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.
- This process occurs because 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

Fig. 16.1

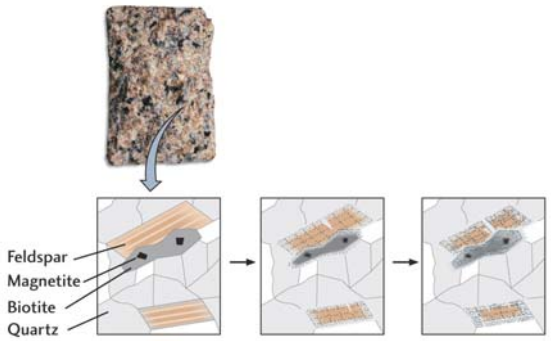
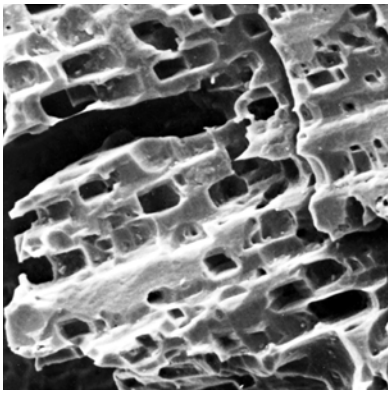
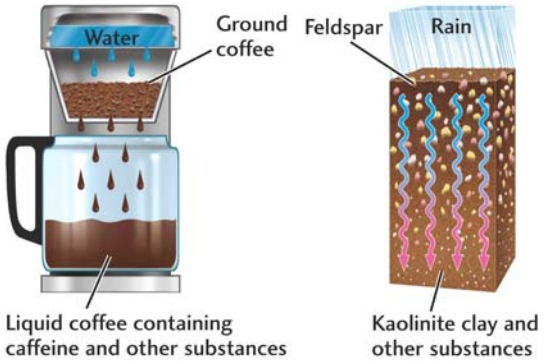


Fig. 16.2




Water
Ground coffee
Feldspar
Rain
Liquid coffee containing caffeine and other substances
Kaolinite clay and other substances

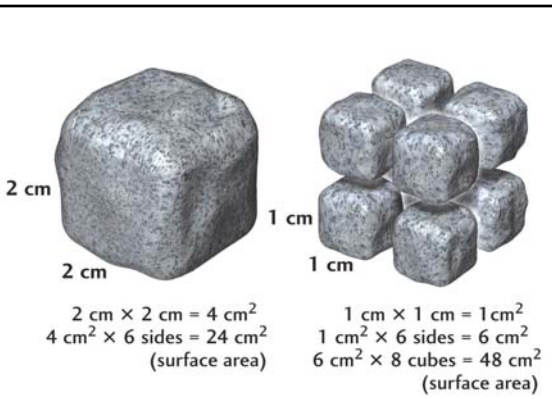

2 cm
2 cm
1 cm
1 cm
2 cm × 2 cm = 4 cm²
4 cm² × 6 sides = 24 cm²
(surface area)
1 cm × 1 cm = 1cm²
1 cm² × 6 sides = 6 cm²
6 cm² × 8 cubes = 48 cm²
(surface area)

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) = $CaCO_3$
- $CaCO_3 + H_2CO_3 = Ca^{2+} + 2HCO_3^-$
- Mafic silicates dissolve much more slowly

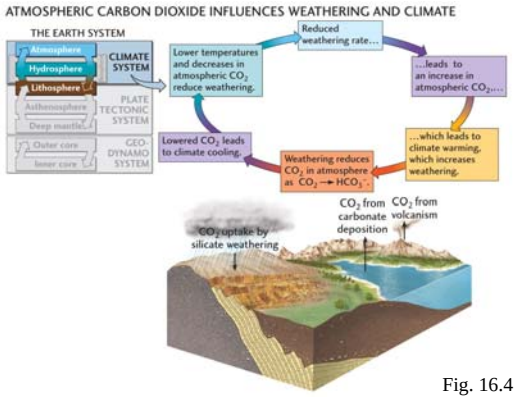


Fig. 16.4

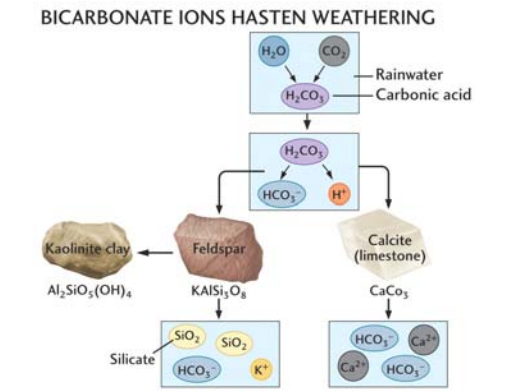


Fig. 16.4

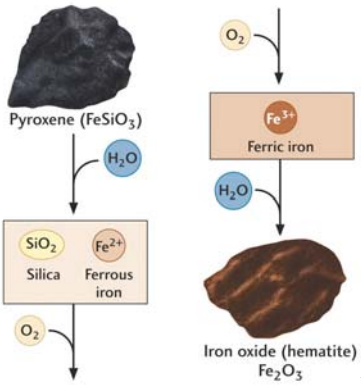


Fig. 16.5

Fig. 16.6

Table 7.2 Major Factors Controlling Rates of Weathering

	Slow → Weathering Rate → 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

Fig. 16.7

Fig. 16.8

Fig. 16.9

Weathering Terminology

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

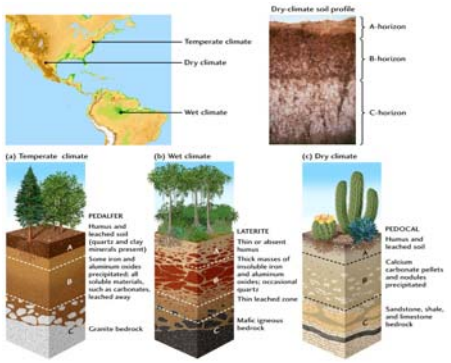


Figure 16.12