Weathering of Orthoclase Feldspar
Mineral in Rock + Weak Acid = Clay + Ions in Solution (Weathering Products)
- Clays Are Resistant Minerals

Where Is Acid Coming From?
\[ \text{CO}_2 + \text{H}_2\text{O} = \text{H}_2\text{CO}_3 \]
Carbon Dioxide + Water = Carbonic Acid

Where Is CO₂ Coming From?
Plant Respiration, Burning Fossil Fuels

K-Feldspar = Orthoclase
Orthoclase Weathering

Starting Point

\[ 2 \text{KAlSi}_3\text{O}_8 + 2 \text{H}_2\text{CO}_3 + 9 \text{H}_2\text{O} \]

Orthoclase + acid + water

Weathering Products

\[ \text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4 + 4 \text{H}_4\text{SiO}_4 + 2 \text{K}^+ + 2 \text{HCO}_3^{2-} \]

Kaolinite (clay) + silicic acid & ions in solution
Sediment
Loose Unconsolidated Particles of Solid Material (that Originate from the Weathering of Rocks, and are Transported by Water, Gravity, Ice, Air, etc.)

Soil
• Earthy Materials that Support Life Out of Doors.
• (vs. Engineer's Definition: Any Earthy Materials)
• Dirt: Out-of-Place Soil

Sedimentary Rocks
Rocks made of Sediments
3 Basic Types of “Sed Rx”
• Clastic ( = Detrital)
  – Made of Rock Fragments
• Biochemical
  – Formed by Organisms
• Chemical
  – Precipitated from Solution
Clastic (Sedimentary) Rocks

- Particle Size (= Texture)
- Geologists’ Texture Scale
  - Gravel >2 mm
  - Sand 0.062 mm to 2 mm
  - Silt 0.004 mm to 0.062 mm
  - Clay <0.004 mm

Gravel

- Granules 2 to 4 mm
- Pebbles 4 to 64 mm
- Cobble 64 to 256 mm
- Boulder >256 mm (~10 in)

- Gravel is a Particle Size, NOT a Rock Type

Maturity

Immature Sediments

- Facies

Mature Sediments
Maturity

- What Happens to Rock Fragments as They are Transported
- Increase In Resistant Minerals (e.g. Quartz) vs. Unstable Minerals
- Increase In Rounding
- Increase In Sorting

<table>
<thead>
<tr>
<th>Mature</th>
<th>Immature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rounded</td>
<td>Angular</td>
</tr>
<tr>
<td>~ 100% Quartz</td>
<td>Mixed Composition</td>
</tr>
</tbody>
</table>

Quartz Sand

Plag

Px

Vole
Types Of Clastic Rocks

- Based on Texture & Mineralogy
- Classification Reflects History of the Rock

Very Coarse-Grained Rx With Lots of “Gravel”

- Breccia: Angular Clasts
- Conglomerate: Rounded Clasts

Which is Most Mature?...
**Breccia**

Sorpresa Zone Breccia, Peru
Candente Resource Corp.

http://www.candente.com/s/PhotoGallery.asp

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**Conglomerate**

Photo by Sean Flanagan

www.geo.arizona.edu/geom256/azgeology/mranwaid/sedrx2.html

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**Sed Rx Made Mostly of Sand**

- **Sandstone**
- Names Based on Mineralogy
- Quartz (= Qtz)
- Feldspar (= F-spar)
- Other Rock Fragments (= Lithics)
**Ternary Diagram**

100% Qtz
95%
75%
50%

100% F-spar

100% "Lithics"

**Example:** 60% Qtz, 35% F-spar, 5% Lithics

---

**Sandstones**

100% Qtz
95%
75%
50%

Quartz Sandstone
Lithic Sandstone

Arkose
Greywacke

100% F-spar

100% "Lithics"

---

---
60% Qtz, 35% F-spar, 5% Lithics: Arkose

100% Qtz

95% Quartz Sandstone

75% Lithic Sandstone

100% F-spar

100% "Lithics"

Arkose

Greywacke

Which Sandstone is Most Mature?
Quartz Sandstone:
- Resistant Well-Rounded Quartz Grains
- ~100% Quartz

Qtz Sandstone

Mixed Composition
- Greywacke
- Plag

Volc

Last Two Rocks

100% Qtz

95% Quartz Sandstone

75% Lithic Sandstone

100% F-spar

100% "Lithics"

Arkose

Greywacke
Fine-Grained Clastic Rx

- Siltstone
  Silt = Grit or Flour Size (Usually Quartz)
- Shale
  - Layered Clay Minerals
  - ("Slate" to Local Miners)
- Mudstone
  - Massive Silt & Clay

Review
3 Basic Types of "Sed Rx"

- Clastic (= Detrital)
  - Made of Rock Fragments
- Biochemical
  - Formed by Organisms
- Chemical
  - Precipitated from Solution
Biochemical Sedimentary Rx

- **Example:** Limestone
- **Calcite or Aragonite Shells or Reefs - Biochemical Sediments**
- **Fossils Common**

Brachiopods in Limestone
Pendleton County, WV

www.wvgs.wvnet.edu/www/museum/musefoss.htm

- Example: Limestone
- Calcite or Aragonite Shells or Reefs - Biochemical Sediments
- Fossils Common

Biochemical Sedimentary Rx

- **Plant Fragments**
  - Wet Low-Oxygen Environments - Little Decay
  - Compaction, Breakdown of Volatile Organic Compounds: Increase in Carbon
- **Peat**
- **Lignite**
- **Bituminous Coal**
  - All Coal in WV, MD, Western PA

Incr. Pressure & Temp.

Plant Fragments - Peat - Lignite - Bituminous Coal

- Increased Pressure or Compacting Grains Through Time
Biochemical Sediments

• Petroleum (Octane)
  – Liquid Hydrocarbons
• Natural Gas (Methane)
  – Gaseous Hydrocarbons
• Source Rock
  – Coal Bed or Organic-Rich Shale
• Reservoir Rock
  – Permeable (Limestone, Sandstone, Possibly Fractured Igneous Rk)

Middle East Oil Fields

Chemical Sedimentary Rocks

• Minerals Crystalize from Dissolved Ions in Solution

Evaporites -
Rock Salt (Halite: NaCl) shown
Gypsum not shown
Chemical Sedimentary Rocks

• Replacement
  • Dolomite

  Mg-Rich Sea Waters React w/ Calcite To Form
  MgCa(CO₃)₂ - Dolomite

  Dolomite = Mineral and Rock

Chemical Sedimentary Rocks

• Replacement
  • Silicification

  – Dissolved Silica Precipitates (H₂O In Xl Lattice)

Geode: www.nature-gallery.com/amethyst/images5.jpg
Concretion

Chert Clovis Points
www.pma.edmonton.ab.ca/human/archaeo/aspects/points.htm

Sedimentary Structures

• Parallel Bedding
Sedimentary Structures

• Graded Bedding
Sedimentary Structures

- Ripple Marks

[Image: ripple_marks_modern.jpg]
Photo: Robert Grantham, Nova Scotia Museum of Natural History

- Mud Cracks

[Image: mudcracks.jpg]
mudcracks in old pond. Sandhills of NC.
Photo © Duncan Heron

More Sedimentary Structures

- Fossils

[Image: trilobites.jpg]
Trilobites
More Sedimentary Structures

- Trace Fossils

Dimetrodon Tracks, Ritchie Co. WV

Diagenesis: Define

Changes in Sediments and sedimentary rock
Up to 150°C
& 1 Kb Pressure

What’s a Kb?

Last two images are from the Mini-Museum of Geology & Natural History
http://www.wvgis.wvnet.edu/www/museum/museum.htm
Diagenesis: Examples

- Compaction
- Cementation
- Replacement
- Recrystalization

Diagenesis: Compaction

Metamorphism:

- Mineralogical and Structural Adjustment to Physical & Chemical Conditions
- $> 150^\circ\text{C}$ or 1 Kb Pressure
Study Suggestions

Test Covers Plummer Text book CH 1-6
http://www.geo.wvu.edu/%7Ekite/Test&QuizHub.html

Old Questions: Multiple Choice Test Questions from All Old Tests

Sample Tests: Test 1: e.g. 2005 Slides: 051111 (Green); 051122 (Blue)