Ocean 201 week 5 Lecture 2: Deep-Sea Sediments (M.J. Mottl)

Text from slides

Where is the Sediment?
- Continental Margins: 87% (covers ~21% of ocean area)
- Deep-ocean floor: 13%

Sediment Deposition Rates (time to deposit 1 cm on seafloor)
- **Terrigenous Deposits**
  - Ala Wai Canal ~3 mo
  - Near large rivers 1-10 yr
  - Continental Shelf 30 yr
  - Continental Rise 100 yr
- **Pelagic Deposits**
  - Biogenic sediment 200-1000 yr
  - Abyssal Clay 2000-10000 yr
  - Mn nodules/crusts >1 M year

Sediment classification by:
- Mode of formation: ***chemical*** vs ***detrital*** (particles)
- Location (and source)
- Degree of lithification

Types of **Detrital** Sediments
- ***Terrigenous***: from land and transported by…
  - rivers
  - turbidity currents (= mudslides: graded deposits)
  - wind
  - floating ice ("ice rafted": poorly sorted)
- ***Biogenic***: from organisms
- ***Volcanogenic***: from volcanoes (esp. ash)
- ***Cosmogenic***: from outer space

Sediment from Rivers
Three rivers account for most of sediment input to Atlantic Ocean:
Amazon, Congo, Mississippi

Turbidity Currents
- Density-driven mudslides off continental shelf; essentially "undersea avalanches"
- Usually triggered by earthquakes
- Fast moving, travel long distances
- Produce submarine canyons, fans, and graded deposits

Hyperpycnal currents

- Hyperpycnal currents: freshwater whose density is increased above saltwater by TSS load
- Are probably a major mechanism for transporting sediments from continents to the offshore seafloor

Sediment Carried by Wind

Ice Rafted Sediment

**Biogenic** Sediments
- From organisms: ***calcareous*** (CaCO3) and ***siliceous*** (SiO2)

Other Detrital Sediments
- **Cosmogenic:** From space (dust, tektites, Fe-Ni spherules)
- **Volcanogenic:** From volcanoes (note that these are also terrigenous)

**Chemically** Derived Sediments
- ***Authigenic***: formed in place, within sediment
- ***Hydrogenous***: precipitated directly from seawater (Fe-Mn nodules, Crusts, Evaporites)
- ***Hydrothermal***: precipitated from hot water (polymetallic sulfides, metalliferous Fe-rich sediments)

Classification by **Location**
- ***Pelagic***: Found in open ocean
- ***Hemipelagic***: Oceanic but near land (>25% terrigenous component)
- ***Neritic***: Nearshore, continental shelf

Classification by Degree of **Lithification**
- ***Ooze***: calcareous (CaCO3) or siliceous (SiO2)
- ***Chalk***: calcareous
- ***Limestone***: calcareous
- ***Chert***: siliceous

Deep-Sea Sediment: Sampling
- Grab sampling
- Gravity coring
- Piston coring
- Drilling

Deep-Ocean Drilling
- International deep-sea sampling program
- Oil-drilling technology/ships
- DSDP, then ODP, now IODP
- Key to confirmation of plate tectonics
- Recovered 1000’s of meters of sediment and seafloor rock

Re-entering a hole (after changing the drill bit) was the key to drilling deeply into the seafloor:

- Re-entry cone and sonar beacon on seafloor
- 14 Computer-driven thrusters on ship, with variable-pitch propellers

**Factors Affecting Sediment Composition**

**Nearly all sediments are mixtures**, depending on:

- **Supply**
- **Dissolution**
- **Dilution** (especially by terrigenous component)
- **Alteration** after deposition

Distribution of Deep-Sea Sediment

- Mean thickness
  - Atlantic: 1000 m, from river input
  - Pacific: <500m; starved because of mountains, narrow continental margins, and marginal seas
- Nearly all deep-sea sediments are mixtures, with three dominant components.

Deep-Sea Sediment Components

1) ***Calcareous Ooze*** **48%**
   - Foraminifera (protozoa)
   - Nannofossils (algae)
   - Pteropods (planktonic mollusks)
2) ***Abyssal Clay*** **38% by vol.**
3) ***Siliceous Ooze*** **14%**
   - Radiolaria (protozoa, common near equator)
   - Diatoms (algae, common near Antarctica)

Organisms Contributing to Biogenic Sediments

| Composition | Plants | Animals |
|---|---|---|
| CaCO3 | Coccolithophores | Foraminifera |
| SiO2 | Diatoms | Radiolaria |

***Carbonate Compensation Depth***

- CaCO3 is more soluble in deeper colder water.
- At the ***CCD***, for calcareous sediment:
  - rate of supply = rate of dissolution
  - CaCO3 dissolves as fast as it is supplied.
  - None accumulates in sediment at or below this depth.

Carbonate Compensation Depth: II

- Previously deposited calcareous sediment transported below the CCD can survive if buried by other (e.g., siliceous) sediment.

Supply vs Dissolution
Supply (flux) of particles is important to accumulation.
Areas of high productivity (equatorial, polar) have large particle fluxes that lead to accumulation.