont.)

2. Mineral composition

- a. Explained by Bowen's reaction series which shows the order of mineral crystallization
- b. Influenced by crystal settling in the magma

II. Igneous Rocks (cont.)

D. Naming igneous rocks

1. Basaltic rocks

- a. Derived from the first minerals to crystallize
- b. Rich in iron and magnesium
- c. Low in silica
- d. Common rock is basalt



II. Igneous Rocks (cont.)

2. Granitic rocks

- a. From the last minerals to crystallize
- b. Mainly feldspar and quartz
- c. High silica content
- d. Common rock is granite



III. Sedimentary rocks

- A. Form from sediment (weathered products)
- B. Form about 75% of the rock outcrops on the continents
- C. Used to construct much of Earth's history
 1. Clues to past environments
 2. Provide information about sediment transport
 3. Rocks often contain fossils

III. Sedimentary rocks (cont.)

D. Economic importance

1. Coal
2. Petroleum and natural gas
3. Sources of iron and aluminum

III. Sedimentary rocks (cont.)

E. Classification

1. Two groups based on the source of the material
 - a. Detrital rocks
 - i. Material is solid particles
 - ii. Classified by particle size
 - iii. Common rocks are
 - 1) Shale (most abundant)
 - 2) Sandstone
 - 3) Conglomerate
 - 4) Siltstone



III. Sedimentary rocks (cont.)

b. Chemical rocks

- i. Derived from material that was once in solution and precipitates to form sediment
 - 1) Directly precipitated or
 - 2) Through life processes (biochemical origin)

III. Sedimentary rocks (cont.)

ii. Common rocks are

- 1) Limestone – the most abundant chemical rock
- 2) Travertine
- 3) Microcrystalline quartz
 - a) Chert
 - b) Jasper
 - c) Flint
 - d) Avgate)
- 4) Evaporites
 - a) Rock salt
 - b) Gypsum)
- 5) Coal
 - a) Lignite
 - b) Bituminous)



III. Sedimentary rocks (cont.)

F. Produced through lithification

1. Loose sediments are transformed into solid rock
2. Lithification processes
 - a. Compaction
 - b. Cementation by the materials
 - i. Calcite
 - ii. Silica
 - iii. Iron oxide

III. Sedimentary rocks (cont.)

G. Features

1. Strata, or beds (most characteristic)
2. Bedding planes separate strata



III. Sedimentary rocks (cont.)

3. Fossils

- a. Traces or remains of prehistoric life
- b. Are the most important inclusions
- c. Help determine past environments
- d. Used as time indicators
- e. Used for matching rocks from different places



IV. Metamorphic rocks

A. “Changed form” rocks

B. Can form from

1. Igneous rocks
2. Sedimentary rocks
3. Other metamorphic rocks

C. Degrees of metamorphism

1. Show in the rock’s texture and mineralogy
2. Types
 - a. Low-grade (e.g., shale becomes slate)
 - b. High-grade (causes the original features to be obliterated)

IV. Metamorphic rocks (cont.)

D. Metamorphic settings

1. Regional metamorphism

- a. Over extensive areas
- b. Produces the greatest volume of metamorphic rock

2. Contact metamorphism

- a. Near a mass of magma
- b. “Bakes” the surrounding rock

IV. Metamorphic rocks (cont.)

E. Metamorphic agents

1. Heat

2. Pressure

- a. From burial

- b. From stress

3. Chemically active fluids

- a. Water (most common fluid)

- b. Ion exchange among minerals

IV. Metamorphic rocks (cont.)

F. Textures

1. Foliated

- a. Minerals are in a parallel alignment
- b. Mineral are perpendicular to the force

2. Nonfoliated

- a. Contain equidimensional crystals
- b. Resembles a coarse igneous rock

IV. Metamorphic rocks (cont.)

G. Classification

1. Based on texture
2. Two groups
 - a. Foliated rocks
 - i. Slate
 - 1) Fine-grained
 - 2) Splits easily



IV. Metamorphic rocks (cont.)

ii. Schists

- 1) Strongly foliated
- 2) “Platy”
- 3) Types based on composition (e.g., mica schist)



IV. Metamorphic rocks (cont.)

iii. Gneiss

- 1) Strong segregation of silicate minerals
- 2) “Banded” texture



IV. Metamorphic rocks (cont.)

b. Nonfoliated rocks

i. Marble

- 1) Parent rock – limestone
- 2) Calcite crystals
- 3) Used as a building stone
- 4) Variety of colors



IV. Metamorphic rocks (cont.)

ii. Quartzite

- 1) Parent rock – quartz sandstone
- 2) Quartz grains are fused



V. Resources from rocks and minerals

A. Metallic mineral resources

1. e.g. Gold, silver, copper
2. Produced by
 - a. Igneous processes
 - b. Metamorphic processes

V. Resources from rocks and minerals (cont.)

3. Hydrothermal (hot-water) solutions

- a. Hot
- b. Contain metal-rich fluids
- c. Associated with cooling magma bodies
- d. Types
 - i. Vein deposits occur in fractures or bedding planes
 - ii. Disseminated deposits are distributed throughout the rock

V. Resources from rocks and minerals (cont.)

B. Nonmetallic mineral resources

1. Make use of the materials

- a. Nonmetallic elements
- b. Physical or chemical properties

2. Two broad groups

- a. Building materials
 - i. (e.g., limestone, gypsum)
- b. Industrial minerals
 - i. (e.g., fluorite, corundum, sylvite)

Key Terms



Chemical sedimentary rock

Contact metamorphism

Crystallization

Disseminated deposit

Extrusive (volcanic)

Hydrothermal solution

Igneous rock

Intrusive (plutonic)

Lava

Lithification

Magma

Metamorphic rock

Regional metamorphism

Rock cycle

Sediment

Sedimentary rock

Strata

Texture

Vein deposit

Weathering