SEDIMENTS

- Sediments are typically laid down in layers, or strata, usually in a body of water.
- On the seafloor, sediments are thinnest near spreading centers (young seafloor) and thicker away from the ridge, where the seafloor is older and has more time to accumulate. Sediments are also much thickest near continents.
- Sediments can be classified BY ORIGIN: or BY AREA OF DEPOSIT:

  Lithogenous = generated from rocks
  Hydrogenous = generated from water
  Biogenous = generated from life

  Neritic = deposited on the continental shelf
  Pelagic = deposited beyond the continental shelf

Lithogenous = broken bits of rock (the term "terrigenous" is often used interchangably with "lithogenous")

- Sediment layers are thickest near the continents, the source of lithogenous material, and thinner farther out to sea.
- If you determine that the seds are lithogenous, next check grain size: are they fine, medium or coarse?
  Sediments are coarsest near the continental source: the farther from the source, the finer the sediments.
- Land areas highest above sea level have the fastest erosion, and the sea floor near mountains will have the most rapid sediment accumulation.
- Running water is the main delivery mechanism.
  Wet climates have fast erosion on land, and rapid sediment deposition in nearby oceans. Arid regions have slower sedimentation rates.

- **Turbidites** are sediments deposited by underwater landslides (turbidity currents), caused by earthquakes or over-loading of the seds on continental shelf. The seds are sorted out as they flow, and settle in a regular pattern: the coarses particles settle first, then medium, then fine. Repeated sequences of this graded bedding indicates that an are has had many underwater landslides.
- **Volcanic ash** is produced by violent volcanic eruptions. Ash then settles out of the atmosmosphere, through the ocean, and contributes to the sediment column. Where would this type of violent eruption occur?
- **Red Clays** and **Brown Muds** are very fine-grained, thin sediments found on the abyssal plains, where there isn't much contributing to the sediment column. These are the finest lithogenous particles from the continents, carried a long distance out to sea before settling out.

Hydrogenous = precipitate chemically out of seawater. Ions dissolved in seawater combine to form minerals, which precipitate out as solids

- **Polymetal Sulfides:** abundance of metals and sulfur compounds
  - ions dissolved from ocean crust by hot water, precipitate when contact cold water; found at present or past sites of hydrothermal vents
- **Manganese Nodules:** marble-sized to fist-sized lumps, rich in manganese, copper, nickel and silica precipitated from seawater
  - form a kind of cobblestone pavement on parts of the abyssal plains; always at the top of the sediment column
  - form where sediment accumulation rate is very slow: far from continents and plate edges, far from biol. productive zones
- **Evaporites:** layered deposits of salt
  - form in arid regions; form when a body of seawater becomes isolated, the water evaporates & leaves behind solid salt deposit
- **Phosphorite Nodules:** small spherical masses rich in phorphorus

- form on continental shelf mostly, in areas where the concentration of phosphorus in the water exceeds 15%

Biogenous = remains of organisms that die, settle to the sea floor

- The vast majority of biogenous particles in marine sediments come from microscopic floating organisms called **plankton**.
- Biogenous seds will be thickest in areas where the water is rich in nutrients (plant food) so that there is abundant biological productivity.
- Near coastlines, the biogenous component of sediments may be "diluted" or masked by the rapid input of lithogenous sediments.
- If a sediment is > 30% biogenous, we call it an **ooze**.
- If it is an ooze, check the compostion. Is it **calcareous ooze** or **siliceous ooze**? The type of ooze depends on two things.
  (1) the type of organisms that live in the surface water at that location
  (2) whether the material dissolves or is decayed as it settles through the water column

• **Calcareous ooze**: made up mostly of calcium-carbonate ($CaCO_3$) shells
- main organisms: **coccolithophores** (plant plankton) & **foraminifera** (animal plankton)
- note chalky appearance of the $CaCO_3$ tests (shells) under the microscope
- $CaCO_3$ -bearing organisms flourish where the surface water is fairly warm
  $CaCO_3$ dissolves quickly in cold water, so they are not so abundant where surface water is cold
- Calcareous sediments are found mostly on shallow sea floor, because it dissolves as it settles through the cold water in the deep sea
  Dissolving of $CaCO_3$ is also affected by water chemistry and pressure (depth)
- The level below which we don't see carbonate sediments is called the CCD (**Carbonate Compensation Depth**).
  The depth of the CCD varies: Atlantic Ocean = 5000 m; South Pacific = 4500 m North Pacific = <4000 m

• **Siliceous ooze**: made up mostly of silica (SiO_2) shells
- main organisms: **diatoms** (plant plankton) & **radiolaria** (animal plankton)
- note the fine structure and glassy appearance of the silica tests (shells) under the microscope
- these organisms flourish where the surface water is cold, rich & biologically productive. Siliceous oozes are formed under **upwelling** zones.
- Siliceous ooze is found on deeper sea floor, below the level where carbonates have dissolved.
- siliceous material also dissolves a bit in seawater, but much more slowly than carbonate material.

• **Organic muds** = high concentration of organic tissue (the soft parts)
-occur where biological productivity at the surface is great, & not all of the organic tissue decays before it is buried in sediment column.
- usually black, sticky muds, devoid of oxygen (anoxic); often have that "rotten egg smell" produced by the decay of organics in the seds
- marine environments that accumulate organic-rich muds set the stage for the production of an important resource -- hydrocarbons

• **Hydrocarbons** (oil & gas) are formed when organic material (carbon, oxygen, hydrogen) is buried and chemically converted where
- the sedimentation rate is fast enough to bury the organics before they decay away; terrigenous and neritic deposits.
- this conversion is speeded up if the heat flow in the area is a little elevated, but not too hot
- the fluid oil & gas migrates through sedimentary layers that are "permeable" (have pore spaces that let liquids pass through)
- the geologic environments that have all the necessary requirements for the formation/accumulation of hydrocarbons include
  - rifted margins that become passive continental margins: example North Slope of Alaska, Gulf of Mexico / Caribbean Sea
  - old river deltas: example in deeper layers of the Mississippi River delta
  - marginal sea, behind island arcs: example Bering Sea, Sea of Japan

- old ocean basins that are closing up: example Persian Gulf, which is the last remnant of the Tethys that has closed up over time and compressed its sedimentary layers; this area contains 60% of the world's known oil supply.