Sedimentology 001

What is sedimentology?

Sedimentology ...encompasses the study of modern sediments such as sand [1], mud (silt) [2] andclay [3] and understanding the processes that deposit them.[4] It also compares these observations to studies of ancient sedimentary rocks.[5] Sedimentologists apply their understanding of modern processes to historically formed sedimentary rocks, allowing them to understand how they formed.

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Sand

- Sand is any eroded material (igneous, metamorphic or sedimentary) that has a grain size from 1/16th to 2 millimeters in size.

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Mud (silt)

- Mud or Silt is any material eroded from another form of rock to the size of 1/256th to 1/16th millmeter in size.
  - A good test is to rub it against your teeth, if it feels 'gritty' and is small enough you have a hard time seeing grains, then it's mud or silt.

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Clay

- Clay is any material eroded from other forms of rock that has a size of <1/256th of a millimeter.
  - To test for clay rub the material against your teeth or between your fingers. If it feels 'slippery' or smooth, then it's probably Clay.

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What are some types of sedimentary rock?

- There are four basic types of sedimentary rocks.
  - 1) Clastic – consist of rock pieces cemented together
  - 2) Biogenic – produced from biologic organisms, may consist of shells and skeletons organisms.
  - 3) Organic – consist of plant remains
  - 4) Chemical – formed from minerals that are precipitated from chemical solutions.

How do sediments form?

- Clastic Rocks are formed by weathering, erosion, transportaion and deposition.
  - Classified by
    - Grain Size
      - Gravel -
        - >256 mm Boulders — Conglomerates, and Breccia
        - >64- 256mm Cobbles
        - >2 -64 mm Pebbles
      - Sand-
        - >1/16th mm – 2 mm Sand — Sandstone
      - Mud
        - >1/256th mm - 1/16th mm Silt — Mudstone, Siltstone
        - <1/256th mm Clay — Claystone, Shale

How do sediments form? (cont.)

- **Biogenic rocks : produced by biological processes, often consist or contain 'hard parts' (fossils) of organisms**
- **Types of Biogenic rocks**
  - **Carbonates : particles cemented with $CaCO_3$**
    - **Limestones and Chalks**
  - **Siliceous rocks : cemented/composed of SiO_2**
    - **Chert and Diatomite (diatomaceous earth)**
  - **Organic rocks : consist of plant remains**
    - **Coal**
  - **Chemical rocks : produced from evaporation of water from a solution.**
    - **Evaporites: halite, gypsum**

How did these sedimentary rocks form?

- Erosion of 'older' rocks caused by ...
  - Water : running water causes rocks to collide, breaking rocks into smaller pieces and polishing them
  - Wind : air movement causes particles to bounce off one another (saltation) and chips pieces off the surfaces
  - Gravity: gravity causes rocks to fall to lower levels smashing other rocks on the way
  - Biological erosion : plants (and animals) cause damage to rocks, breaking them into smaller pieces.

How do you tell which type of erosion caused a sediment?

- Fluvial / Water erosion causes sediments to be 'well rounded' if they are moved by it for a long time, these tend to be well sorted and can form into layers.
- Wind / Alluvial erosion causes sediments that are chipped looking and angular, unless they have been a long time in forming.
- Gravity causes sharply angular and poorly sorted sediments.
- Biological can be either extremely fine grained or larger more angular grains.
  - Finer sediments form either over a long period (loess) or in calm water where they can slowly settle out (mudstone/shale)
  - Coarse sediments were formed fairly rapidly

How can rocks tell us about the environment in which they formed?

- These characteristics help determine what the depositional environment was like.
  - Color
  - Texture
  - Composition
  - Sedimentary Structures

What can color of sediments tell us about depositional environment?

- Black coloration: suggests organic material and iron. (Anoxic environment)
  - Possible abundance of organisms
  - Low oxygen content
  - Usually produced in Swamps, or restricted (shallow?) basins (not much movement of water)
- Red coloration: suggests iron oxide
  - Oxidizing conditions
  - Subaerial exposure
  - Hot climate
  - Usually produced in Terrestrial settings, or possibly shallow marine.

What can texture tell us about depositional environment?

- Texture refers to
  - Grain Size: finer particles = longer weathering
  - Grain Sorting: better sorting = longer weathering
  - Grain Shape : the longer a grain is weathered the more spherical it will become.
  - Arrangement of grains: various types of deposition can cause the arrangement to vary.
- Fluvial deposits tend to be well sorted, and more spherical, but they can vary in size depending on water velocity etc.
- Alluvial deposits tend to be well sorted, less spherical, but typically 'graded' from larger grains to smaller moving upward.

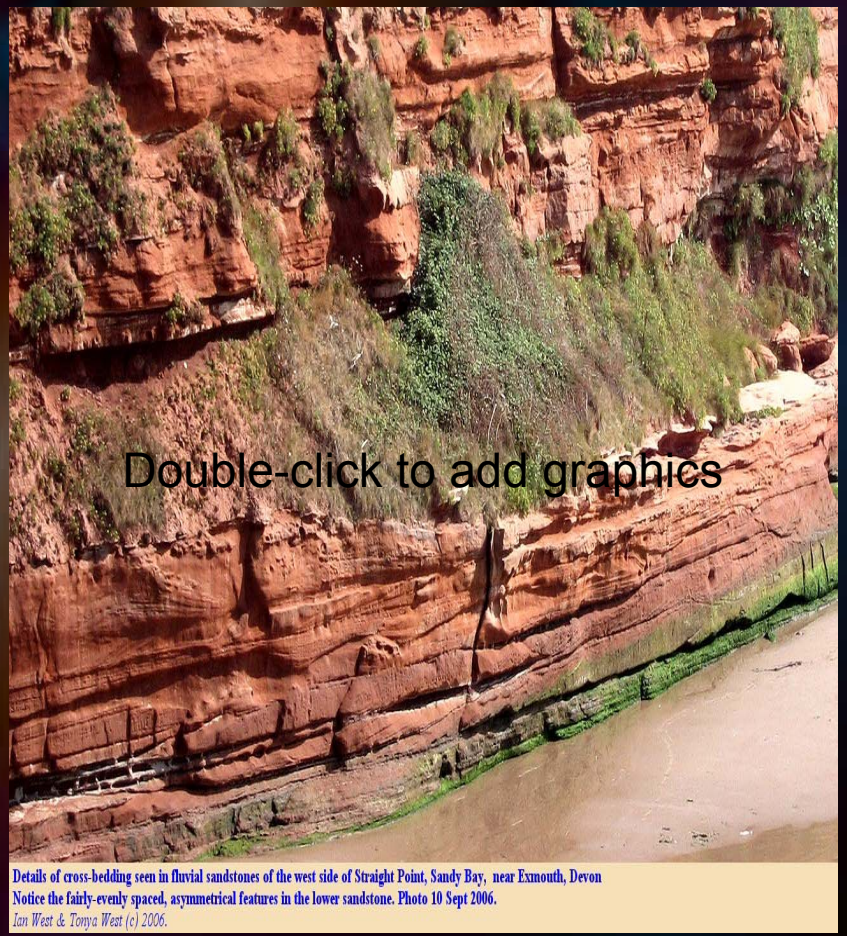
What can sedimentary structures tell us about the depositional environment?

- Sedmimentary Structures
  - Bedforms and surface markings
    - The shape and structure of these markings can tell what type of transport caused them (alluvial or fluvial). They can also tell such things as direction of movement and give an idea of velocity.
  - Internal structure : Can identify calm settling environment, or a steady movement of air/water, OR a violent episode of rapid motion (turbidity).
  - Bioturbation : might be seen as fossils, fossil tracks, or footprints. Anything caused by an organism.
  - Biological formations : any structure created by organic organisms. A reef is one example, 'devils corkscrew' burrows is another.

Examples of sedimentary structures for identification of depositional environment.

- Examine the following slides and try to determine what the depositional environment was like.

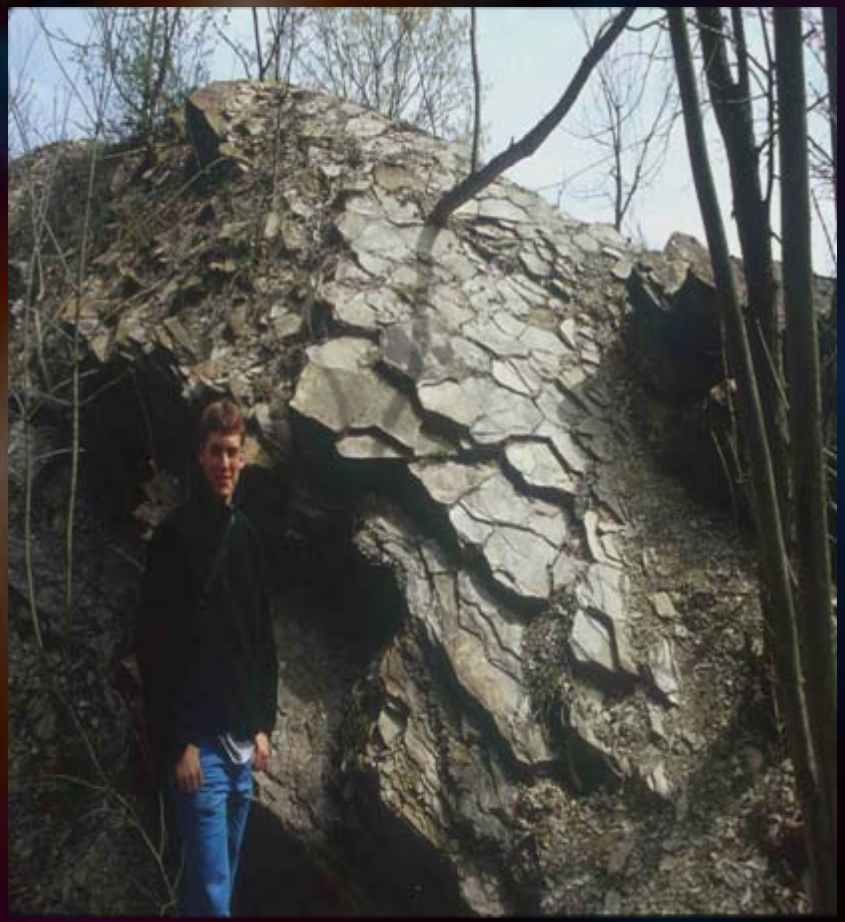
What type of depositional environment?



Details of cross-bedding seen in fluvial sandstones of the west side of Straight Point, Sandy Bay, near Exmouth, Devon
Notice the fairly-evenly spaced, asymmetrical features in the lower sandstone. Photo 10 Sept 2006.
Ian West & Tonya West (c) 2006.

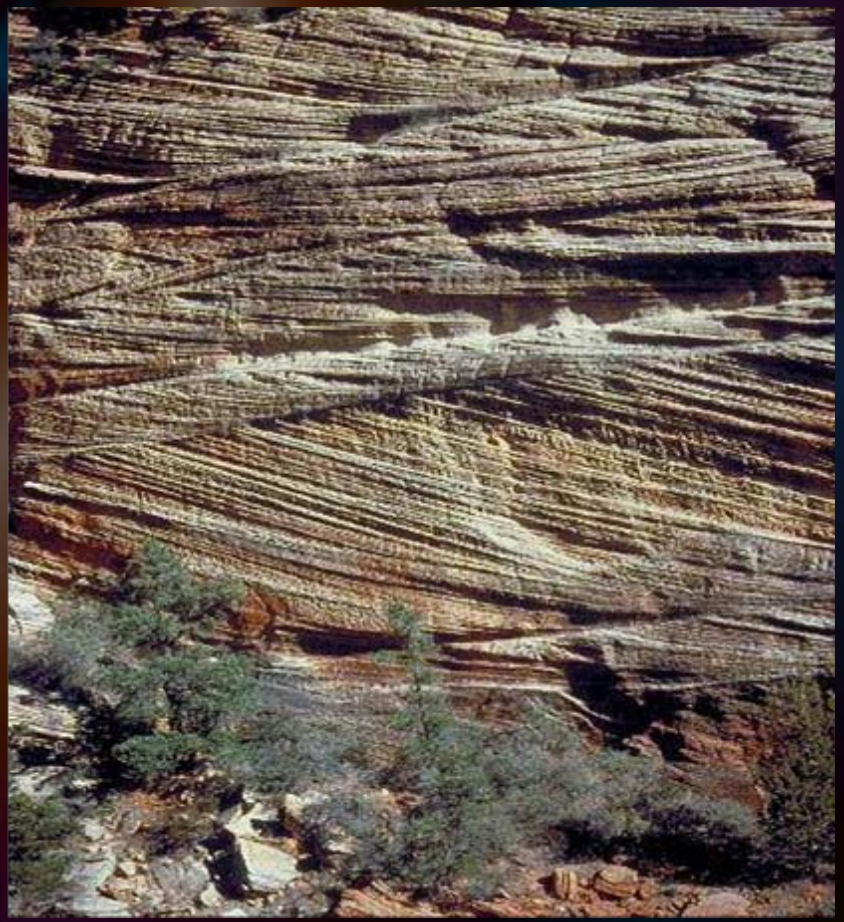
- Red sandstone
  - Iron rich environment
  - Good bedding?
    - Alluvial or fluvial??

What type of depositional environment?



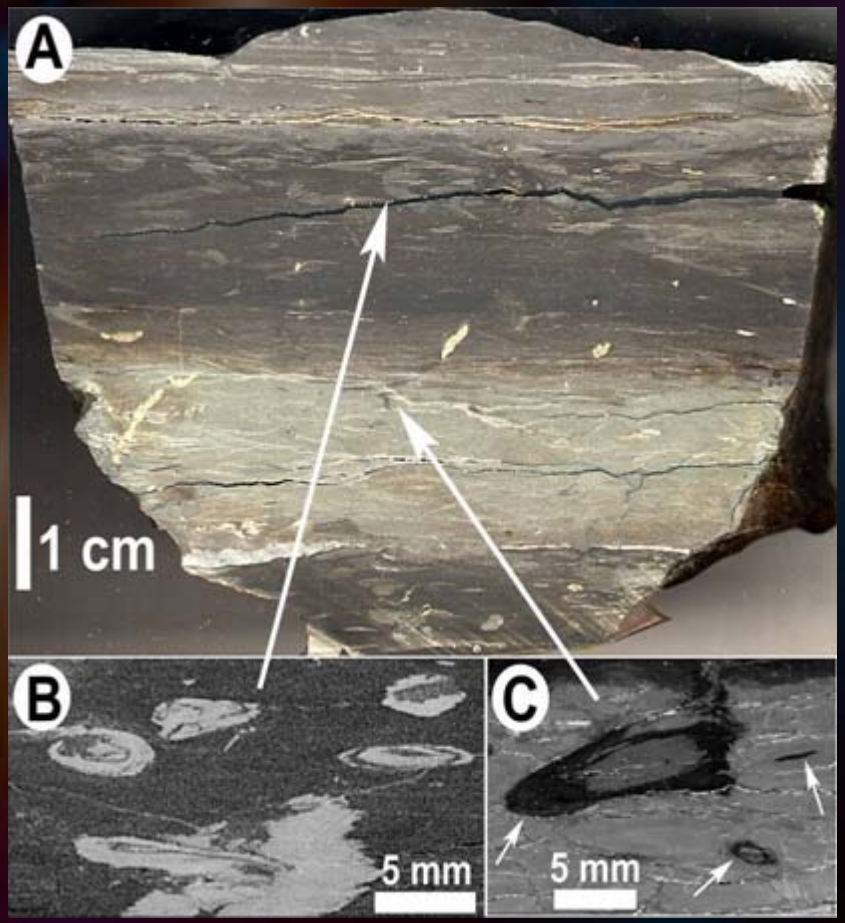
- Dark, dense, orthogonal shapes.
  - Silt or Mudstone
  - Dark(organic rich)
  - Mud cracks

What type of depositional environment?



- Az sandstone, much crossbedding.
  - Probable alluvial deposition.
  - Winds shifting over time.

What type of depositional environment?



- Black shale, rich organics....
  - Marks inside shale indicate moving organisms.
  - Silt / mud structure implies shallow marine, calm water
  - Anoxic environment

What type of depositional environment?

- Ancient reef structure.
  - Biogenic structure
  - Shallow marine
  - Tropical climate

What type of depositional environment?

- Fossile roots ? Or organisms.
  - Bioturbation
  - Probably temperate to tropical.
  - Swamp or wetlands.

What type of depositional environment?

- Well bedded dark shale.
  - Shallow marine
  - Anoxic environment
  - Much biological material = shallow marine or swamp
  - Tropical/temperate climate