Sedimentary Rock - forms by accumulation and lithification of sediment (loose grains)

Importance

- Most abundant rock type at Earth's surface
- Major economic resource - building stone, aggregate, cement, brick
- Geology - fossils, geologic history

Classification

- Clastic (detrital) - transportation and deposition of layers of sediment that is compacted and cemented
- Chemical - chemical precipitation, dissolved ions combine to form solid mineral grains
- Organic (biochemical) - accumulation of plant or animal remains, e.g., calcite shells

Clastic Sedimentary Rock Classification - based on grain size

- Conglomerate - large rounded grains (>2mm), coarse-grained texture
- Breccia - large angular grains, coarse-grained
- Sandstone - medium grained, sand-size (0.0624 - 2mm)
- Siltstone - fine grained (0.0625 - 0.004 mm)
- Shale - very fine grained (<0.004 mm), fissile (splits into thin sheets)
- Mudstone - very fine grained and massive (does not split)

Sandstone Classification

- Sand grains = framework grains
- Quartz, feldspar (plagioclase and K-feldspar) and lithics (rock fragments of any type)
- Space between sand grains = pore space (empty or filled with mineral cement (chemically precipitated) or matrix (mud/clay).
- Sandstones classified by abundance of framework grain type and abundance of matrix (Fig. 15.3)
- Arenite = sandstone with <5% matrix (empty or cement-filled pore space)
- Wacke = sandstone with >5% matrix
- Prefix = dominant framework grain type
- Quartz arenite (>90% quartz and little matrix), feldspathic arenite (arkose, feldspar-rich and little matrix), lithic wacke (rich in rock fragments and matrix

Optical Features of Sandstone

- Quartz (framework grains or cement) - low relief in PPL and low birefringence in XPL; always unaltered; (Uncemented Quartz Arenite - p. 115 in MacKenzie & Adams, 1994)
- Calcite (cement) - high relief, 2 cleavage directions at 60° and 120°, very high birefringence; (Calcite-cemented Quartz Arenite - p. 127 in M & A)
- Feldspar (framework grains) - low relief in PPL and low birefringence in XPL; plagioclase (polysynthetic twinning) and K-feldspar (cross-hatch twinning, exsolution lamellae); usually altered to clay minerals, often extensively (Feldspathic Wacke - p. 119 in M & A)
- Lithics (framework grains) - any rock type, multiple minerals in single grain, highly variable appearance (Lithic Wacke - p. 116 in M & A)
- Clay (matrix) - fine-grained, moderate birefringence (Lithic Wacke - p. 116 in M & A)
Depositional Environment - chemical, physical and biological conditions at Earth's surface associated with sediment deposition (Table 7.2); sediment source area = kinds of rock undergoing weathering to produce sediment; Quartz arenite - from quartz-rich rock, e.g., sandstone and weathered granite, Feldspathic arenite - from ~unweathered granite, Lithic wacke - from many ~unweathered rocks

New Textural Terms

Clastic texture (cemented, compacted) = clastic sedimentary rock with framework grains and pore space, empty or filled with cement or matrix

Roundness = smoothness of grains, related to sediment transportation, > transportation causes > rounded grains; Fig. 1 = reference scale

Sorting = similarity of grain sizes, related to sediment transportation type - wind and moving water = well sorted sediment (narrow range in grain size), landslides and glacial ice = poorly sorted sediment (broad range in grain size); Fig. 14.16 = reference scale

Packing = closeness of framework grains; Fig. 5-8 = reference scale for types of grain contacts, related to degree of packing

Induration = cohesiveness of rock; poorly indurated = loose and crumbly from weak cement and compaction, well indurated = resists crumbling, well cemented and compacted

Mature Sediment = well sorted, well rounded and mainly quartz with little matrix; extensive physical and chemical weathering, lengthy transport by wind or moving water

Immature Sediment = poorly sorted, angular and abundant feldspar, lithics and matrix; little physical and chemical weathering, little transport by wind or moving water

Reading Assignment for Next Week - Chemical Sedimentary Rocks


Begin to prepare your soil presentation (scheduled for March 26)!
Table 6-1 Detrital Sediments and Rocks

<table>
<thead>
<tr>
<th>Particle Size (mm)</th>
<th>Particle Name</th>
<th>Name of Rock Formed</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;0.004</td>
<td>Clay*</td>
<td>Shale</td>
</tr>
<tr>
<td>0.004-0.063</td>
<td>Silt</td>
<td>Siltstone</td>
</tr>
<tr>
<td>0.064-2</td>
<td>Sand</td>
<td>Sandstone</td>
</tr>
<tr>
<td>2-4</td>
<td>Granule</td>
<td>Breccia (if particles are angular)</td>
</tr>
<tr>
<td>4-64</td>
<td>Pebble</td>
<td>Conglomerate (if particles are rounded)</td>
</tr>
<tr>
<td>64-256</td>
<td>Cobble</td>
<td></td>
</tr>
<tr>
<td>&gt;256</td>
<td>Boulder</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gravel</td>
<td></td>
</tr>
</tbody>
</table>

1 mm = 0.039 inch

*Note that the term "clay," when used in the context of sediment size, denotes very fine particles of any rock or mineral (as opposed to the term "clay mineral," which refers to a compositionally specific group of minerals); all clay minerals have clay-sized particles, but not all clay-sized particles are composed of clay minerals.

from Chernicoff (1999) Geology

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Grain Roundness Reference

Angular

Subangular

Subrounded

Rounded

Well Rounded

Fig 15.3

Siliceous resistsates

Matrix<5%

ARENITES

Quartz arenite

Arenites

Feldspathic arenite

Lithic arenite

Feldspars

50

Siliceous resistsates

Matrix>5%

WACKES

Quartz wacke

Wackes

Feldspathic wacke

Lithic wacke

Feldspars

50

# Clastic Sedimentary Environments

<table>
<thead>
<tr>
<th>ENVIRONMENT</th>
<th>AGENT OF TRANSPORTATION, DEPOSITION</th>
<th>SEDIMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONTINENTAL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alluvial</td>
<td>Rivers</td>
<td>Sand, gravel, mud</td>
</tr>
<tr>
<td>Desert</td>
<td>Wind</td>
<td>Sand, dust</td>
</tr>
<tr>
<td>Lake</td>
<td>Lake currents, waves</td>
<td>Sand, mud</td>
</tr>
<tr>
<td>Glacial</td>
<td>Ice</td>
<td>Sand, gravel, mud</td>
</tr>
<tr>
<td>SHORELINE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delta</td>
<td>River + waves, tides</td>
<td>Sand, mud</td>
</tr>
<tr>
<td>Beach</td>
<td>Waves, tides</td>
<td>Sand, gravel</td>
</tr>
<tr>
<td>Tidal flats</td>
<td>Currents</td>
<td>Sand, mud</td>
</tr>
<tr>
<td>MARINE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continental shelf</td>
<td>Waves, tides</td>
<td>Sand, mud</td>
</tr>
<tr>
<td>Continental margin</td>
<td>Ocean currents</td>
<td>Mud, sand</td>
</tr>
<tr>
<td>Deep sea</td>
<td>Ocean currents, settling</td>
<td>Mud</td>
</tr>
</tbody>
</table>

**Figure 14.16**

Degrees of sorting.