Weathering: Big Ideas

- **Water's unique physical and chemical properties are essential to the dynamics of all of Earth's systems**
- **Understanding geologic processes active in the modern world is crucial to interpreting Earth's past**
- **Earth's systems are dynamic; they continually react to changing influences from geological, hydrological, physical, chemical, and biological processes.**

Weathering

- **Physical and chemical changes that occur in sediments and rocks when they are exposed to the atmosphere and biosphere**
- ***Not* the same as erosion**

Chemical Weathering

- **The principle agent of chemical weathering is water.**
- **Minerals formed deep in the earth's interior are not stable under the conditions on the surface of the Earth.**
- **Stability is generally the reverse of Bowen's reaction series.**

Table 7.1 Relative Stabilities of Common Minerals Under Weathering

Stability of Minerals	Rate of Weathering
MOST STABLE	Slowest
Iron oxides (hematite)	
Aluminum hydroxides (gibbsite)	
Quartz	
Clay minerals	
Muscovite mica	
Potassium feldspar (orthoclase)	
Biotite mica	
Sodium-rich feldspar (albite)	
Amphiboles	
Pyroxene	
Calcium-rich feldspar (anorthite)	
Olivine	
Calcite	
Halite	
LEAST STABLE	Fastest

Chemical Weathering of Silicates

- **Quartz**: very stable
- **Feldspars**: form clay minerals
- **Mafic minerals**: decompose to oxides

Chemical Weathering in the Graveyard

Fig. 16.1

Weathering of Granite

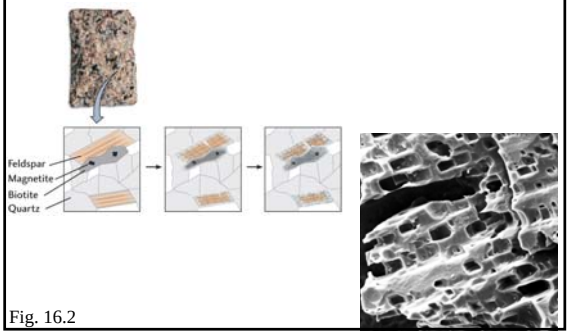
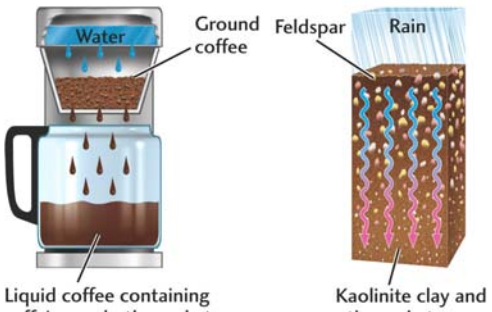


Fig. 16.2

Weathering and Soils



Weathering and Surface Area

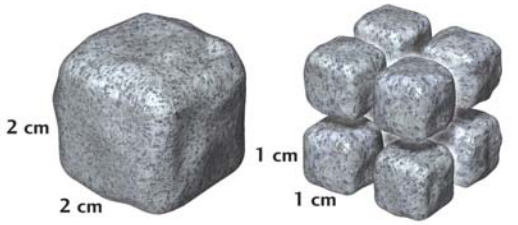


Fig. 16.3

Weathering by Solution

- The complete breakup of minerals into ions in solution
- NaCl (halite) is the best example, but is geologically unimportant
- Calcite (limestone)
  $CaCO_3 + H_2CO_3 = Ca^{2+} + 2HCO_3^-$
- Mafic silicates dissolve much more slowly

Oxidation of Mafic Rocks

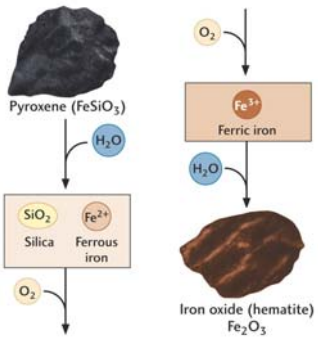


Fig. 16.5

Rocks "rust"

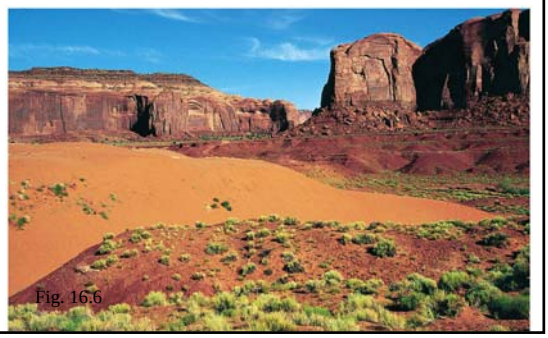


Fig. 16.6

Weathering Takes CO_2 out of the atmosphere

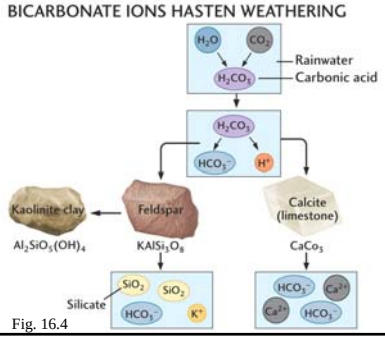


Fig. 16.4

Weathering buffers Earth's Climate

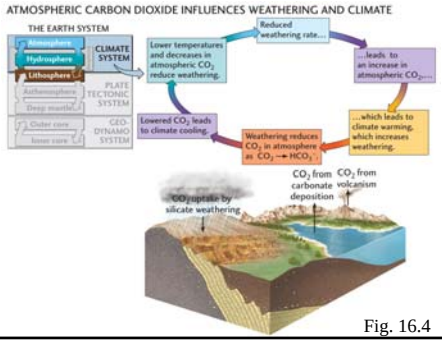


Fig. 16.4

Weathering Rates

Table 7.2 Major Factors Controlling Rates of Weathering

	Weathering Rate: Slow			Fast
PROPERTIES OF PARENT ROCK				
Mineral solubility in water	Low (e.g., quartz)	Moderate (e.g., pyroxene, feldspar)	High (e.g., calcite)
Rock structure	Massive	Some zones of weakness	Very fractured or thinly bedded
CLIMATE			
Rainfall	Low	Moderate	Heavy
Temperature	Cold	Temperate	Hot
PRESENCE OR ABSENCE OF SOIL AND VEGETATION			
Thickness of soil layer	None—bare rock	Thin to moderate	Thick
Organic activity	Sparse	Moderate	Abundant
LENGTH OF EXPOSURE			
Short	Moderate	Long	

Mechanical weathering

- Frost - water expands by 9% when it freezes
- Thermal expansion - differential thermal expansion of minerals creates stress in rocks
- Organic activity - tree roots to micro-organisms
- Mechanical abrasion - things go bump

Freeze and Thaw

Fig. 16.9

Depressurization Cracks/Joints

Fig. 16.7

Tree Roots

Fig. 16.8

Weathering Products

- Bedrock - unaltered rock of any kind
- Regolith - a layer of broken pieces of rock and slightly altered rock that overlies the bedrock
- Soil - a layer of altered mineral material usually mixed with organic material

Soils depend on Climate and Parent Rock

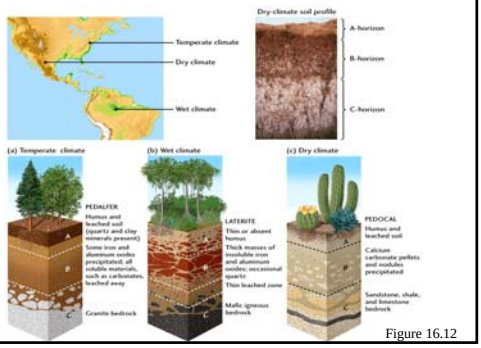


Figure 16.12