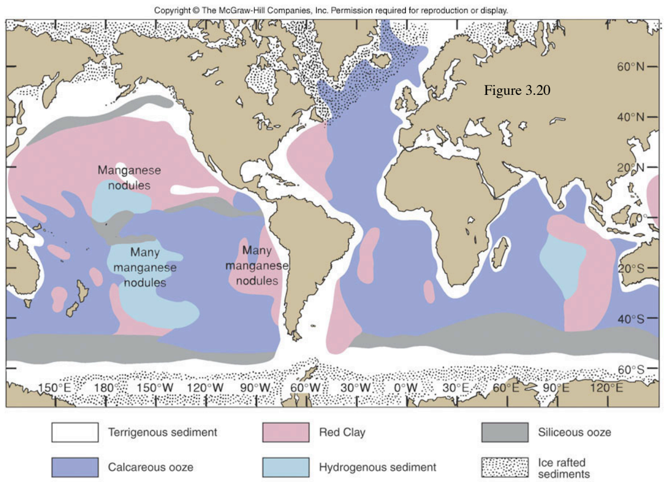
Sediments of the Sea Floor



Sediment sizes

- Sediments are categorized by their size
  - Gravel > 2 mm
  - Sand 0.06 mm – 2 mm
  - Silt 4 µm – 60 µm
  - Clay <4 µm
  - (Book combines silt & clay as mud)
- Size classification is independent of composition or origin of sediment particles

Sediment sizes

- Sediment size determines transportability
  - Larger particles sink more rapidly
    - Deposit closer to their point of origin
  - Smaller particles sink more slowly
    - Deposit farther from their point of origin

Table 3.2 Sediment Sinking Rate and Distance Traveled Garrison Table 5.1 p. 118

Sediment Size	Approximate Sinking Rate (m/s)	Time for a Vertical Fall of 4 km (days)	Horizontal Distance Traveled in a 5 cm/s Current (km)
Very fine sand	9.8×10^{-3}	4.7	20.4
Silt	9.8×10^{-5}	470	2040
Clay	9.8×10^{-7}	47,000	204,000

Sediment formation

- Sediments are categorized by their mode of formation :
  - Lithogenous
    - Created from rock (by erosion)
  - Hydrogenous
    - Created from water (by chemical reactions)
  - Biogenous
    - Created from living creatures (dead skeletons)
      - Calcareous, siliceous
  - *Cosmogenous*
    - *From outer space*

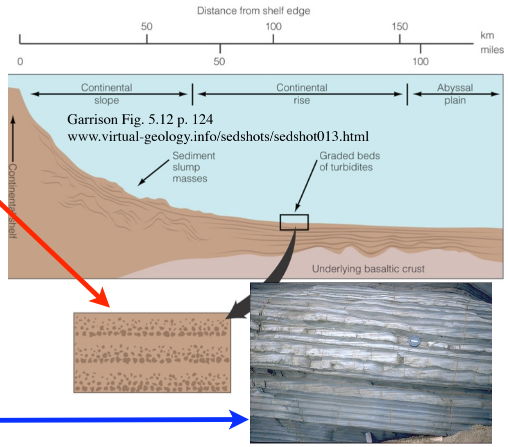
Lithogenous Sediments

- Erosion of terrestrial material=terrigenous
  - Made of same material, i.e. Al & Mg silicates
  - Usually indication of land nearby
- Transported by rivers, water currents, turbidity currents & submarine landslides.
- Global transport of very fine material
  - Wind & currents
  - Red clay, brown mud—"dust"
  - Dominant on abyssal plains
    - Lack of other sources

curriculum.calstatela.edu/courses/builders/lessons/less/les5/abyss.html

Lithogenous Sediments

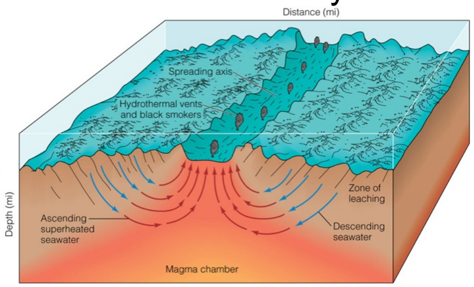
- Turbidity currents leave characteristic sediments
  - Graded beds
    - Repeated sequence from coarse to fine
  - Diagnostic of a continental rise or trench
  - Lithify to form "turbidites"



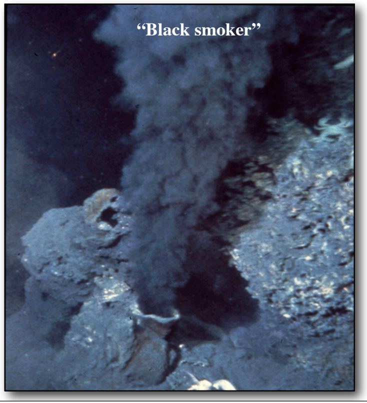
Garrison Fig. 5.12 p. 124
www.virtual-geology.info/sedshots/sedshot013.html

Hydrogenous Sediments

- Hydrothermal metallic sulfides
  - Form from underwater volcanic action
  - Found in present or relict rift valleys



Garrison Fig. 4.26 p.104

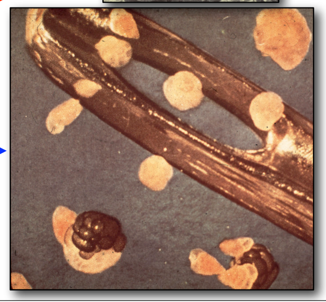


Hydrogenous Sediments

- Manganese nodules
  - Mn, Fe, Cu, Co, Ni
  - In deep-water or current-scoured areas where other sediments are scarce
  - Form like pearls around a nucleus
  - Form slowly (1-10 mm/million years)

Biogenous Sediments

- Microscopic algae & animal skeletons
  - >30% biogenous=ooze
- Calcareous (calcium carbonate)
  - Coccolithophorids
    - 1-celled algae
  - Foraminifera
    - 1-celled animals (Protozoa)
    - White cliffs of Dover



Calcareous Sediments

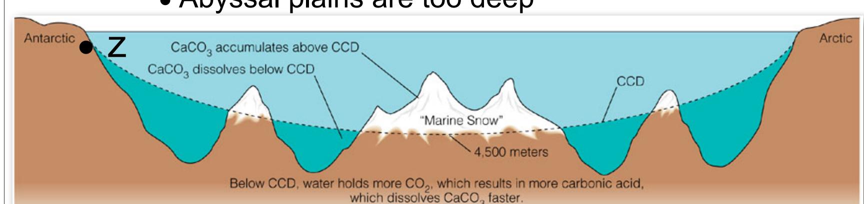
- Pteropods—swimming sea slugs
  - Vestigial shell
  - “Pteropod ooze”

Calcareous Sediments

- Calcareous skeletons dissolve in sea water
  - Solubility = rate of dissolution increases with depth
    - Higher pressure
    - Lower temperature
    - Higher carbon dioxide (acid)
  - Begins dissolving below about 500 (Pacific) to 1500 (Atlantic) meters
    - “Lysocline”—depth at which sea water is undersaturated

Calcareous Sediments

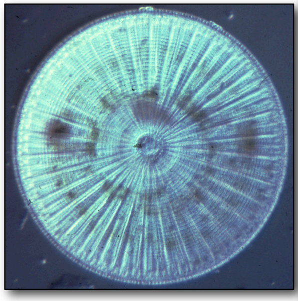
- Calcareous skeletons dissolve in sea water
  - Completely dissolve below about 4500 m
    - “Carbonate compensation depth” or “Snow Line”
  - Mainly deposits on elevated sea floor
    - Flanks of mid-ocean ridges & seamounts
    - Abyssal plains are too deep

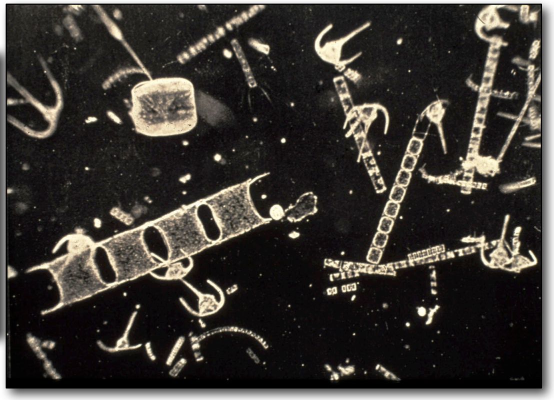


Garrison Fig. 5.14 p.126

Biogenous Sediments

- Siliceous — Silica skeletons
  - Diatoms = 1-celled algae



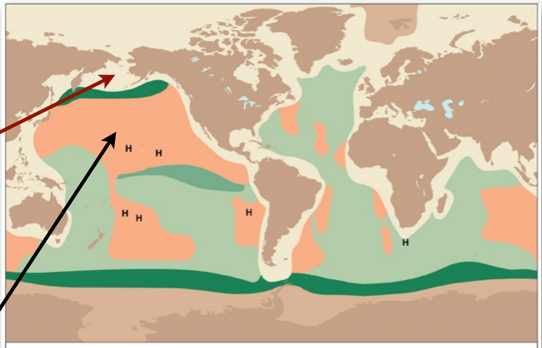


Biogenous Sediments

- Siliceous — Silica skeletons
  - Radiolaria = 1-celled animals (Protozoa)
  - Do not dissolve readily in sea water
  - Deposits mirror surface production of organisms

Sediment Distribution: Size

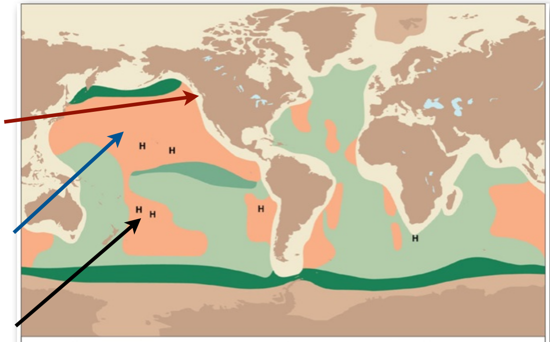
- Lithogenous
  - Coarser near shore
    - Sand & gravel on the shelf
  - Finer far from shore
    - Red clay on the abyssal plains



Garrison Fig. 5.10 p.123

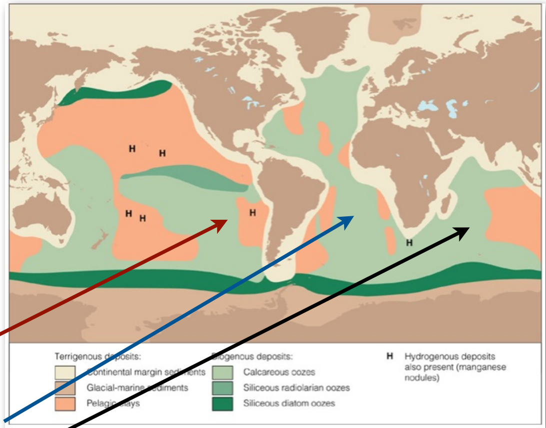
Sediment Distribution: Supply

- Lithogenous
  - Abundant near shore
    - Close to source
  - Sparser far from shore
  - Mn nodules where sediment supply is sparse



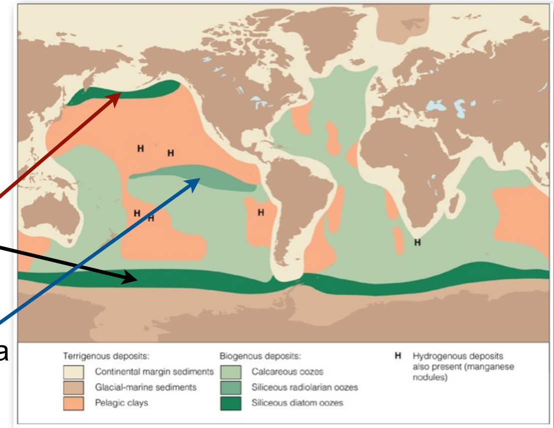
Sediment Distribution: Supply

- Calcareous
  - Skeletons produced widely
  - Deposits follow mid-ocean ridges
    - E. Pacific Rise
    - Mid-Atlantic
    - Mid-Indian



Sediment Distribution: Supply

- Siliceous
  - Skeletons dominant sub-polar waters
    - Diatoms
  - And at Equator
    - Radiolaria
  - Diluted on shelf



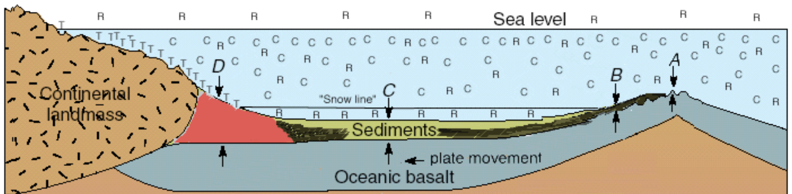
Summary

- Terrigenous
  - Determined mainly by transport processes
    - Coarse sand & gravel on continental margins close to shore
    - Fine red clay in deepest areas farthest from shore
- Hydrogenous
  - Special chemical/physical conditions
    - Hydrothermal vents
    - Mn nodules where other sediments are scarce

Summary

- Calcareous
  - Determined mainly by dissolution (snow line)
  - Common on upper areas of mid-ocean ridges & seamounts
- Siliceous
  - Determined mainly by production
  - High latitudes & Equator
- Sediment cores
  - Layers & thickness of sediment at a given location give clues to age of sea floor & changes in ocean conditions over time

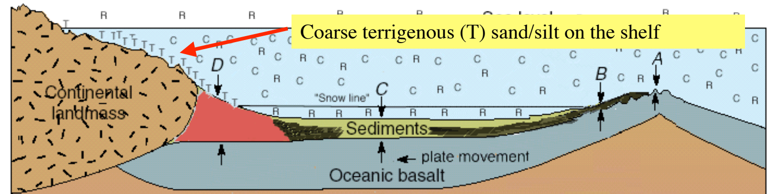
Understanding Sediment Cores



	Sediment age		Sediment type	
Location	Thickness	Surface	Bottom	Surface	Bottom
A	1–5 m	recent	100 years		
B	10–100 m	recent	10 × 10⁶ years		
C	500 m–1 km	recent	75 × 10⁶ years		
D	1–3 km	recent	130 × 10⁶ years		

Sverdrup Figure 2.16 (modified) Passive margin

Understanding Sediment Cores



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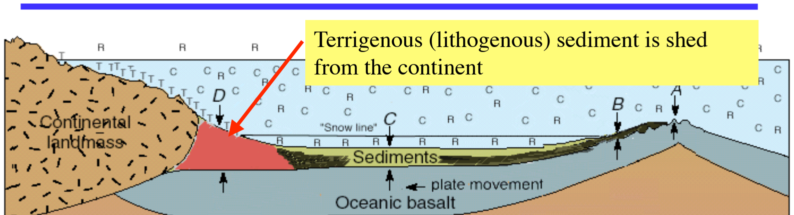

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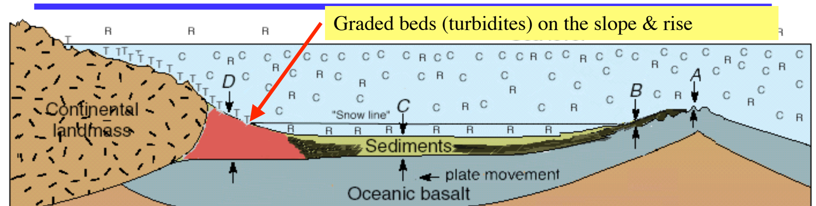

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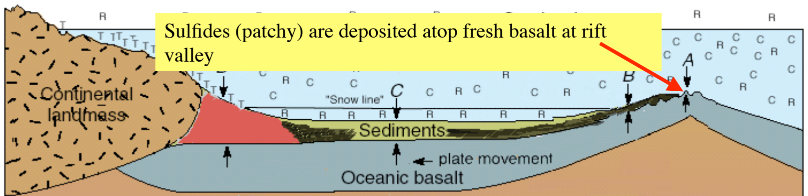

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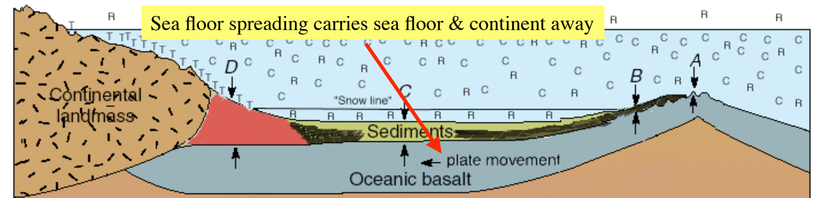

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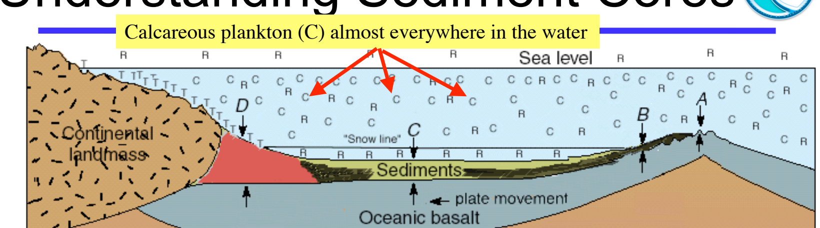

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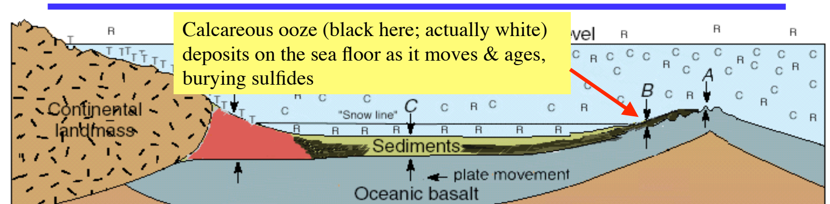

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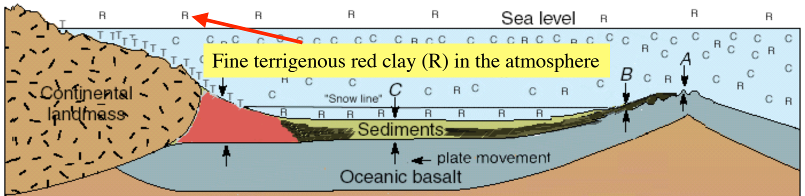

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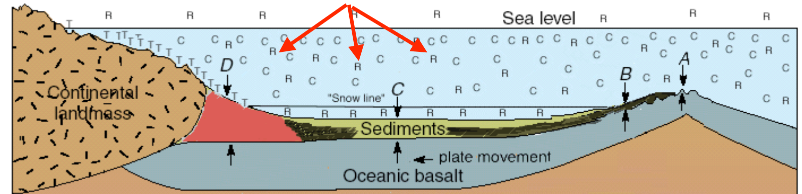

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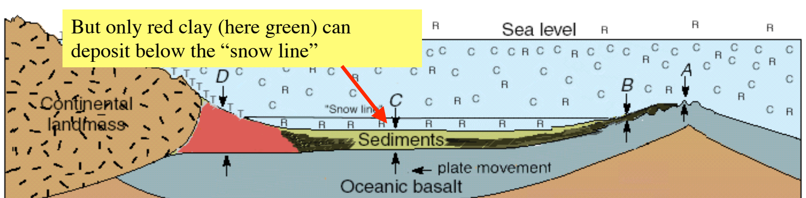

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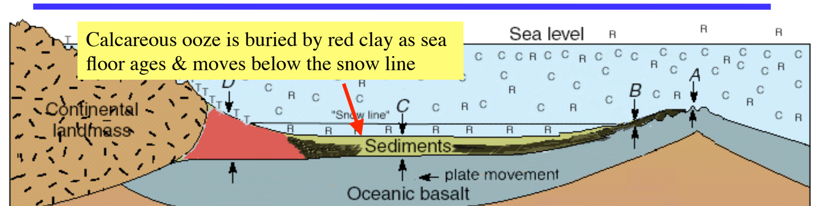

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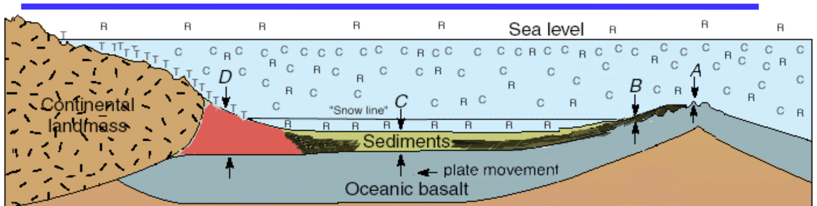
Sverdrup Figure 2.16 (modified) Passive margin

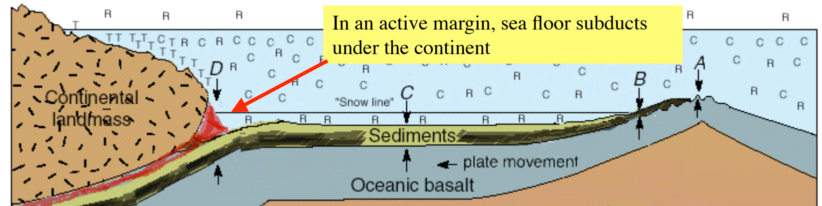
Passive Margin Summary



Location	Thickness	Sediment age: Surface	Sediment age: Bottom	Sediment type: Surface	Sediment type: Bottom
A	1–5 m	recent	100 years	metallic sulfides	(basalt)
B	10–100 m	recent	10×10^6 years	calcareous ooze	sulfides
C	500 m–1 km	recent	75×10^6 years	red clay	sulfides & calcareous ooze
D	1–3 km	recent	130×10^6 years	graded beds (turbidites)	graded beds (turbidites)

Sverdrup Figure 2.16 (modified) Passive margin

Sediment Cores: Active Margin



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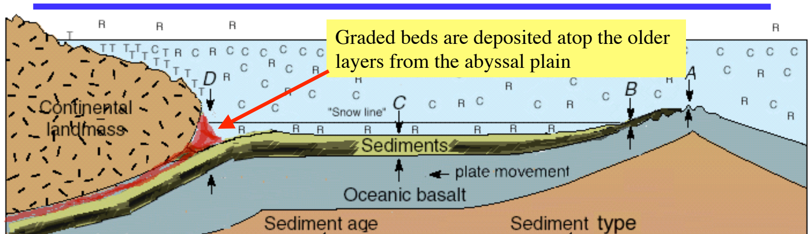
Sverdrup Figure 2.16 (modified) Active margin

Sediment Cores: Active Margin



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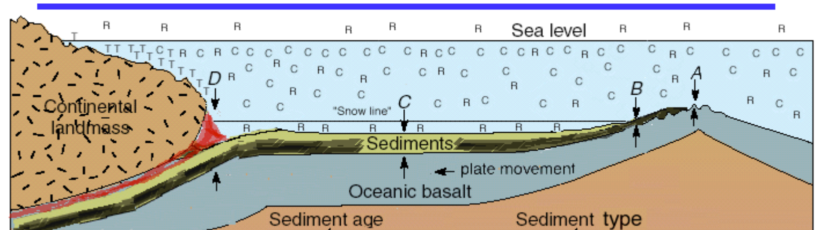

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