Lecture 9

Sedimentary Rocks

Sedimentary Rocks

Clastic Rocks

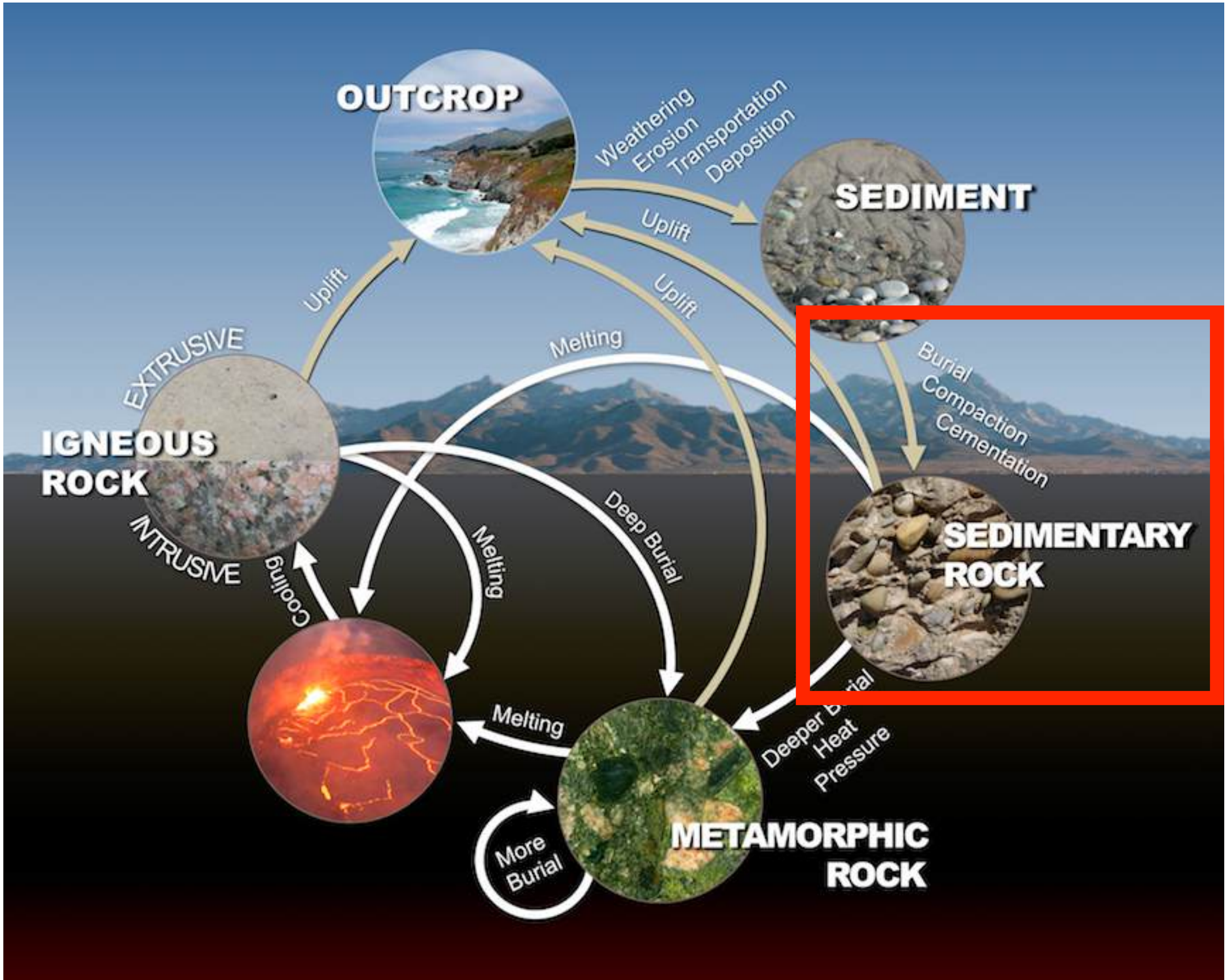
Chemical Rocks

Organic Rocks

Classification

Sedimentary Rocks

THE ROCK CYCLE



Sedimentary Rocks

- Sedimentary rocks and sediments cover **75%** of the land area
- Most of the ocean floor is covered by sediments
  - The igneous rocks (crust) are underneath the sediment and sedimentary rocks
- Sedimentary rocks contain evidence for past environments and are economically important
  - Coal
  - Petroleum and natural gas
  - Sources of iron, aluminum, and manganese
- Most fossils are found in sedimentary rocks

Sedimentary Rocks

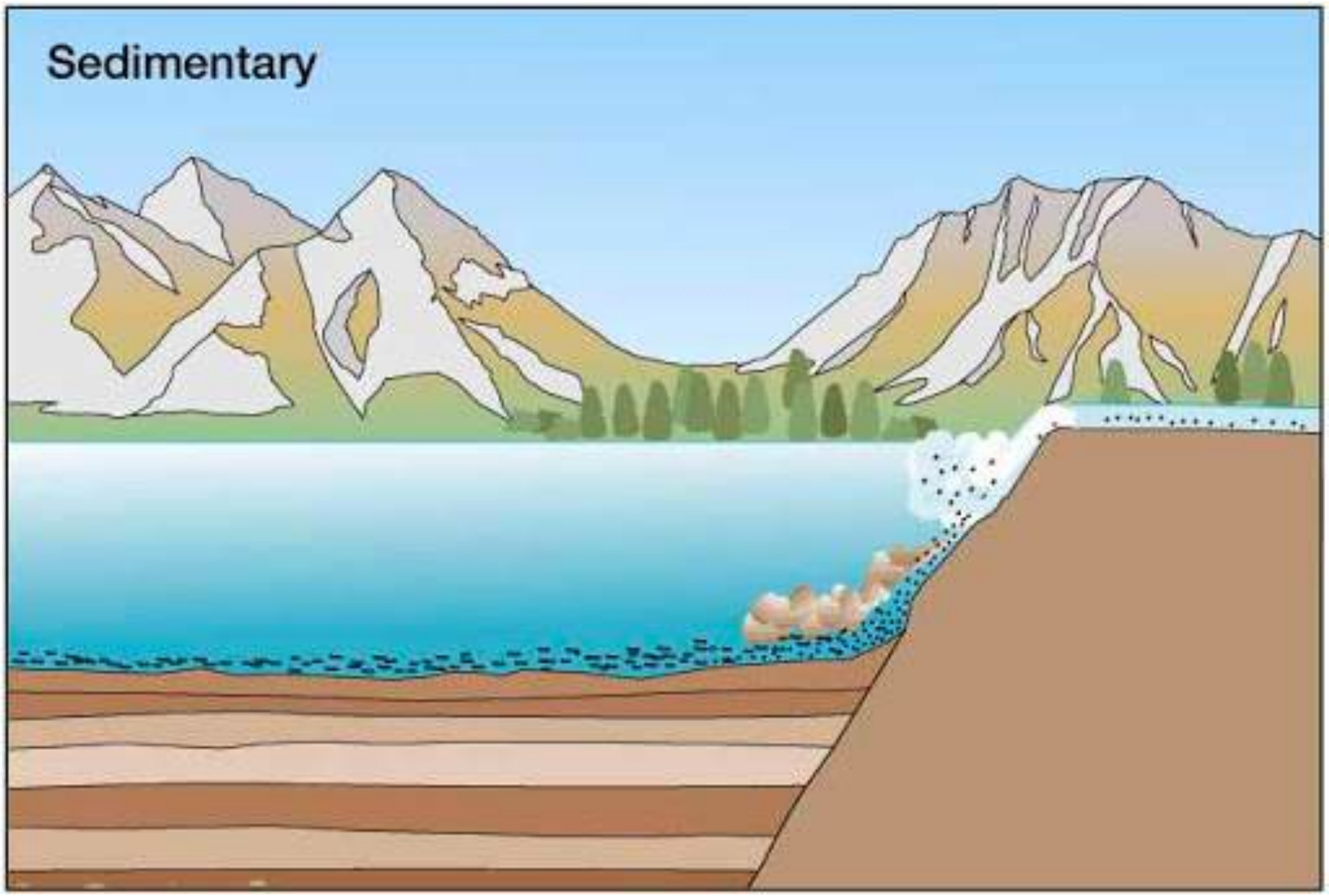
- When the wind or water slows down, or if the ice melts, the **solid sediments are deposited**

Sedimentary Rocks

- What about the dissolved ions from chemical weathering?
- These ions precipitate out of solution (become a solid particle), usually in the ocean
  - When the solution is super saturated
  - When there is a change in chemistry or temperature of the water that allow the ions to precipitate
- When they precipitate, the sediment falls to the bottom of the ocean

Sedimentary Rocks

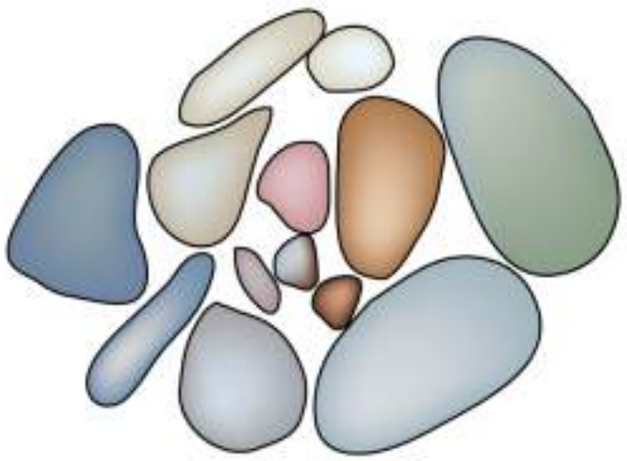
- As deposition continues, older sediments are continually buried beneath younger sediments



Sedimentary Rocks

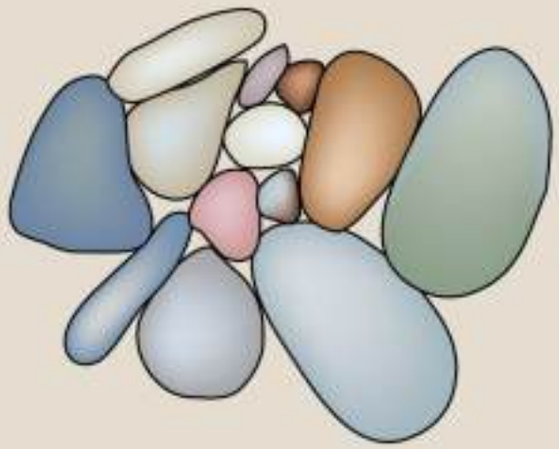
- **Sedimentary rocks** are produced through the **lithification** of these deposited sediments
- Compaction and cementation

Deposition



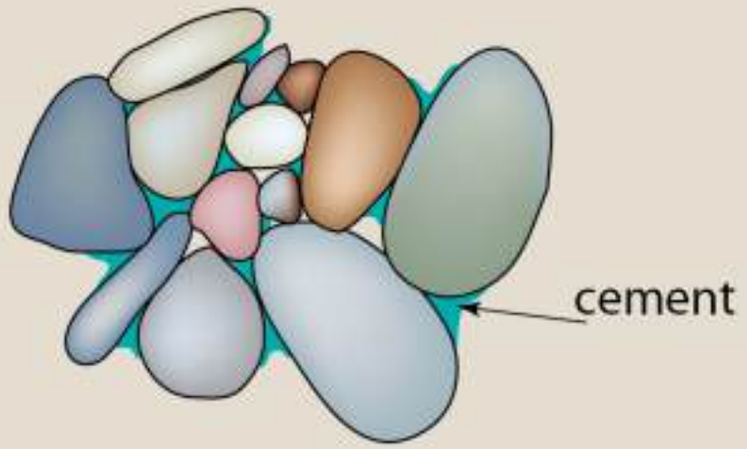
Clasts are dropped or settle out.

Compaction



As more sediments accumulate above, clasts are forced closer together.

Cementation



Groundwater moves between the grains and leaves behind mineral deposits, bonding the grains to each other.

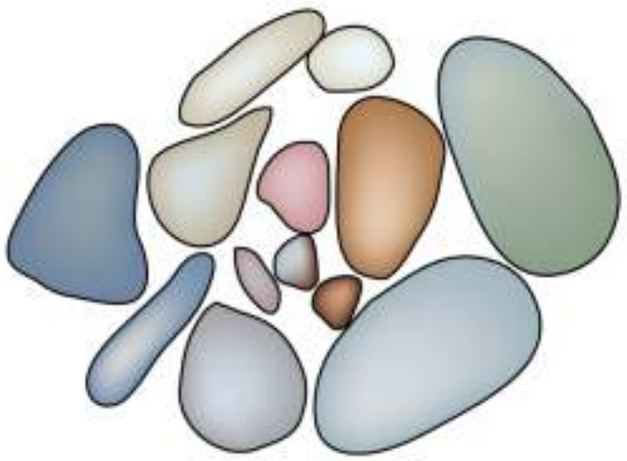
Lithification turns sediment into rock

LITHIFICATION

Sedimentary Rocks

- Sediment is **compacted** by the overlying weight of additional sediment that is deposited on top.

Deposition



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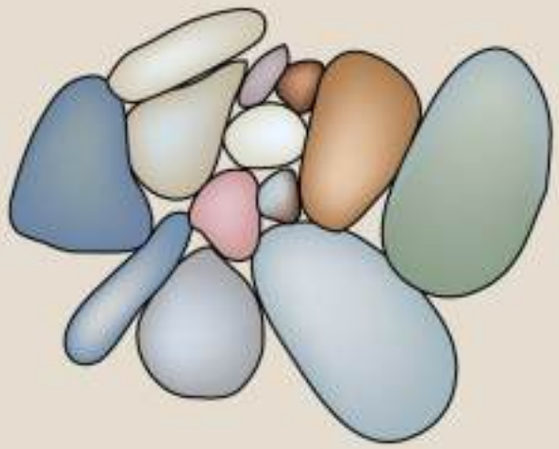

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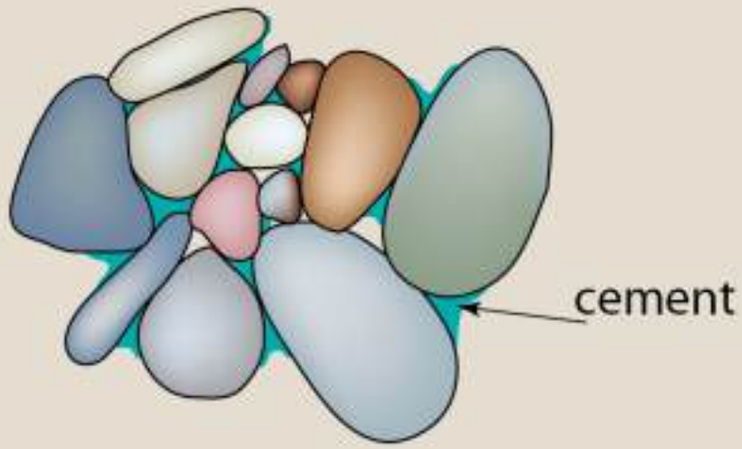


Groundwater moves between the grains and leaves behind mineral deposits, bonding the grains to each other.

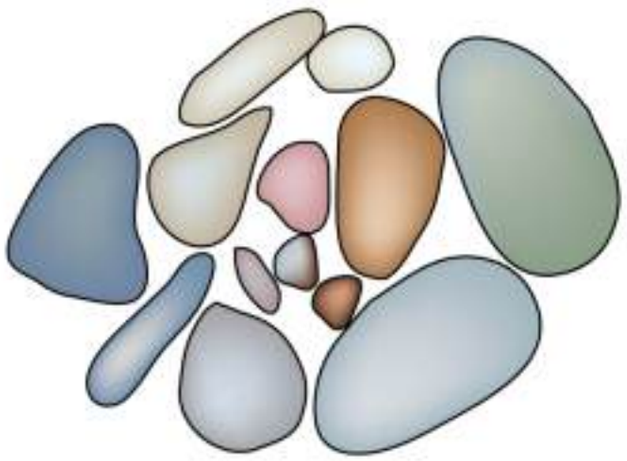
Lithification turns sediment into rock

LITHIFICATION

Sedimentary Rocks

- As water is squeezed out of the pore spaces by pressure, dissolved ions will precipitate and **cement** the sediment grains together to form a sedimentary rock

Deposition



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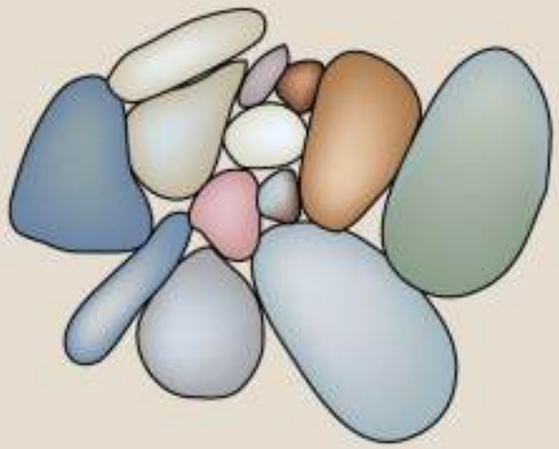

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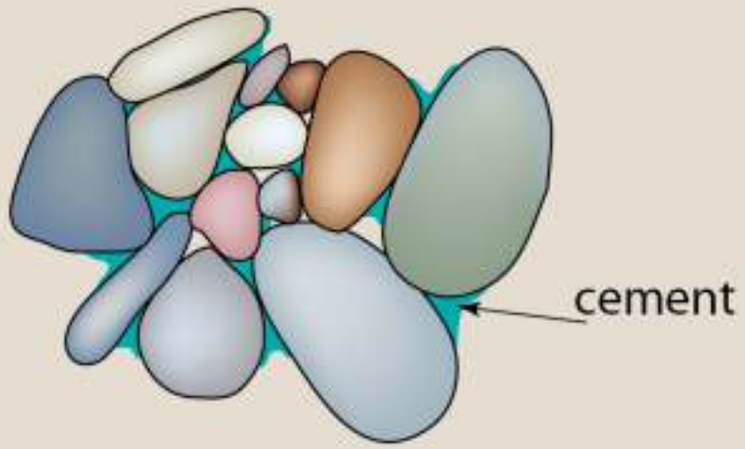


Groundwater moves between the grains and leaves behind mineral deposits, bonding the grains to each other.

Lithification turns sediment into rock

LITHIFICATION

Sedimentary Rocks

- There are 3 types of sedimentary rocks:

- **Clastic** (detrital) – Solid pieces of other rocks

- **Chemical** – Precipitation of ions out of solution

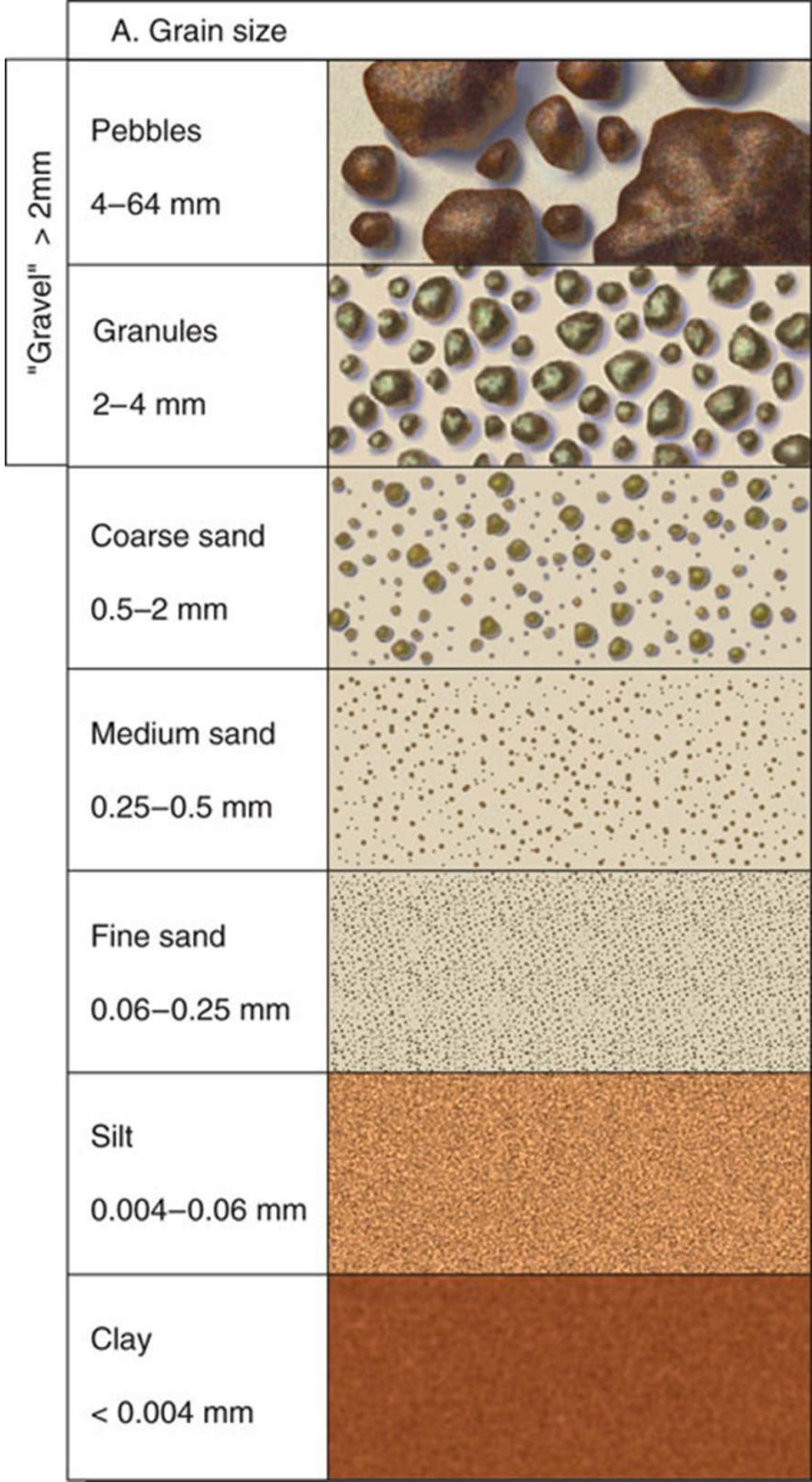
- **Organic** – Carbon-rich remains of organisms

Clastic Rocks

- Clastic rocks are primarily composed of quartz and clay minerals
- Most other minerals weather into new substances (e.g. clay minerals)
- If minerals like feldspars and micas are present, this indicates erosion and deposition occurred quickly, and the minerals did not have enough time to chemically weather

Clastic Rocks

- Clastic sedimentary rocks are classified based on their **grain size**
- Size of the sediments making up the rock



Clastic Rocks

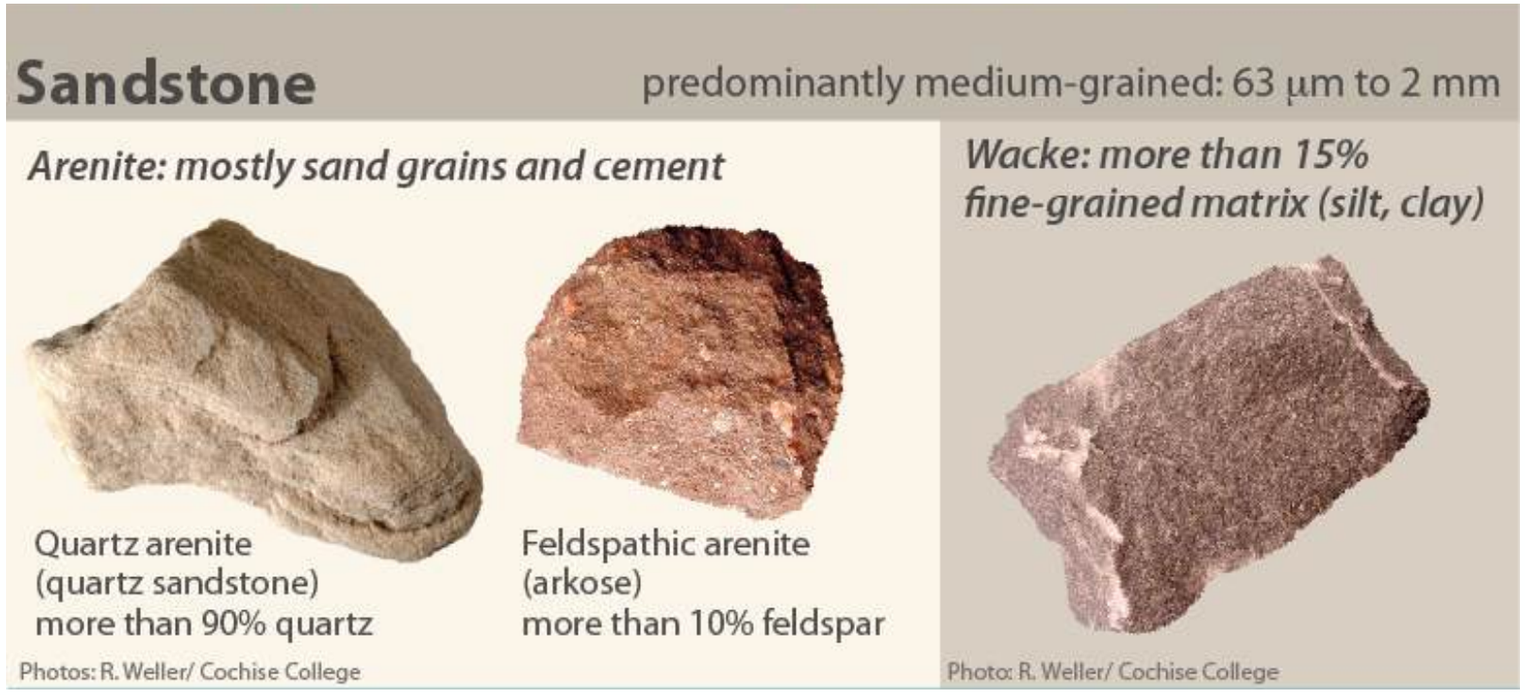
- Detrital sedimentary rocks are classified based on their **grain size**
- Size of the sediments making up the rock

Clastic Rocks

- Fine grained rocks will feel smooth to the touch
- **Shale** is brittle (breaks easy), and has thin layers
- **Mudstone/siltstone** is blocky
- Deposited in **low energy environments**
  - Lakes, slow rivers, deep ocean

Clastic Rocks

- **Sandstone** is medium to coarse grained
- Sand-sized grains
- Will feel **gritty** like sandpaper
- Deposited in **higher energy** environments
  - Shorelines, deserts, fast moving rivers, shallow marine



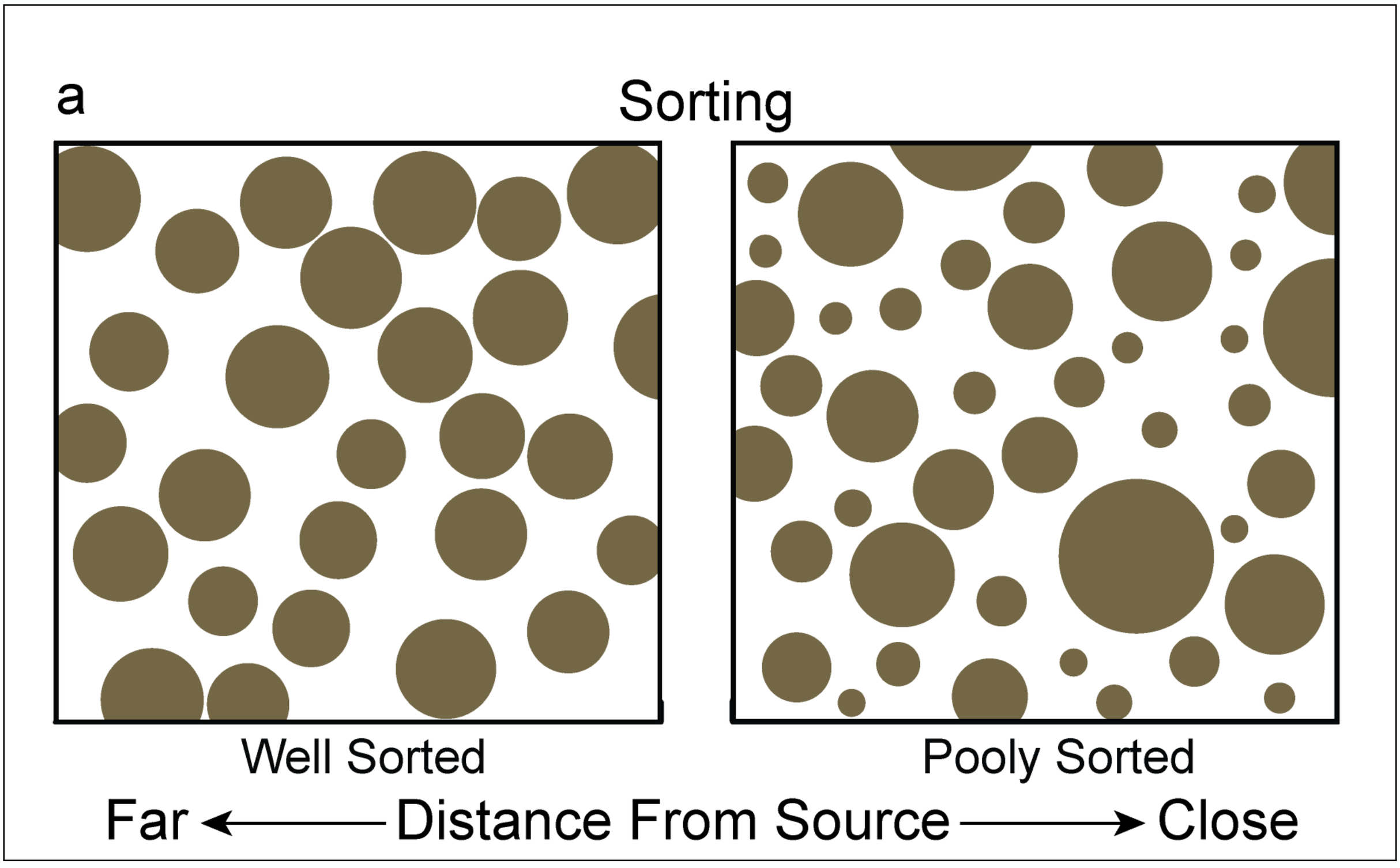
Clastic Rocks

- Conglomerates and breccias have large clasts in a finer grained matrix
- **Conglomerates** have rounded clasts
- **Breccias** have angular clasts

https://sketchfab.com/models/13274fd51ec0414ab3e346f207c6b789

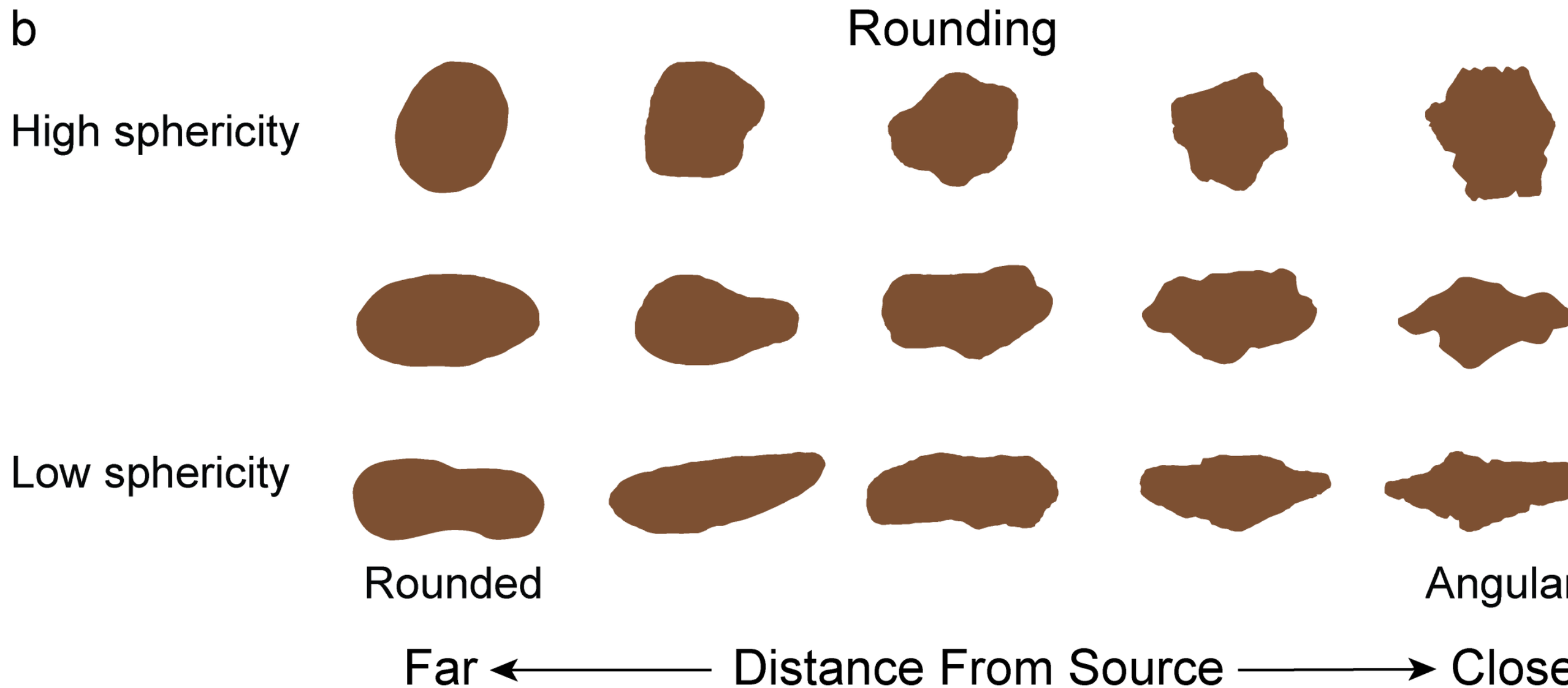
Clastic Rocks

- Sorting - grain size variability



Clastic Rocks

- Particle shape - how angular or rounded the grain edges are

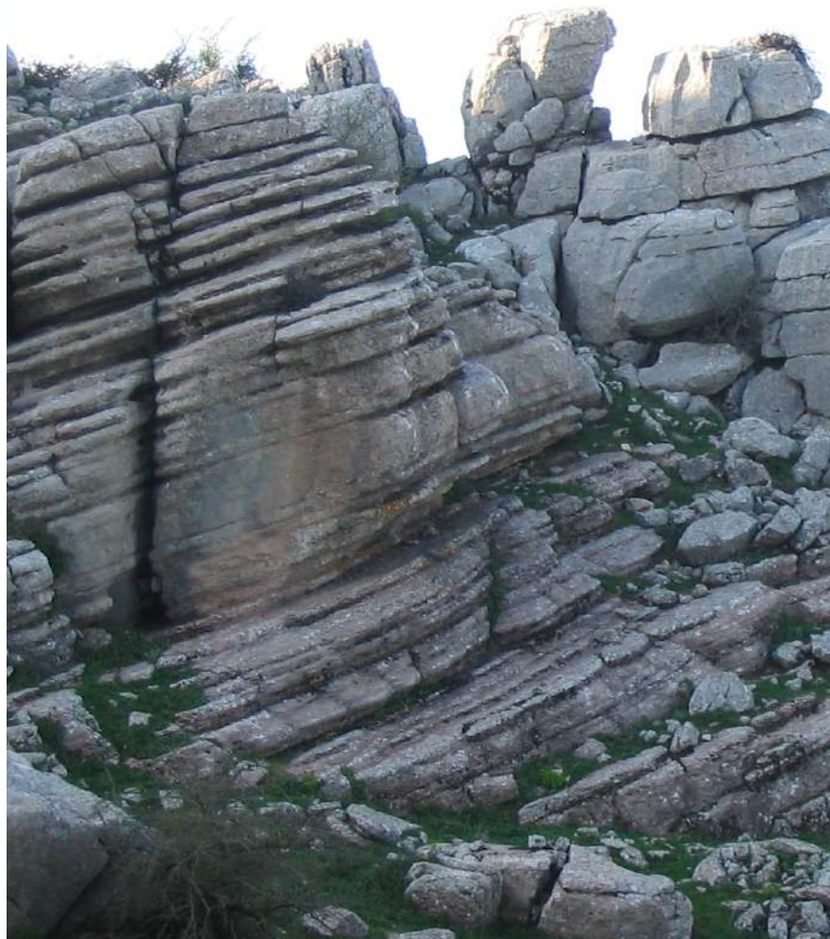


Chemical Rocks

- Form when dissolved **ions precipitate** out of solution (become a solid)
- Precipitation of material occurs by
  - **Inorganic processes**
    - Water is super-saturated with an ion
  - **Organic processes** (biochemical)
    - Precipitation of ions that form shells for organisms
    - When they die, their shells accumulate on the ocean floor

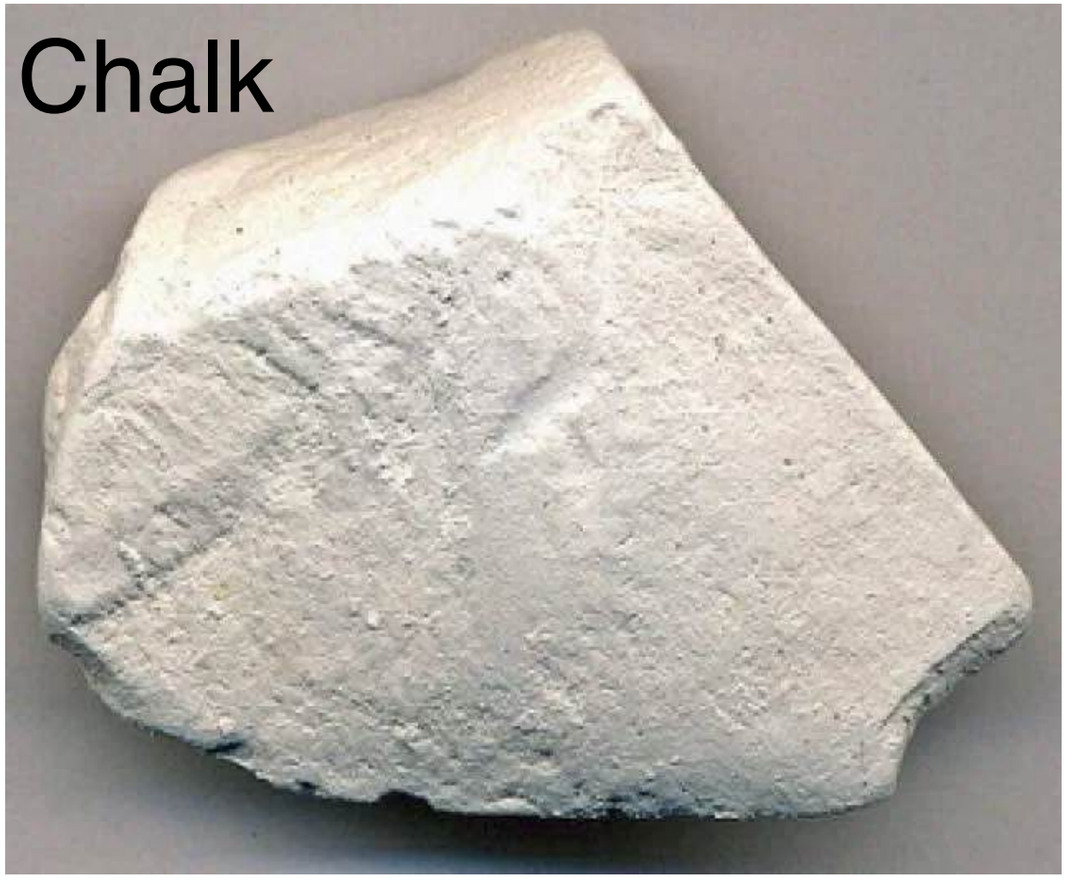
Chemical Rocks

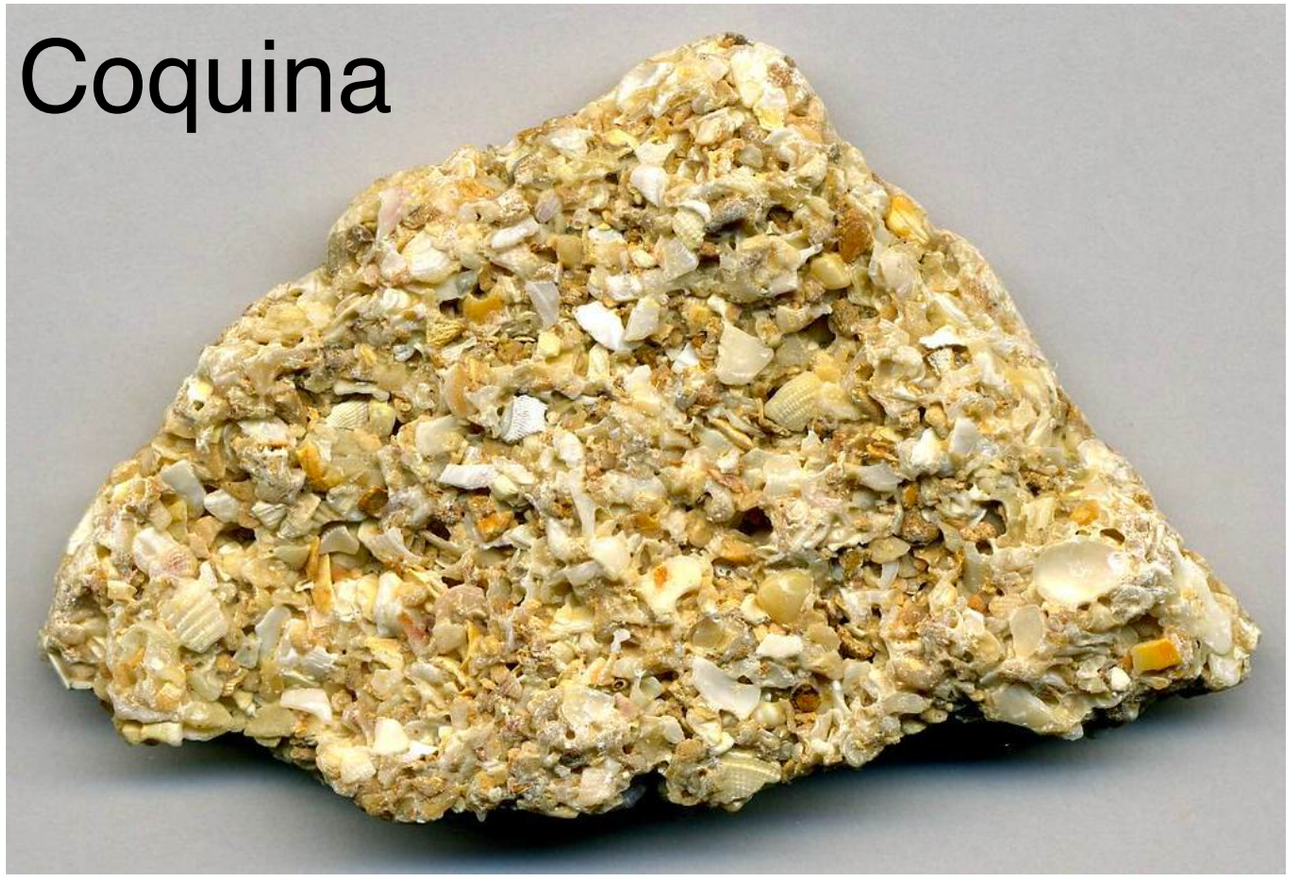
- **Limestone** is the most common chemical sedimentary rock
  - Composed of the mineral calcite



Chemical Rocks

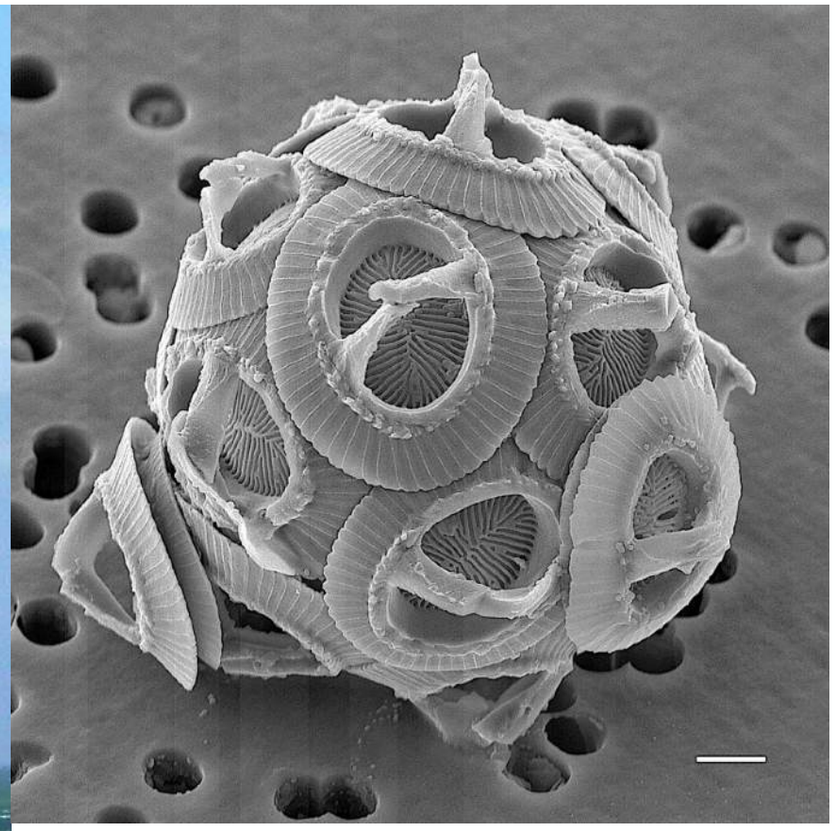
- Marine biochemical limestones form as coral reefs, coquina (broken shells), and chalk (microscopic organisms)





Chemical Rocks

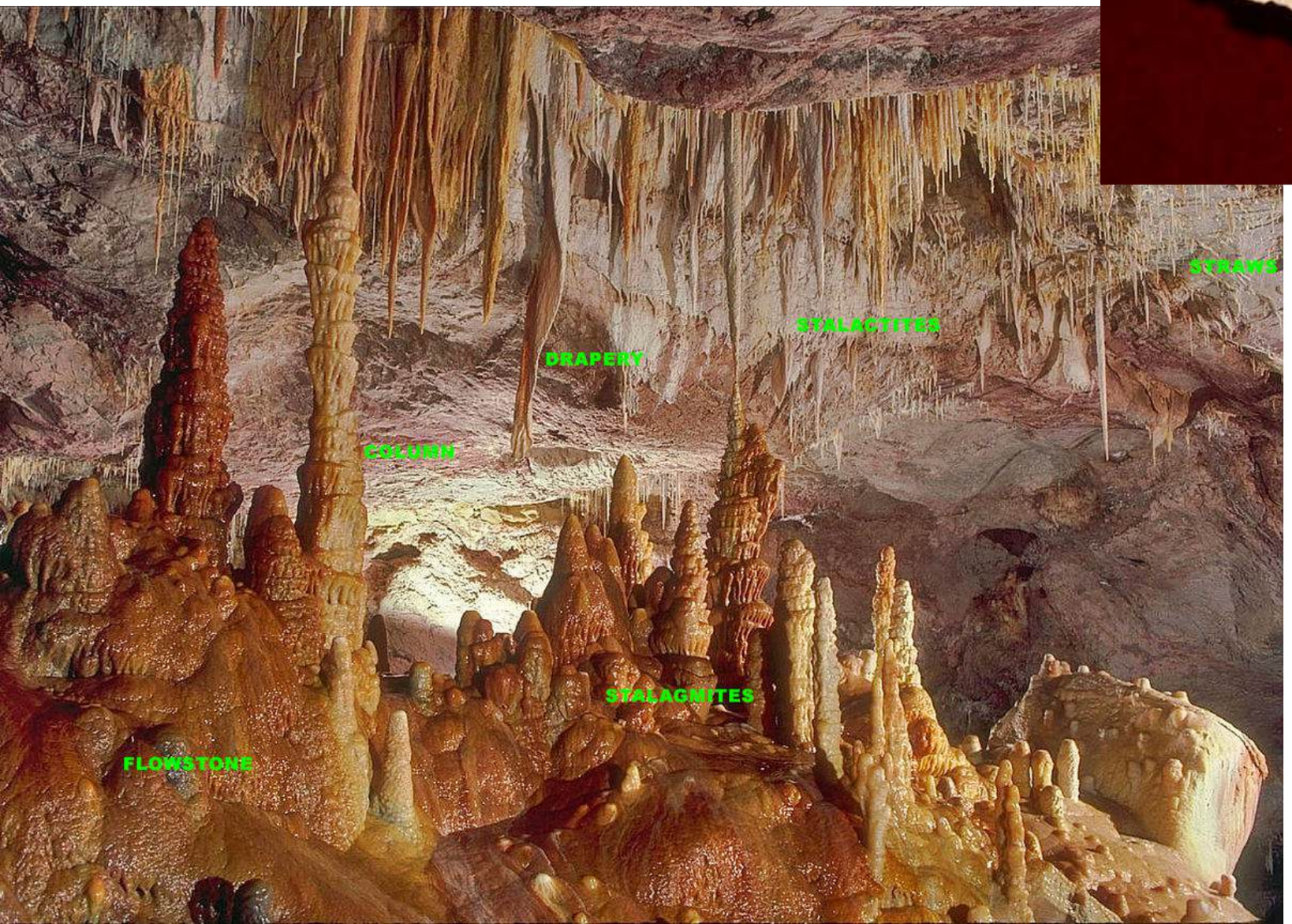
- The White Cliffs of Dover in England are made of the shells of tiny algae called coccolithophores



The scale is 1 micron (0.001 mm)

Chemical Rocks

- Inorganic limestone includes travertine
- Typical of caves



Chemical Rocks

- **Chert** – forms similar to limestone, but made with quartz instead of calcite
  - Flint, jasper, agate

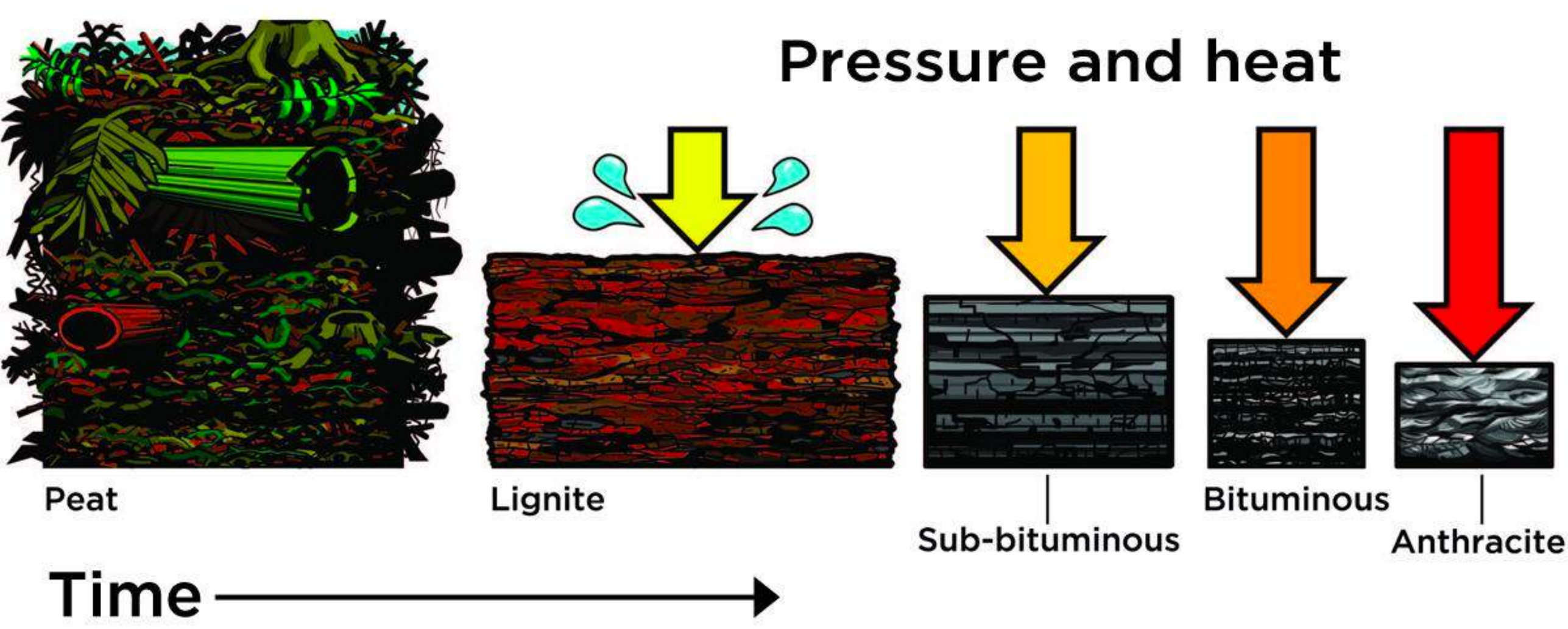
Chemical Rocks

- **Evaporites** form as a body of water evaporates, forcing ions to precipitate
- Rock salt (halite)
- Gypsum

Chott el Djerid, Tunisia

Organic Rocks

- Form from the accumulation of plant remains
  - Coal
- Remains need to be **buried quickly in an anoxic environment** (no oxygen)



Organic Rocks

Organic Rocks

Types of coal

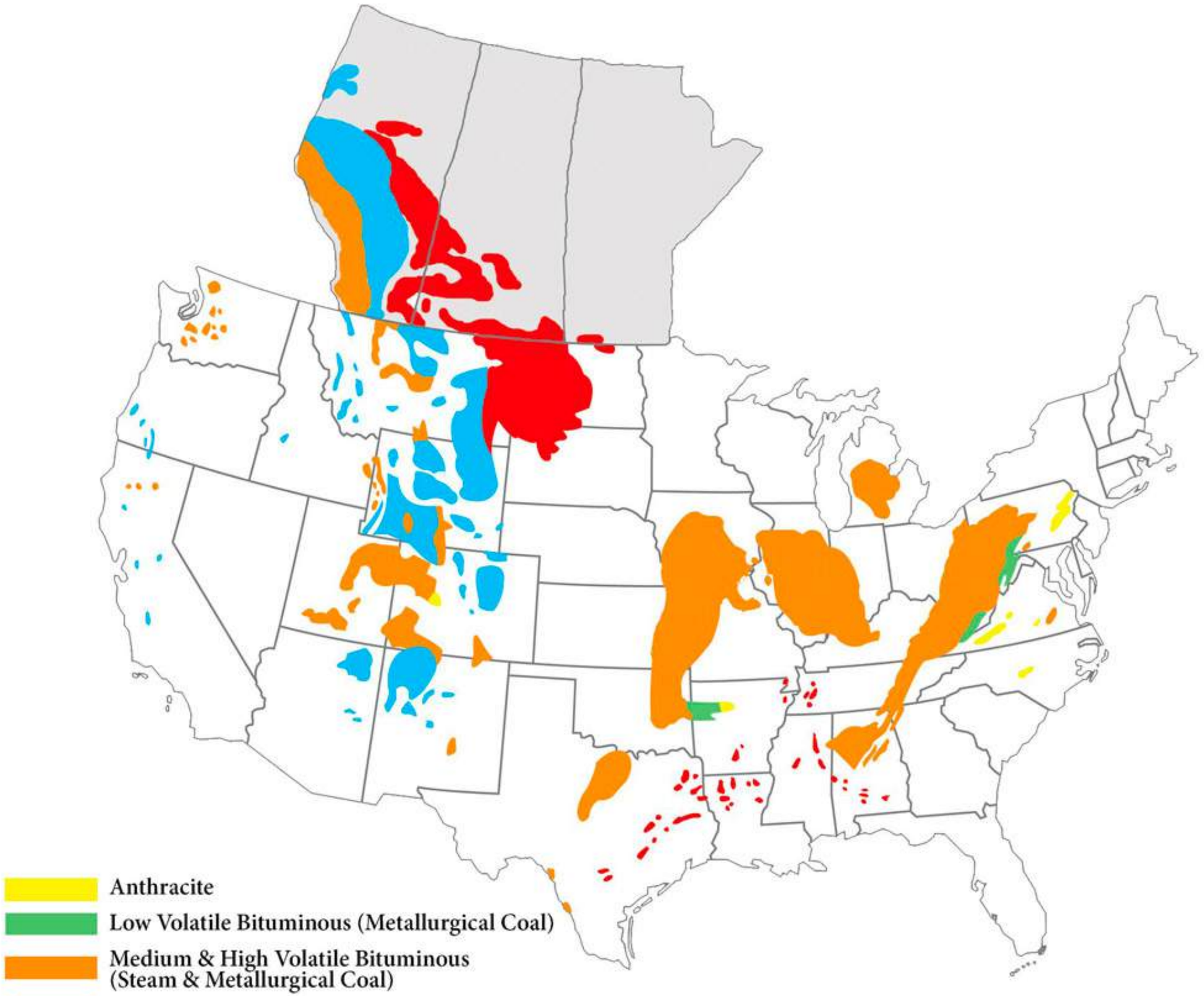
Increasing heat and carbon content

Increasing moisture content

Peat (not a coal)	Lignite (brown coal)	Bituminous (soft coal)	Anthracite (hard coal)
			
Heat, Pressure	Heat, Pressure	Heat, Pressure	
Partially decayed plant matter in swamps and bogs; low heat content	Low heat content; low sulfur content; limited supplies in most areas	Extensively used as a fuel because of its high heat content and large supplies; normally has a high sulfur content	Highly desirable fuel because of its high heat content and low sulfur content; supplies are limited in most areas

Organic Rocks

U.S. Coal



Anthracite

Low Volatile Bituminous (Metallurgical Coal)

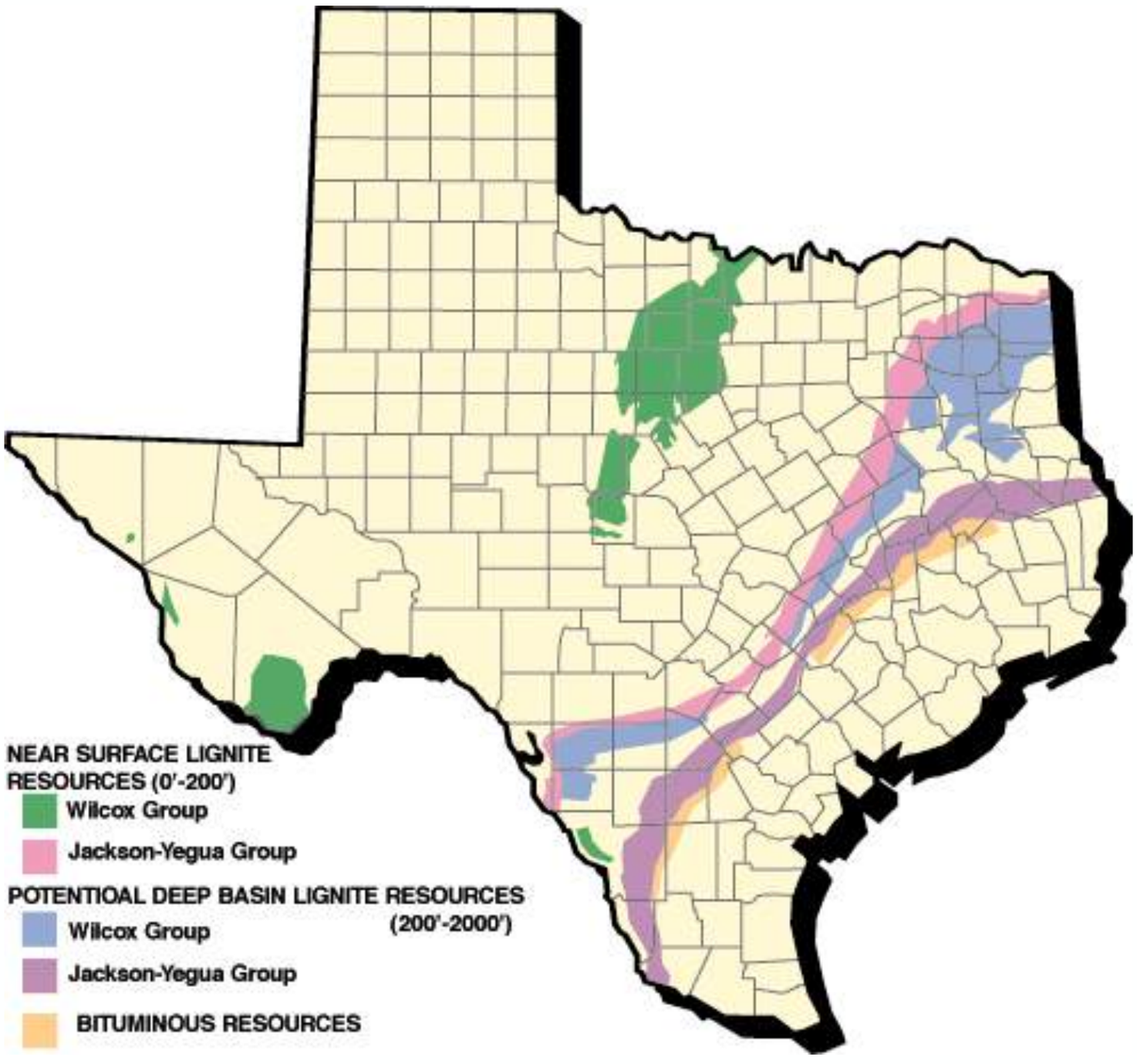
Medium & High Volatile Bituminous
(Steam & Metallurgical Coal)

Subbituminous (Steam Coal)

Lignite (Steam Coal)

Organic Rocks

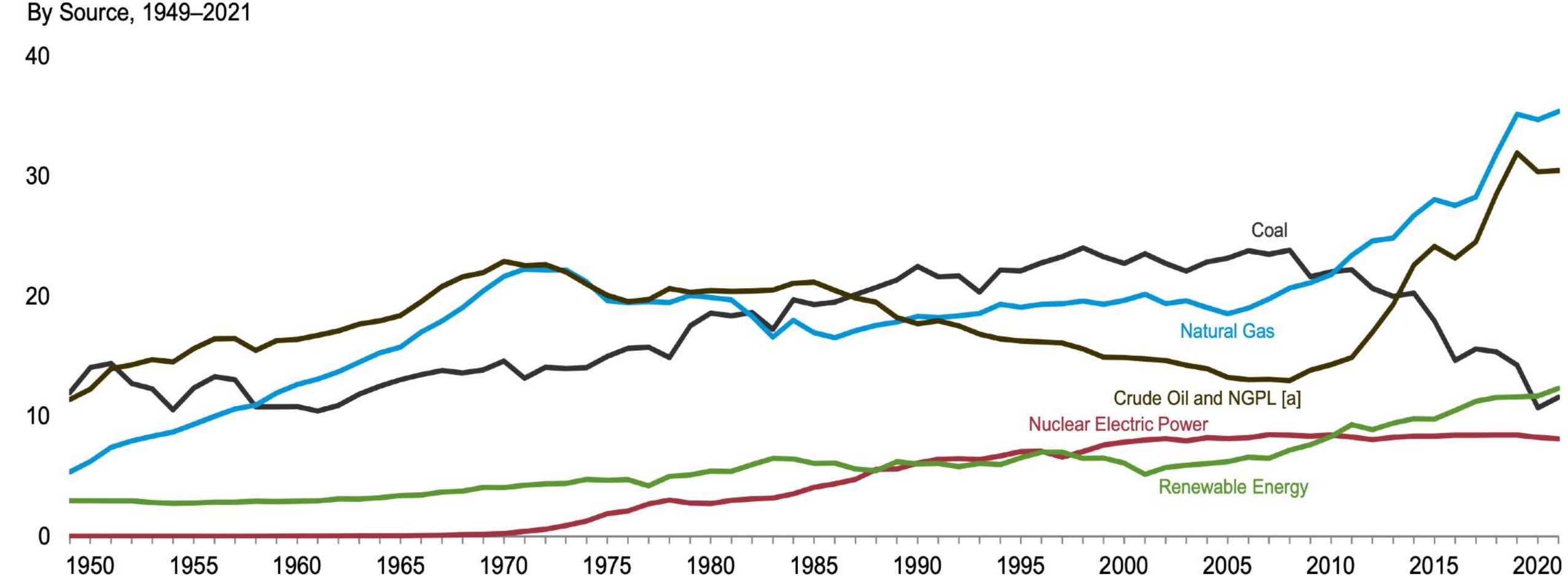
Texas coal



Organic Rocks

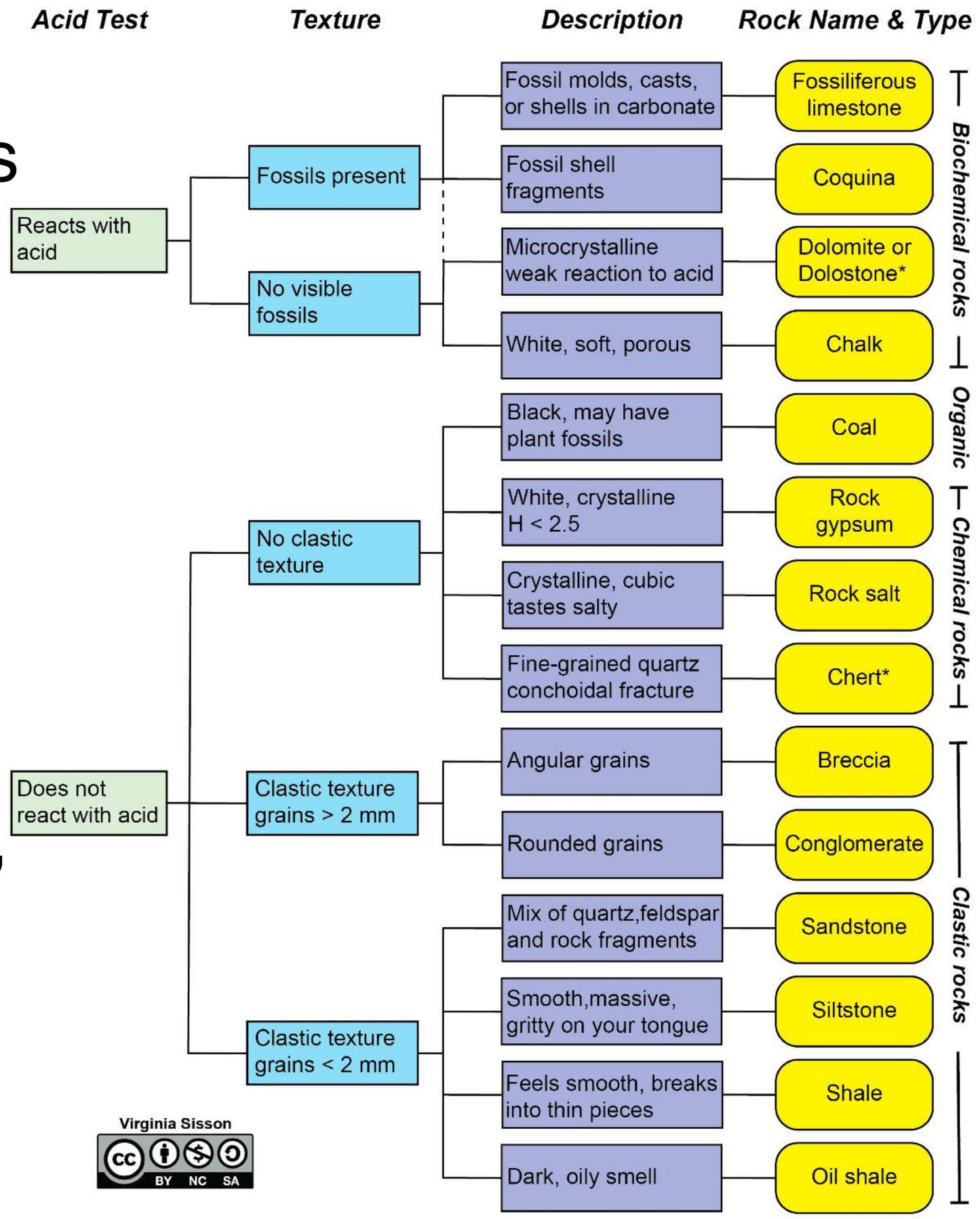
- Coal is probably not going to make a comeback
- Too expensive, bad for the environment, hazardous to miners

Figure 1.2 Primary Energy Production
(Quadrillion Btu)



Classification

- Clastic vs chemical vs organic
- Clastic rocks classified by particle size
- Chemical and Organic determined by their composition
- Calcite, quartz, halite, etc…



* Both dolomite and chert can be classified as either biochemical and chemical sedimentary rocks. Also, dolomite may or may not have fossils