Wentworth’s Grade Scale for Clasts

- Pebbles: 4–64 mm
- Granules: 2–4 mm
- Coarse Sand: 0.5–2 mm
- Medium Sand: 0.25–0.5 mm
- Fine Sand: 0.06–0.25 mm
- Silt: 0.004–0.06 mm
- Clay: <0.004 mm
Rounding and Sorting in Clasts

Rounding and Sorting in Detrital Sediments

<table>
<thead>
<tr>
<th>Angular</th>
<th>Sub-rounded</th>
<th>Well-rounded</th>
</tr>
</thead>
</table>

Rounding

Poorly sorted

Well-sorted
well-rounded beach pebbles
# Sedimentary Structures Chart

## Summary of Sedimentary Structures

<table>
<thead>
<tr>
<th>Physical Sedimentary Structures (produced by processes such as currents)</th>
<th>Characteristics</th>
<th>Origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laminations (or laminae)</td>
<td>Layers less than 1 cm thick</td>
<td>Form mostly as particles settle from suspension</td>
</tr>
<tr>
<td>Beds</td>
<td>Layers more than 1 cm thick</td>
<td>Form as particles settle from suspension and from moving sediment as sand in a stream channel</td>
</tr>
<tr>
<td>Graded-beding</td>
<td>Individual layers with an upward decrease in grain size</td>
<td>Deposition by turbidity currents or during the waning stages of floods</td>
</tr>
<tr>
<td>Cross-beding</td>
<td>Layers deposited at an angle to the surface on which they accumulated</td>
<td>Deposition on a sloping surface as the downwind side of a sand dune</td>
</tr>
<tr>
<td>Ripple marks</td>
<td>Small (&lt; 3 cm high) ridges and troughs on bedding planes</td>
<td></td>
</tr>
<tr>
<td>Current ripple marks</td>
<td>Asymmetric ripple marks</td>
<td>Result from deposition by water or air currents flowing in one direction</td>
</tr>
<tr>
<td>Wave-formed ripple marks</td>
<td>Symmetric ripple marks; generally with sharp crests and broad troughs</td>
<td>Formed by oscillating currents (waves)</td>
</tr>
<tr>
<td>Mud cracks</td>
<td>Intersecting cracks in clay-rich sediments</td>
<td>Drying and shrinkage of mud along a lakeshore, on a floodplain, or on tidal flats</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Biogenic Sedimentary Structures (produced by organisms)</th>
<th>Characteristics</th>
<th>Origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trace fossils</td>
<td>Tracks, trails, tubes, and burrows</td>
<td>Indications of organic activity. Intense activity results in bioturbation involving disruption of sediment</td>
</tr>
</tbody>
</table>
Turbidity Currents Creating Graded Bedding

As turbidity current slows, largest particles settle followed by smaller particles.

A graded bed
Diagram of Cross-bedding in a Sand Dune
Cross-bedding
Asymmetrical Current Ripples

**Current Ripple Marks** Current ripple marks are small (< 3 cm high) sedimentary structures with an asymmetric profile.

Current ripple marks form where water or wind flows in one direction over sand. The enlargement shows the internal cross-bedding in one ripple mark.
Current Ripples In a Stream Channel
Symmetrical Wave Ripples

Waves

Wave-formed ripples form where waves move to and fro.
Wave-formed ripples in shallow seawater.
Ancient Wave Ripples
Modern Mud Cracks on a River Flood Plain
Ancient Mud Cracks
Fossil Bioturbation
Modern Depositional Environments

- Glacial environment
- Stream environment
- Lake
- Sand dunes
- Alluvial fan
- Beach
- Delta
- Tidal flat
- Barrier island
- Lagoon
- Continental shelf
- Submarine fan
- Organic reef
- Deep marine environment
## Typical Rocks Deposited in Different Environments

<table>
<thead>
<tr>
<th>Environment</th>
<th>Dominant Type of Rocks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Continental Environments</strong></td>
<td></td>
</tr>
<tr>
<td>Fluvial</td>
<td>Mostly horizontally bedded conglomerate and cross-bedded sandstone; mudrocks not common</td>
</tr>
<tr>
<td>Braided stream</td>
<td>Mostly mudrocks deposited on floodplains; subordinate but distinctive lenticular sandstones deposited in point bars</td>
</tr>
<tr>
<td>Meandering stream</td>
<td></td>
</tr>
<tr>
<td>Desert</td>
<td></td>
</tr>
<tr>
<td>Alluvial fan</td>
<td>Poorly sorted conglomerate from debris flows and sandstone- and conglomerate-filled channels</td>
</tr>
<tr>
<td>Sand dune</td>
<td>Well-sorted, rounded sandstone with large-scale crossbeds</td>
</tr>
<tr>
<td>Playa lake</td>
<td>Laminated mudstone/siltstone; evaporites such as rock salt, rock gypsum, and others</td>
</tr>
<tr>
<td>Glacial</td>
<td></td>
</tr>
<tr>
<td>Outwash</td>
<td>Much like braided stream deposits</td>
</tr>
<tr>
<td>Moraines</td>
<td>Unsorted, nonstratified deposits of sand and gravel</td>
</tr>
<tr>
<td><strong>Transitional Environments</strong></td>
<td></td>
</tr>
<tr>
<td>Delta (marine)</td>
<td>Mudrocks and sandstone in coarsening-upward sequences; associated rocks of marine origin; fossils of marine and land-dwelling organisms</td>
</tr>
<tr>
<td>Beach</td>
<td>Rounded sandstone with variable sorting, commonly with shells or shell fragments, wave-formed ripple marks, and small-scale cross-bedding</td>
</tr>
<tr>
<td>Barrier island</td>
<td></td>
</tr>
<tr>
<td>Beach</td>
<td>As above</td>
</tr>
<tr>
<td>Sand dunes</td>
<td>Much like desert dunes but with sand-sized shell fragments</td>
</tr>
<tr>
<td>Tidal flat</td>
<td>Mudstone and sandstone in fining-upward sequences; distinctive herringbone cross-bedding in sandstone</td>
</tr>
<tr>
<td><strong>Marine Environments</strong></td>
<td></td>
</tr>
<tr>
<td>Continental shelf</td>
<td>Mostly cross-bedded sandstone with wave-formed ripples, marine fossils, and bioturbation</td>
</tr>
<tr>
<td>Inner shelf</td>
<td>Mostly mudrocks with subordinate sandstone; marine fossils and bioturbation</td>
</tr>
<tr>
<td>Outer shelf</td>
<td>Turbidite sequences in submarine fans with graded bedding in sandstone and mudrocks</td>
</tr>
<tr>
<td>Continental slope and rise</td>
<td>Limestone (dolostone). Limestone varies from coquina (made of shell fragments) to oolitic limestone to micrite (carbonate mud). Cross-beds, mud cracks, ripple marks common; marine fossils</td>
</tr>
<tr>
<td>Carbonate shelf</td>
<td>Pelagic clay and calcareous and siliceous oozes</td>
</tr>
<tr>
<td>Deep-ocean basin</td>
<td>Rock salt and rock gypsum the most common, but others, including potassium and magnesium salts, may be present</td>
</tr>
<tr>
<td>Evaporite environments</td>
<td></td>
</tr>
</tbody>
</table>
River Meander
Deposits Formed From a Meandering River

(d) The deposits of meandering streams are mostly fine-grained floodplain deposits with subordinate sand bodies.
Typical Desert Environments in the U.S.A

(a) Block diagram showing the association of deposits found in a desert environment.

(b) A playa lake near Fallon, Nevada. Notice the deposits of rock salt that were forming when this image was taken in June 2007.
Active Advancing Glacier

Glaciers and Their Deposits

- Sediment-filled depressions
- End moraine
- Ice block left by retreating glacier
Glacial End Moraine and Outwash Deposits
Glacial Lake Varves and Dropstone
Modern Carbonate Environments

- Algal mats
- Tidal channel
- Desiccation cracks
- Stromatolites
- Carbonate barrier
- Sea level
- Lagoon
- Debris piles
- Patch reef
- Reef breccia
- Micrite and dolomite
- Fossiliferous micrite
- Reef rock
- Fossiliferous micrite
- Micrite

Low or distant source land