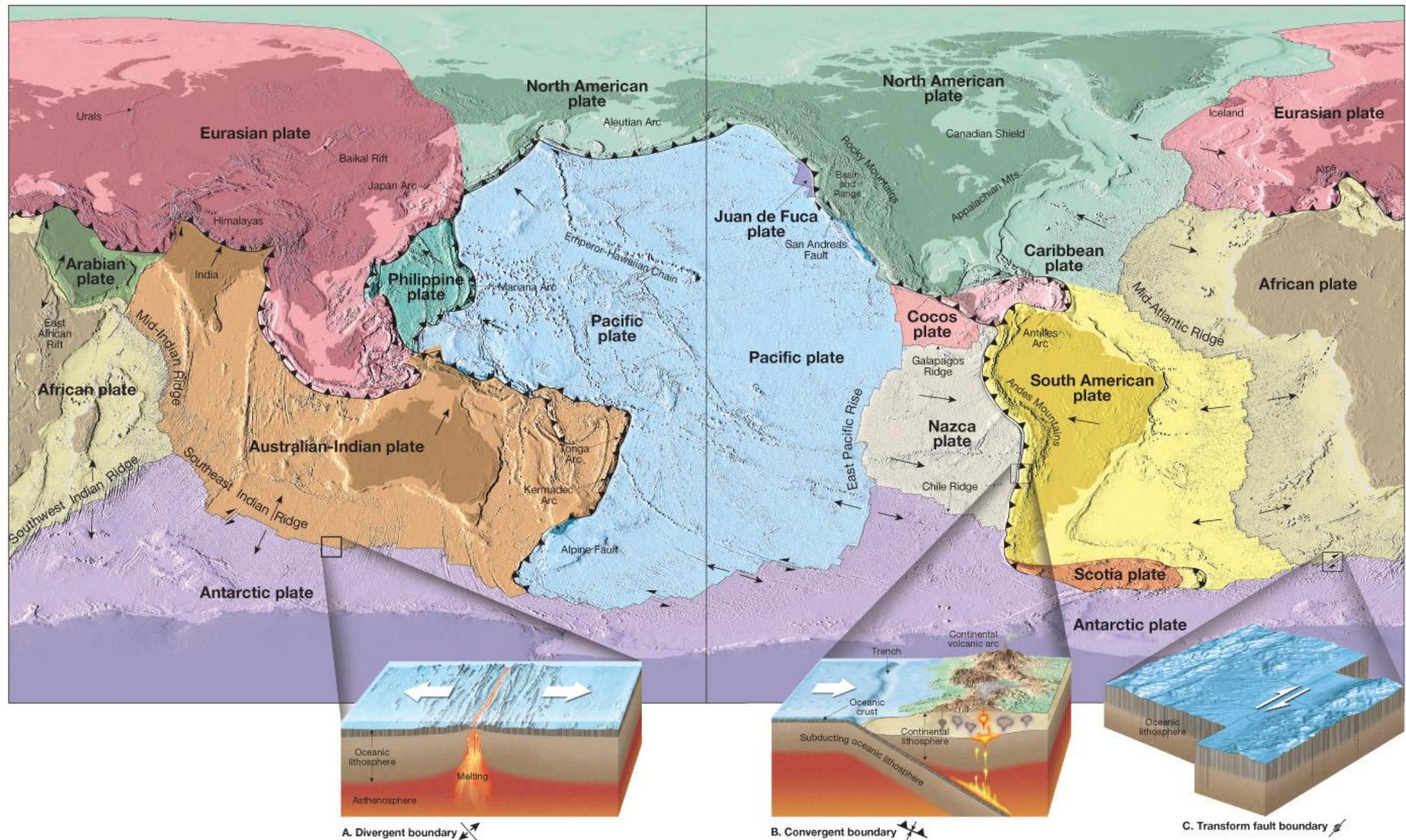




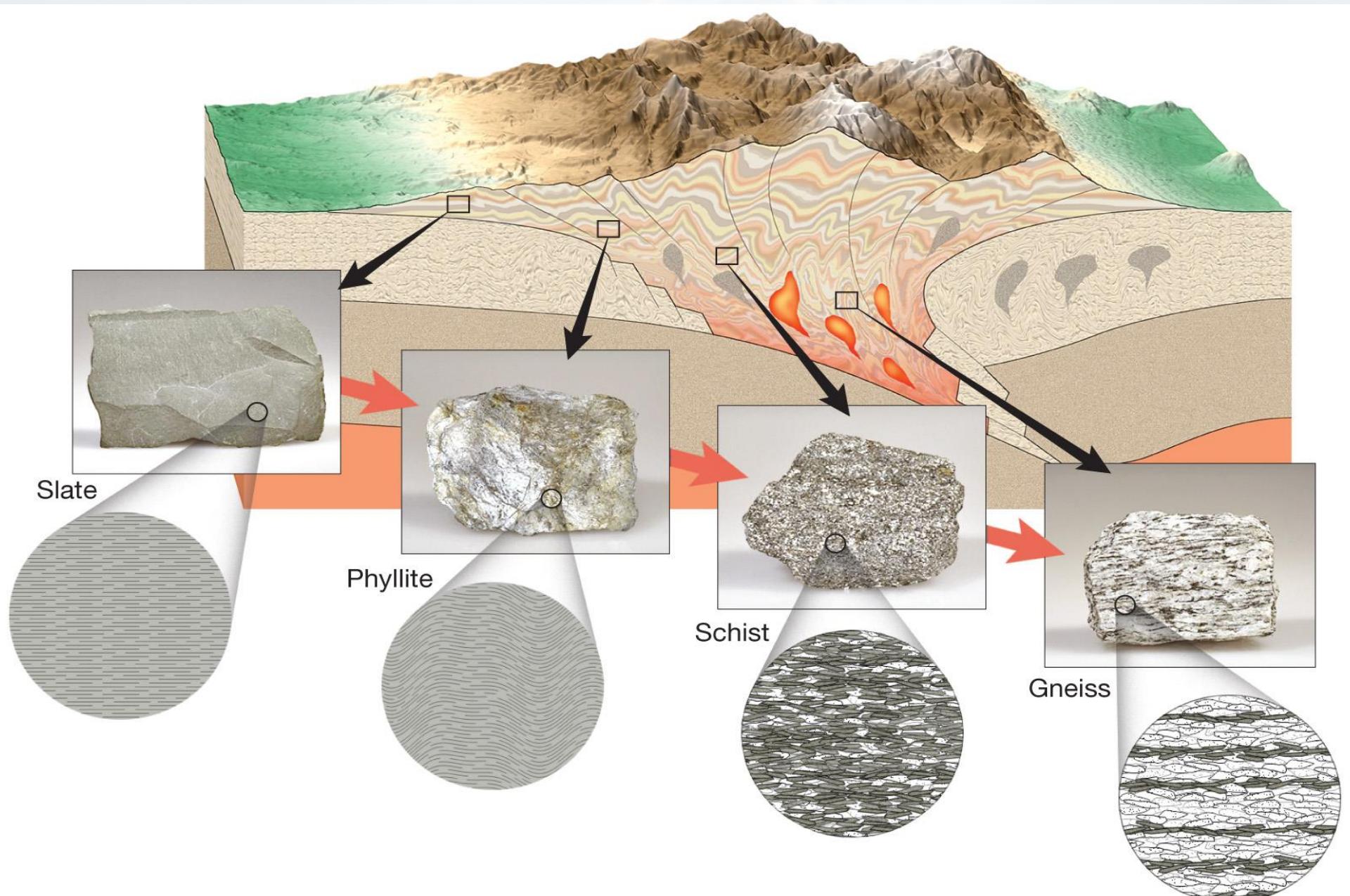
GY4051 Earth Science and Society

Carbonates









Transport - processes

- Gravity



Transport - processes

- Gravity
- Water



Transport - processes

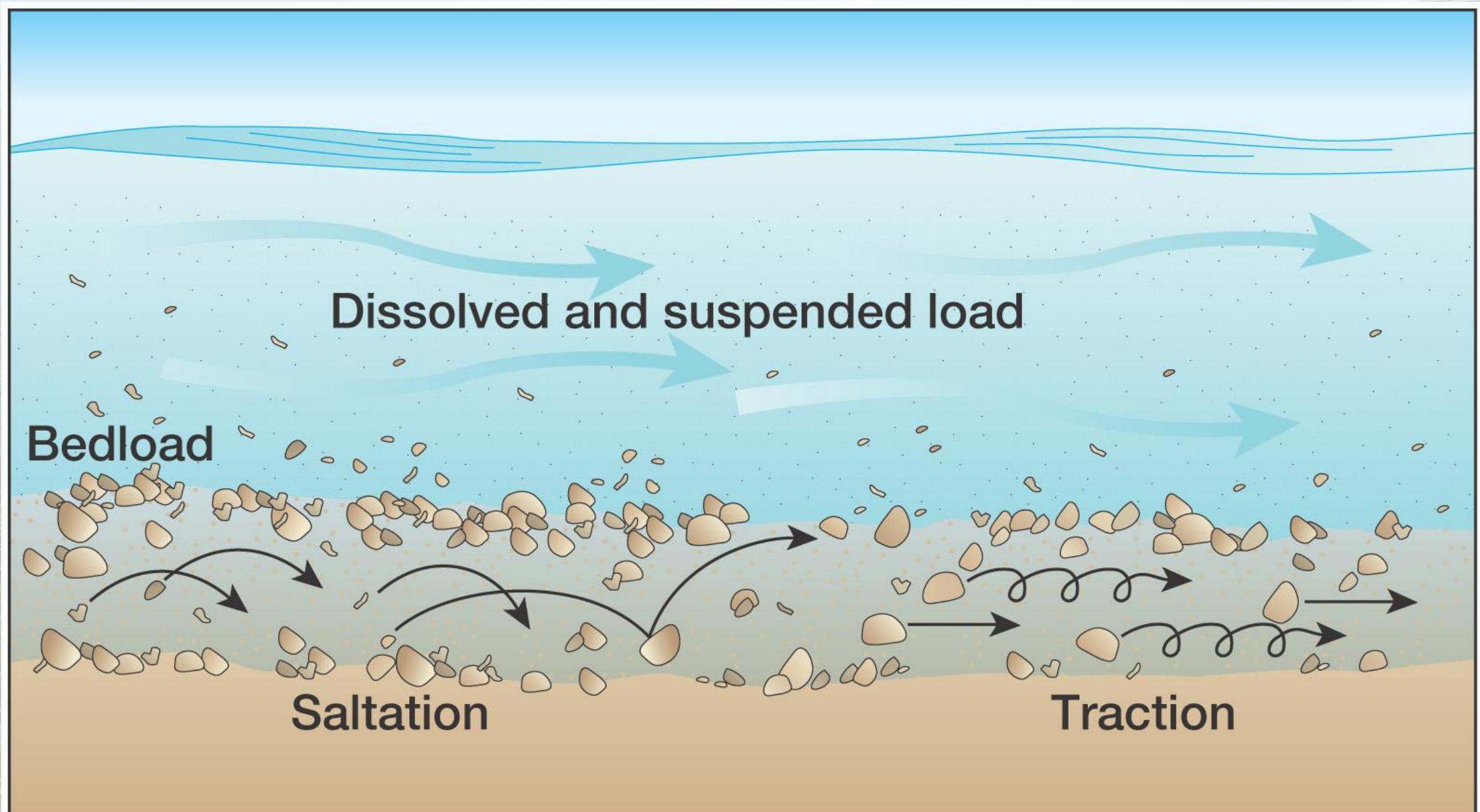
- Gravity
- Water
- Ice



Transport - processes

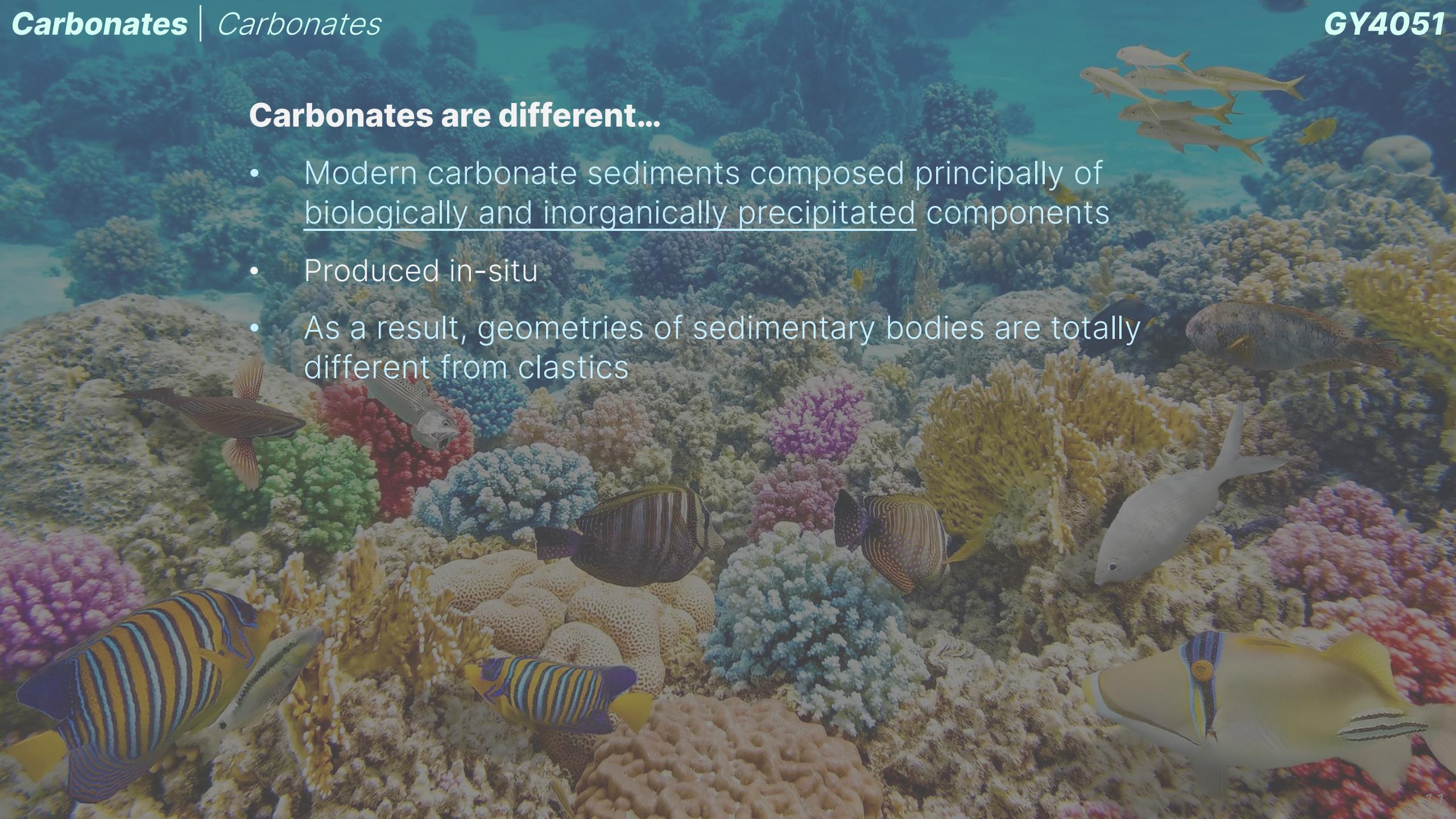
- Gravity
- Water
- Ice
- Air





Carbonates are different...

- Modern carbonate sediments composed principally of biologically and inorganically precipitated components
- Produced in-situ
- As a result, geometries of sedimentary bodies are totally different from clastics



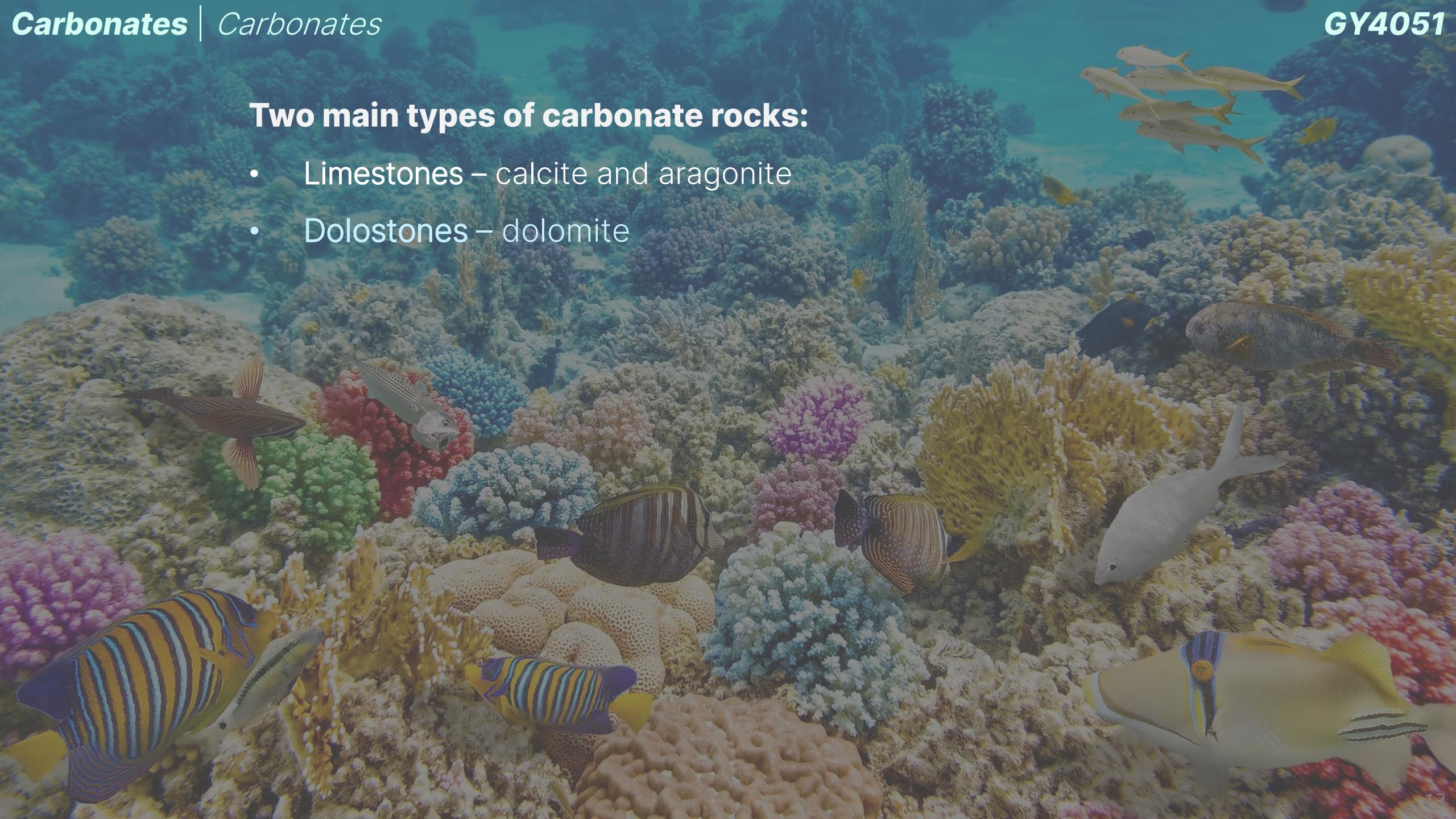
Three principal carbonate minerals:

- Calcite, CaCO_3
- Aragonite, also CaCO_3 – different crystal structure
- Dolomite, $\text{CaMg}(\text{CO}_3)_2$ – diagenic alteration

Calcite<https://www.mindat.org/locentry-675168.html>**Aragonite**<https://www.mindat.org/loc-12795.html>**Dolomite**<https://www.mindat.org/min-1304.html>

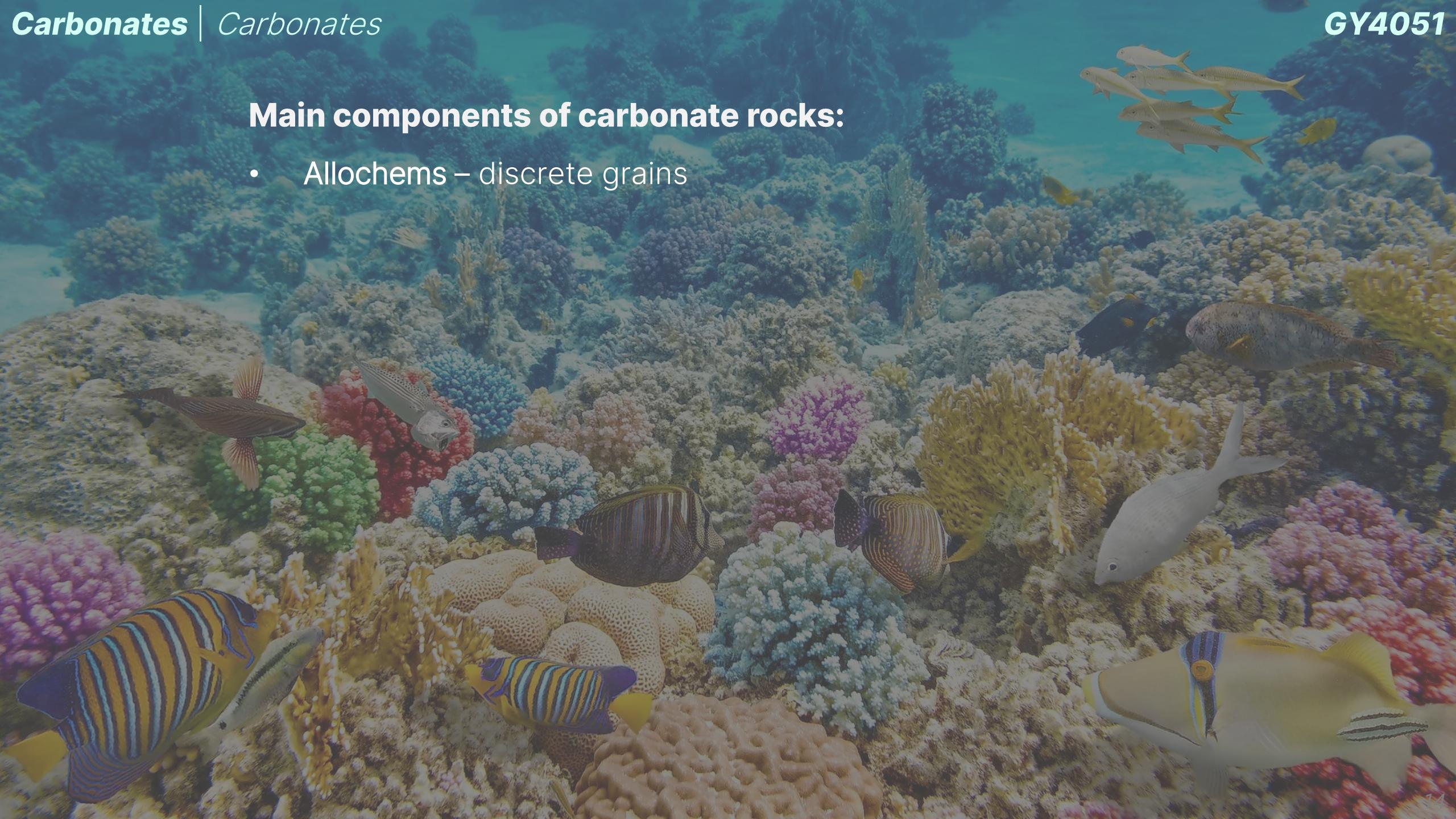
Two main types of carbonate rocks:

- Limestones – calcite and aragonite
- Dolostones – dolomite



Main components of carbonate rocks:

- Allochems – discrete grains



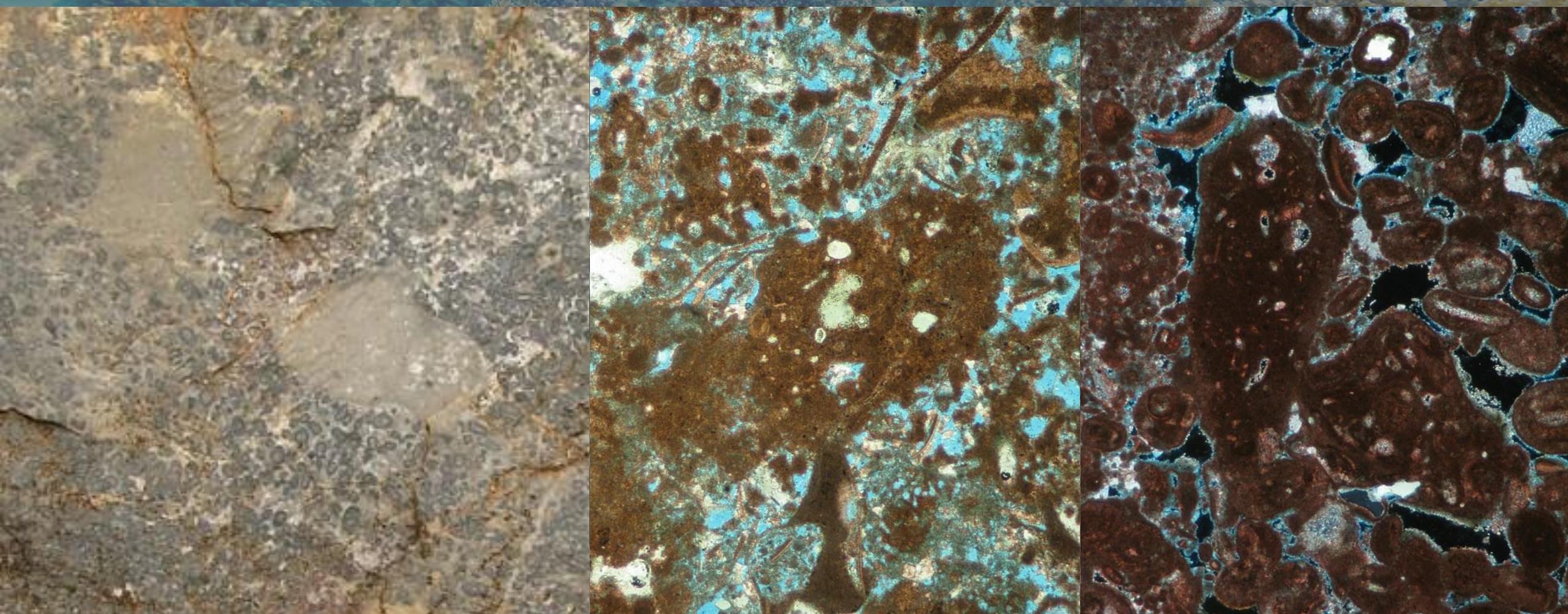
Types of carbonate allochems:

- Bioclasts – fossils, biogenic carbonate skeletal material



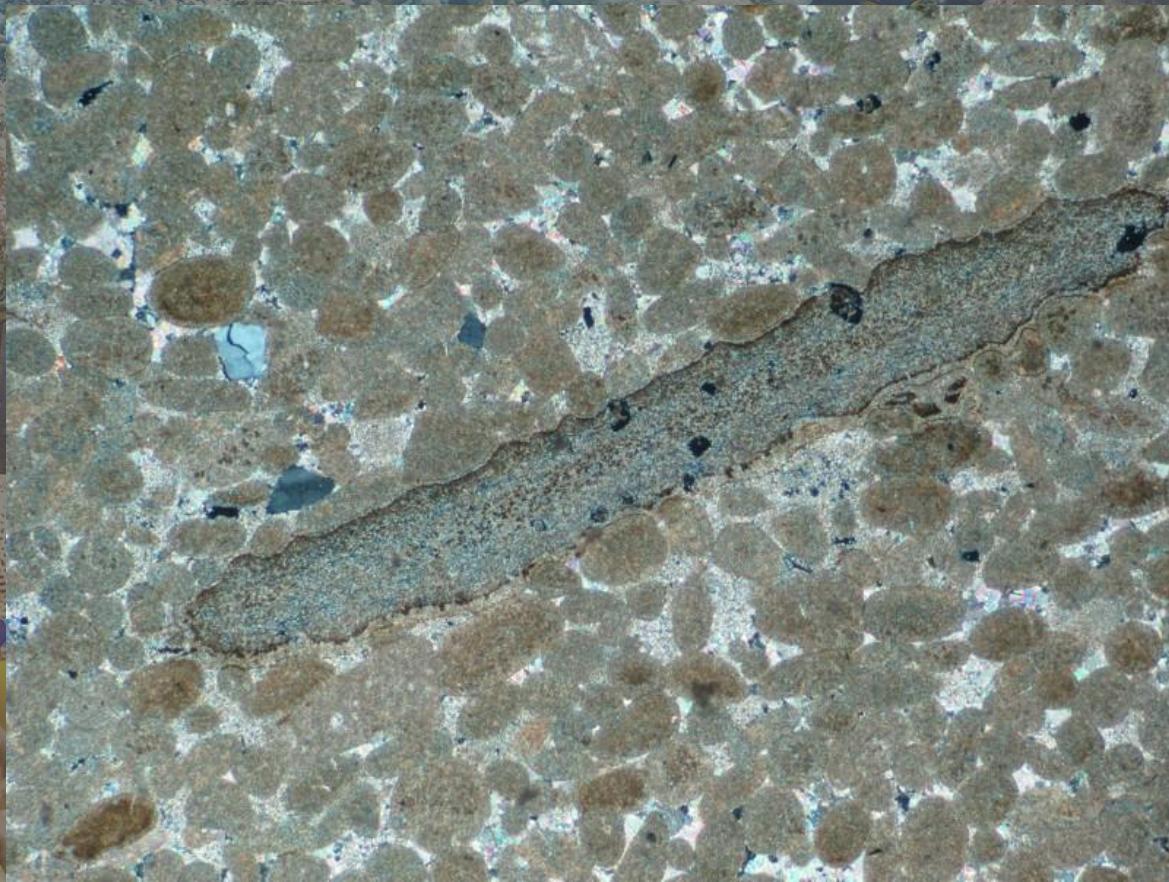
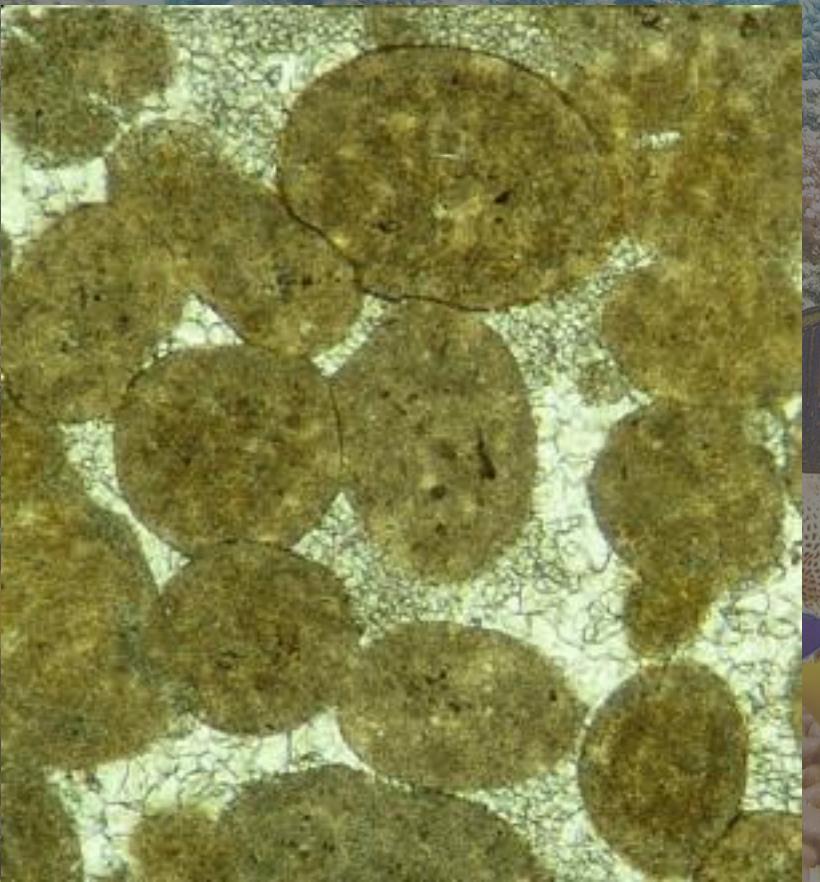
Types of carbonate allochems:

- **Bioclasts** – fossils, biogenic carbonate skeletal material
- **Intraclasts** – fragments of semi-lithified carbonate, re-sedimented



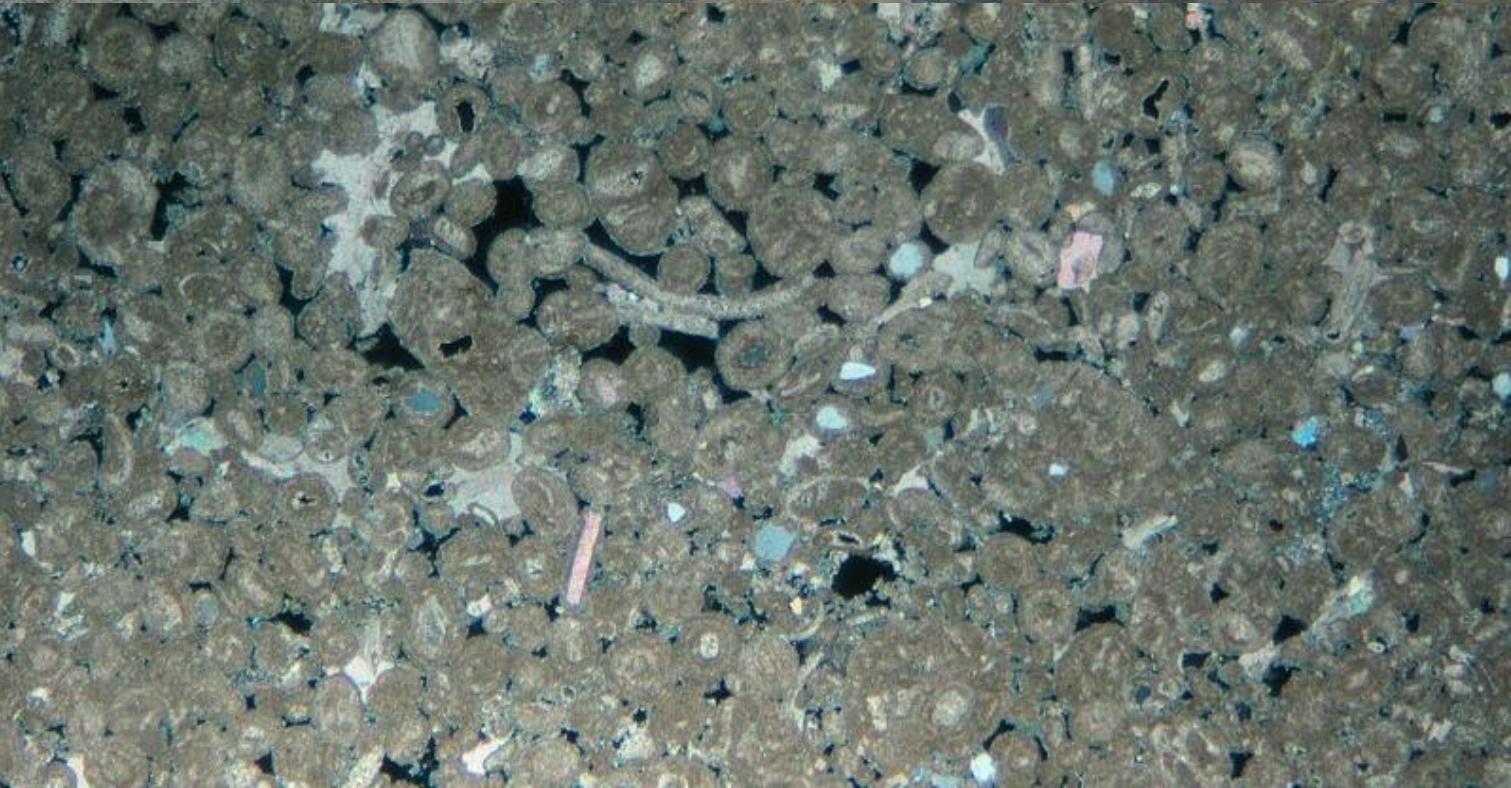
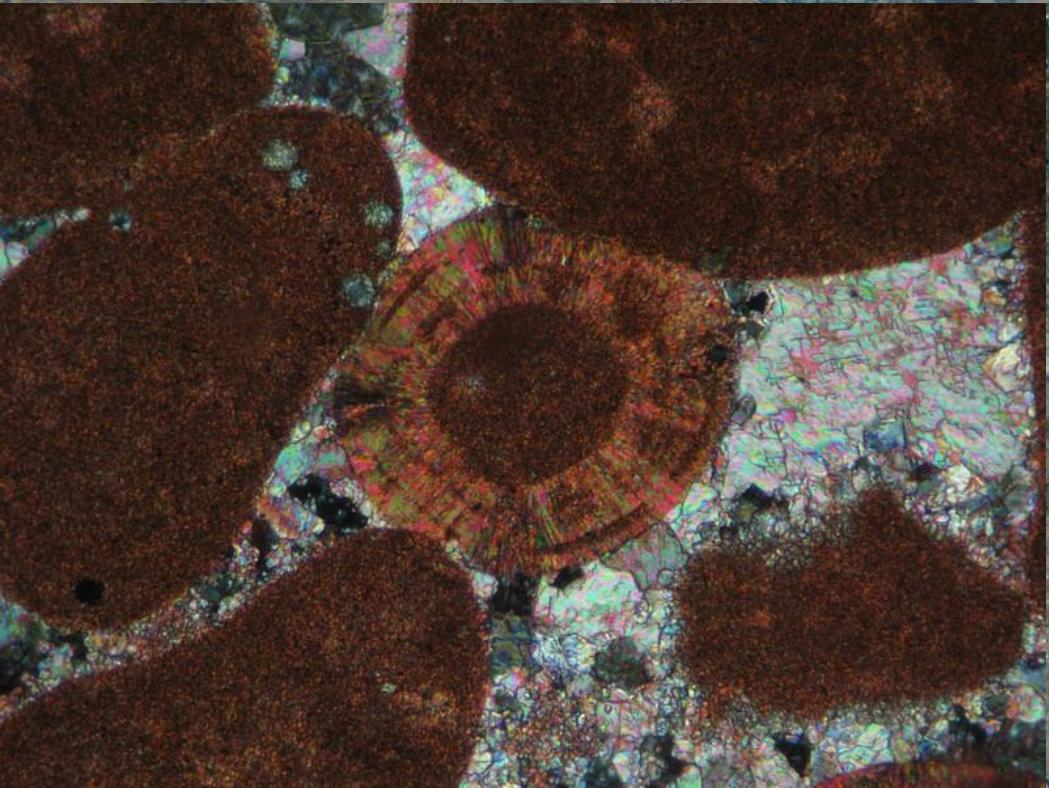
Types of carbonate allochems:

- **Bioclasts** – fossils, biogenic carbonate skeletal material
- **Intraclasts** – fragments of carbonate rocks
- **Peloids** – faecal pellets of carbonate mud (micrite)



Types of carbonate allochems:

- **Bioclasts** – fossils, biogenic carbonate skeletal material
- **Intraclasts** – fragments of carbonate rocks
- **Peloids** – faecal pellets of carbonate mud (micrite)
- **Ooids** – spherical grains concentrically laminated around a nucleus



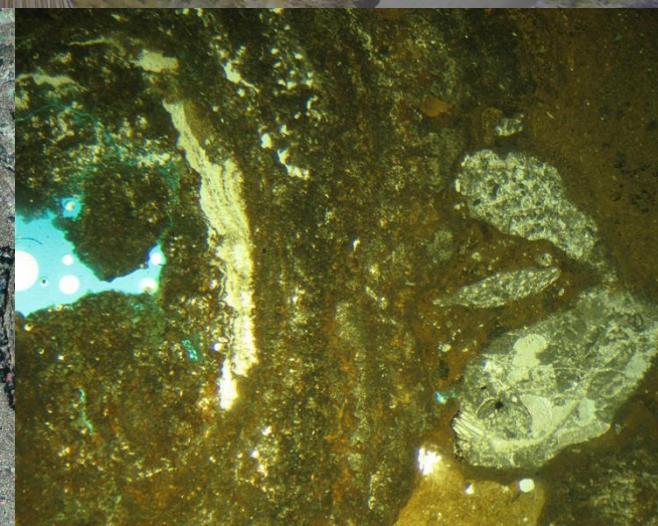
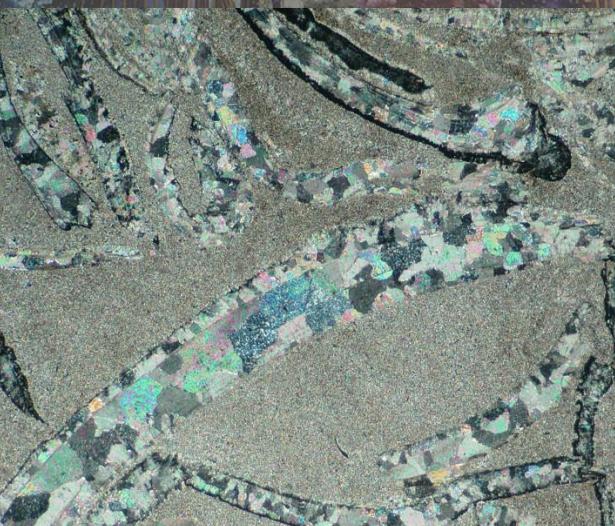
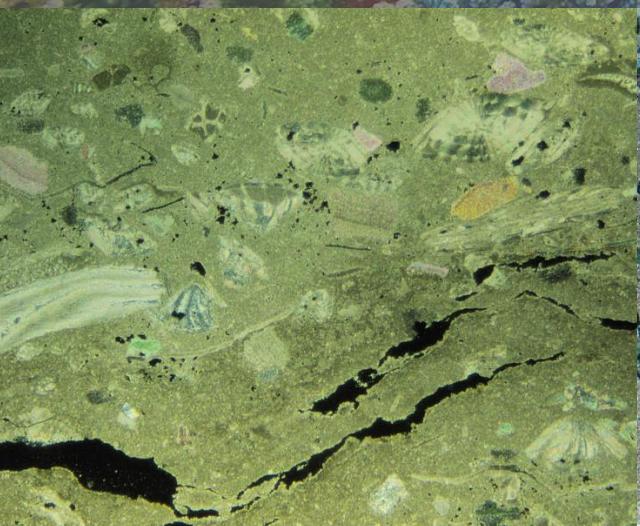
Main components of carbonate rocks:

- **Allochems** – discrete grains
- **Micrite** – carbonate mud
- **Sparite** – carbonate cement
- **Alteration products** – e.g. dolomite; diagenetic replacement crystals
- **Clastic components** – e.g. quartz, clays
- **Pore space** – gaps filled with air, fluid, or hydrocarbons



Main components of carbonate rocks:

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Controls on carbonate deposition | Temperature and pressure

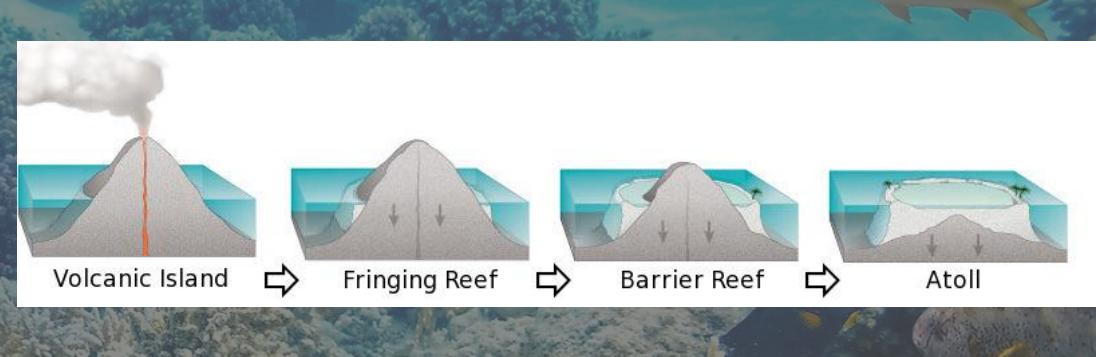
- CaCO_3 is more soluble in colder water



Carbonate environments: tropical | Barrier reefs



Carbonate environments: tropical | Fringing reefs and Atolls



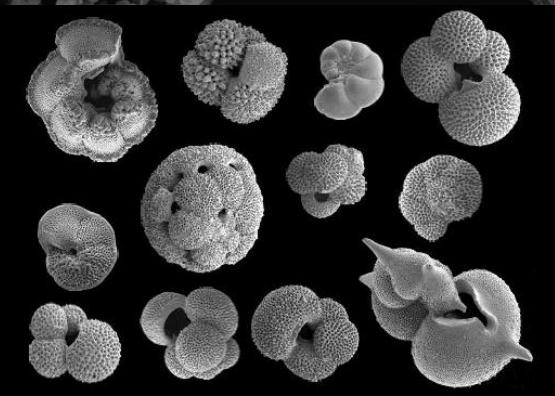
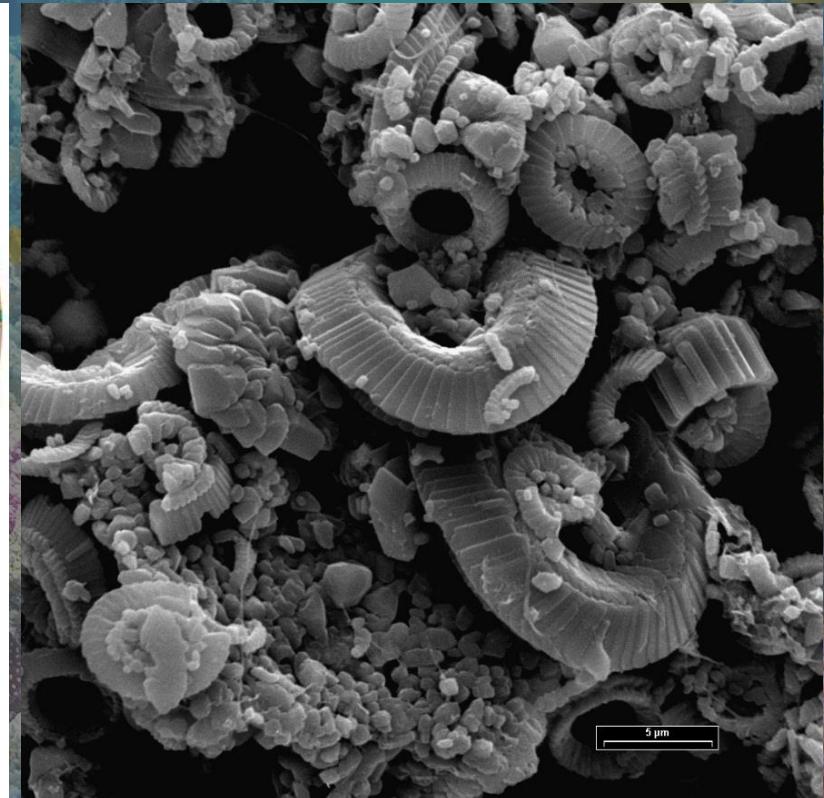
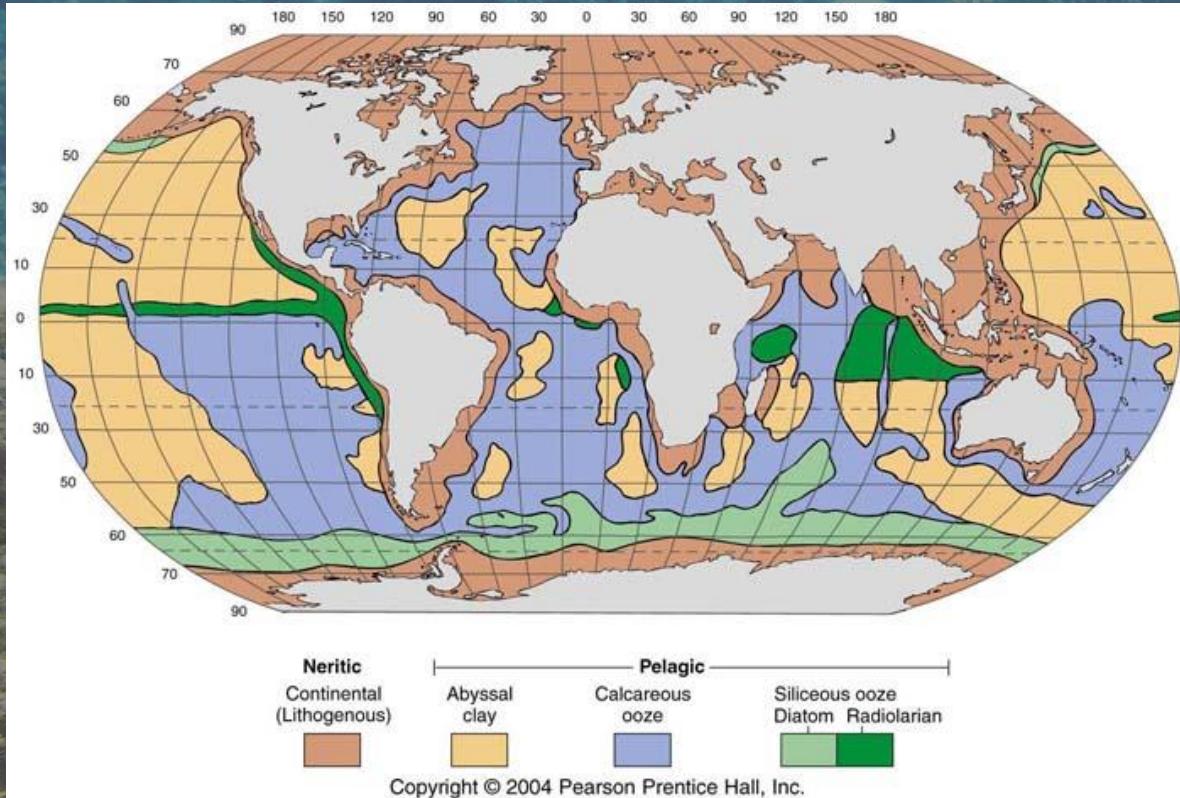
Carbonate environments: tropical | Platforms



Carbonate environments: temperate | Cold water carbonates

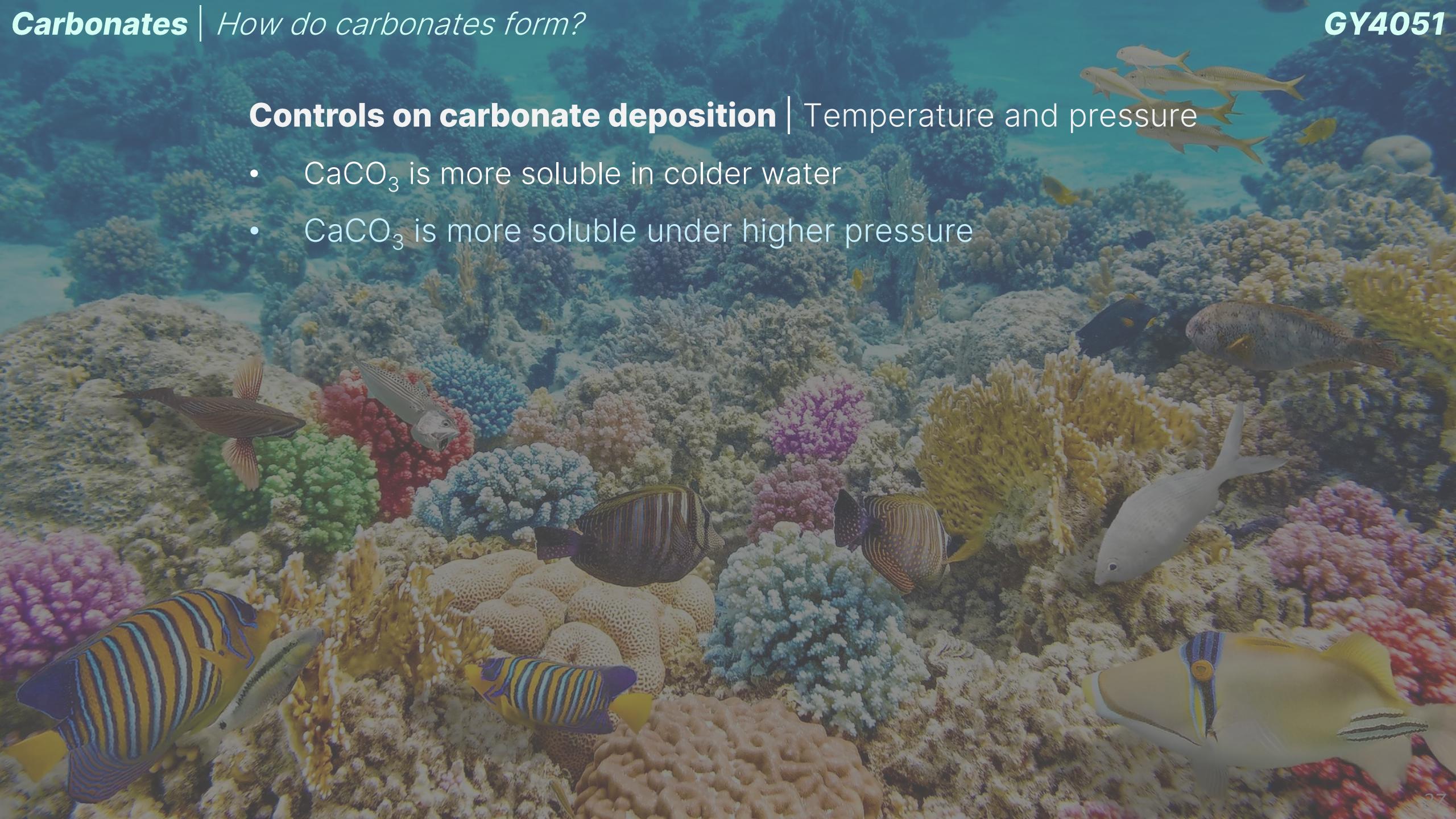


Carbonate environments: temperate | Deep sea



Controls on carbonate deposition | Temperature and pressure

- CaCO_3 is more soluble in colder water
- CaCO_3 is more soluble under higher pressure



Controls on carbonate deposition | Biology

- Surface tropical ocean waters supersaturated with carbonate but precipitation kinetically blocked by Mg^{2+} , SO_4^{2-}
- But kinetic block is overcome by organisms
- Different biological communities in different areas
- Different settings and organisms:
 - reef-building (e.g. coral)
 - sessile benthic (e.g. brachiopods)
 - mobile benthic (e.g. echinoids)
 - nektic (e.g. cephalopods)
 - pelagic (e.g. foraminifera)
- Different biological communities through time: **evolution**

Controls on carbonate deposition: Biology | Depth & Photosynthesis

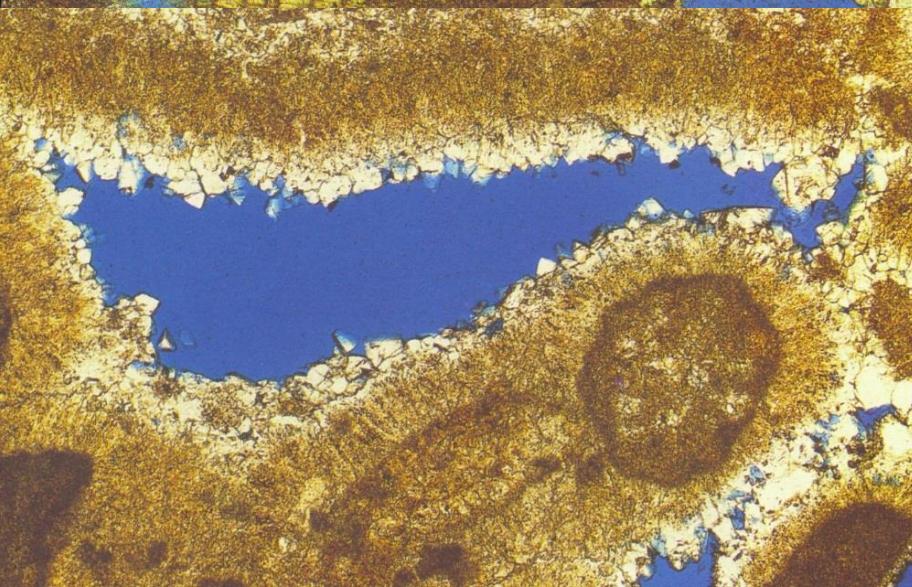
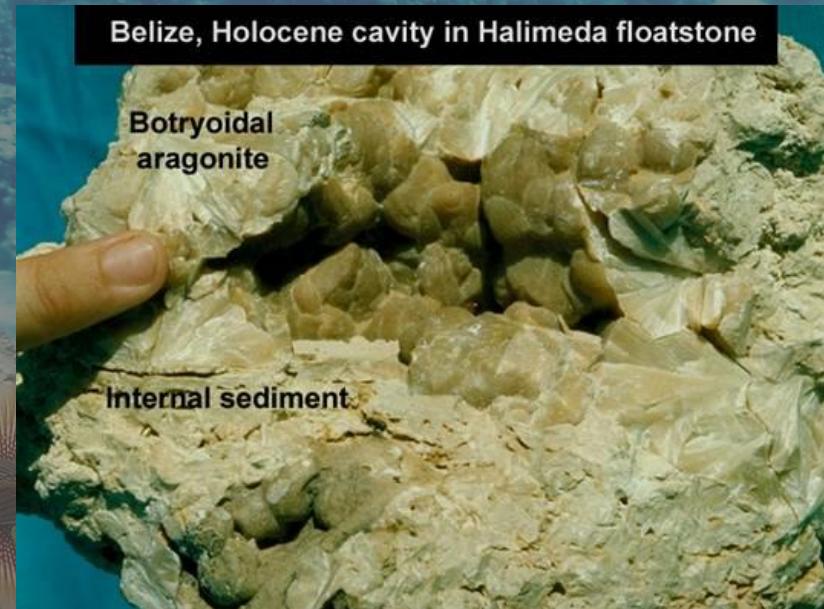


Controls on carbonate deposition: Biology | Bioerosion

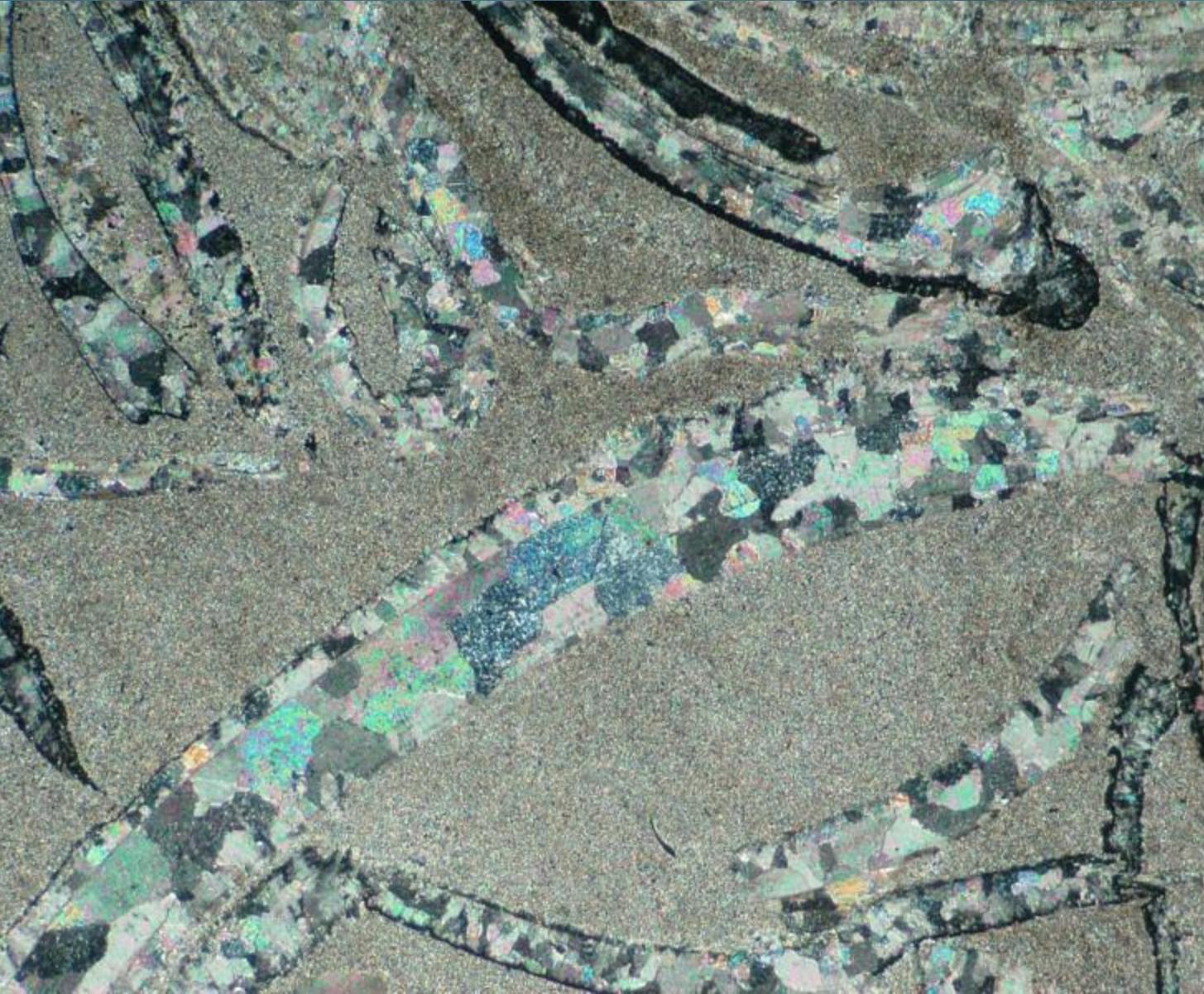
- Parrotfish eat coral, and excrete the skeleton as mud
- Single individual male parrotfish can resediment 5 tonnes per year
- Moved from the most actively growing part of the reef, to huge sediment aprons on the seafloor



Carbonate rock formation: Diagenesis | Cementation



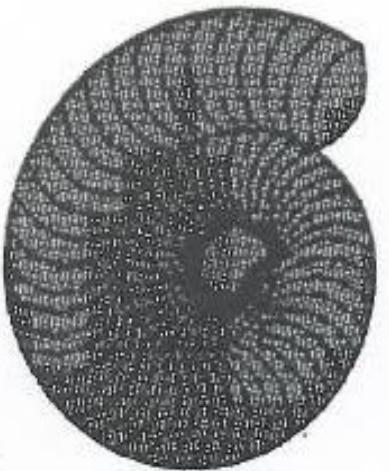
Carbonate rock formation: Diagenesis | Replacement



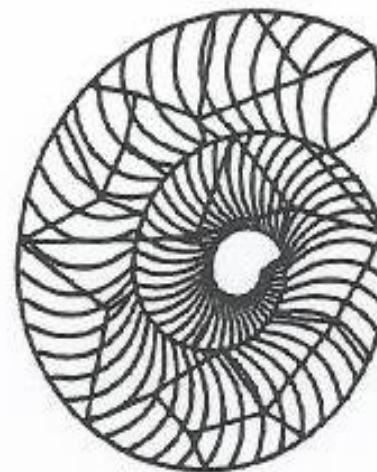
Carbonate rock formation: Diagenesis | Replacement

Recrystallization of unstable minerals

Shell

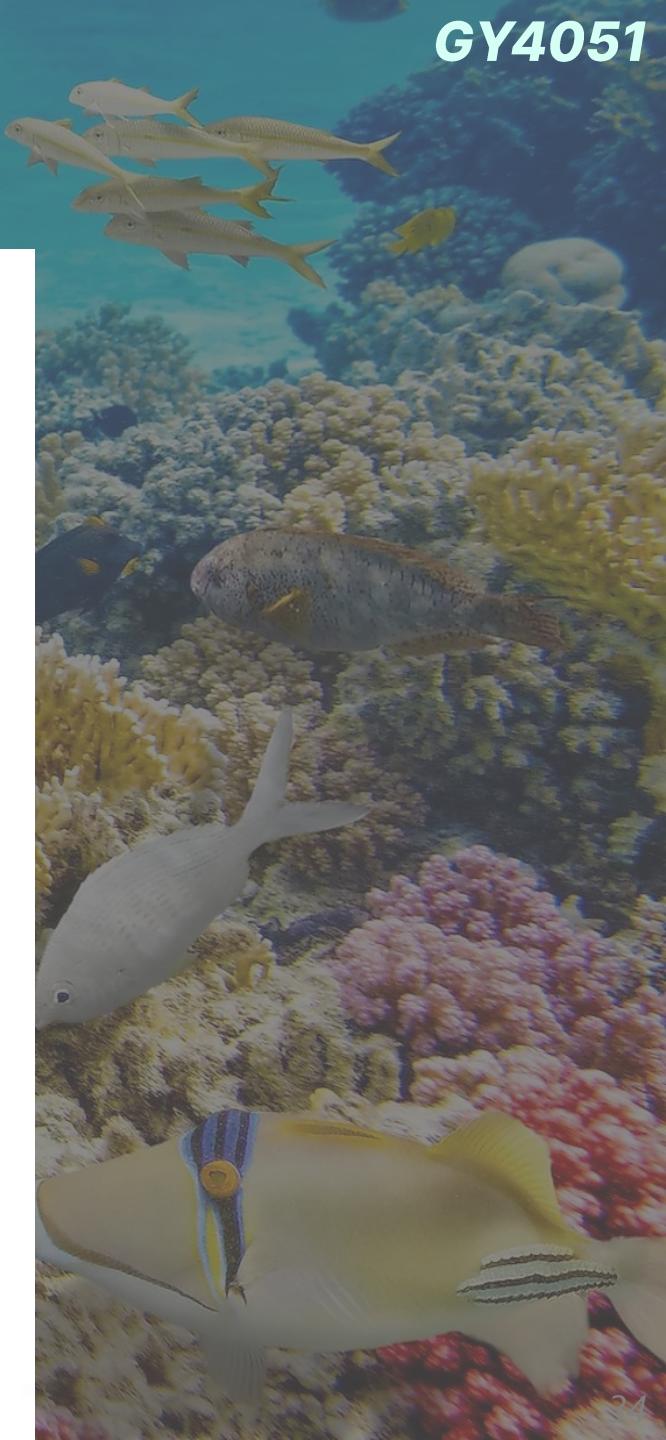


Aragonite: finely
detailed structure



Calcite: coarse mosaic
of crystals obscures
much detail

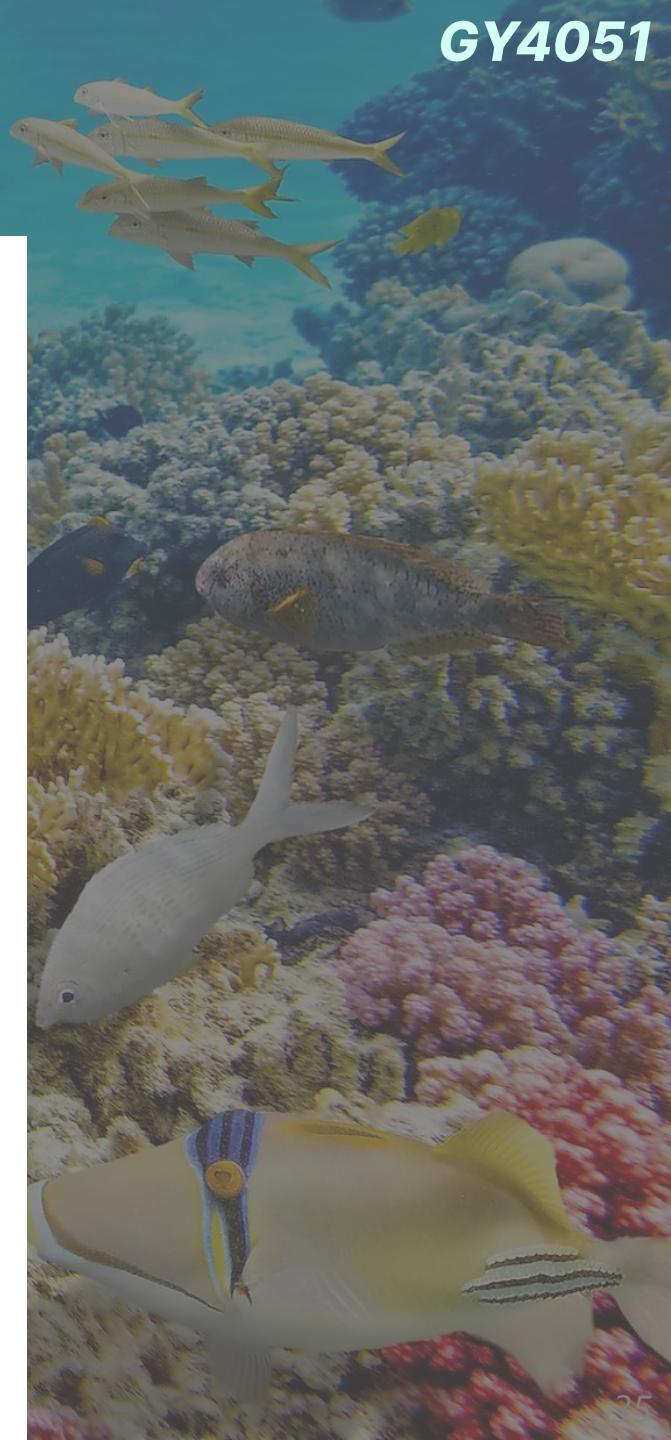
Carbonate rock formation: Diagenesis | Replacement



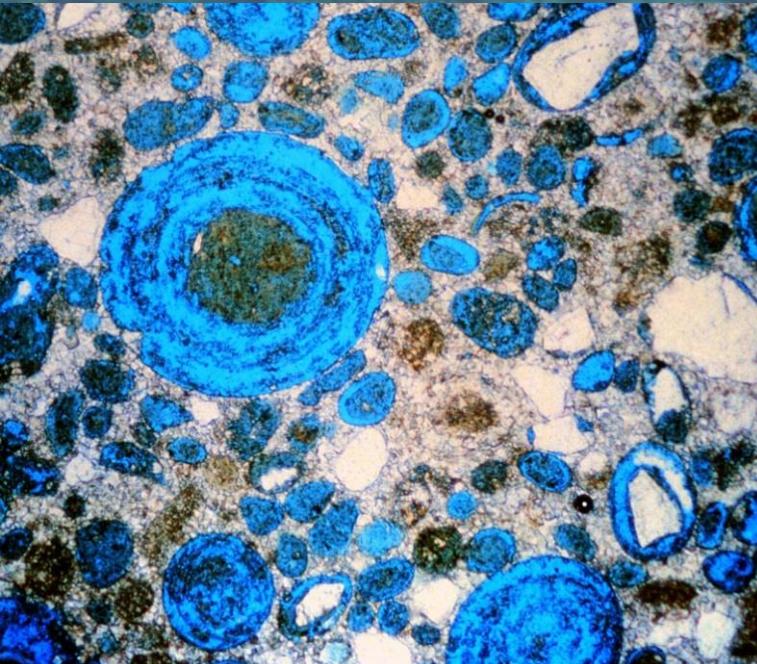
Carbonate rock formation: Diagenesis | Replacement

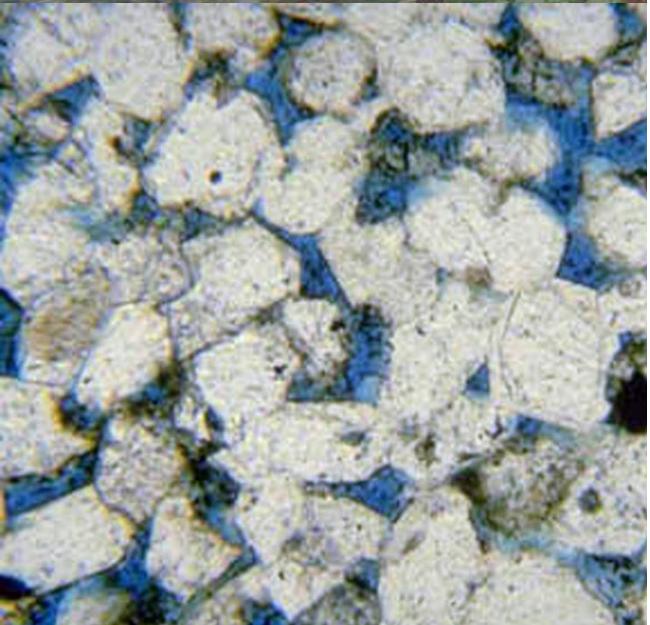
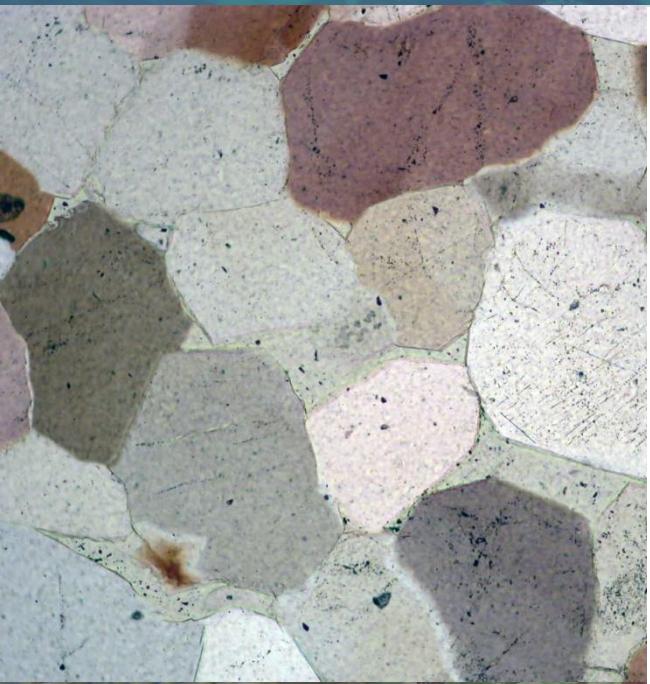


'Piratised' Ammonite



Carbonate rock formation: Diagenesis | Dissolution



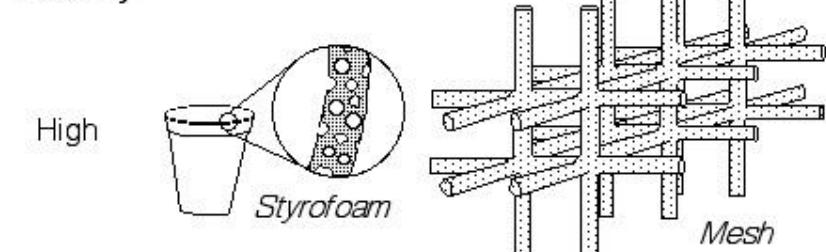
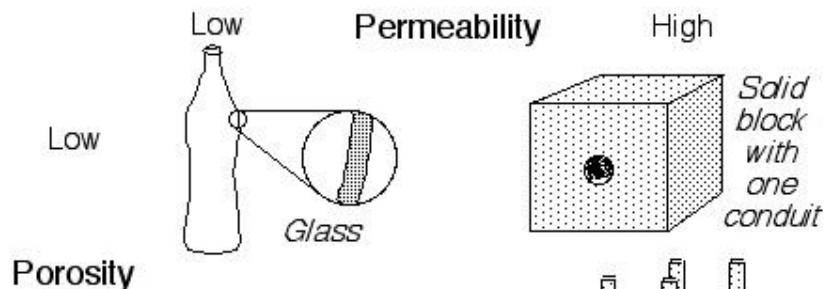


Porosity:

proportion of non-mineral space in a rock or sediment.

Permeability:

extent to which fluids can pass through a rock or sediment.



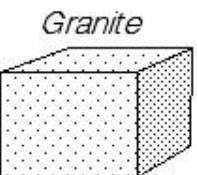
Geologic Examples:

Geologic Examples:

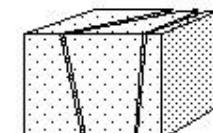
Low

Permeability

High



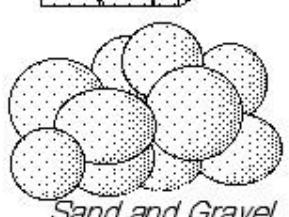
Fractured Granite



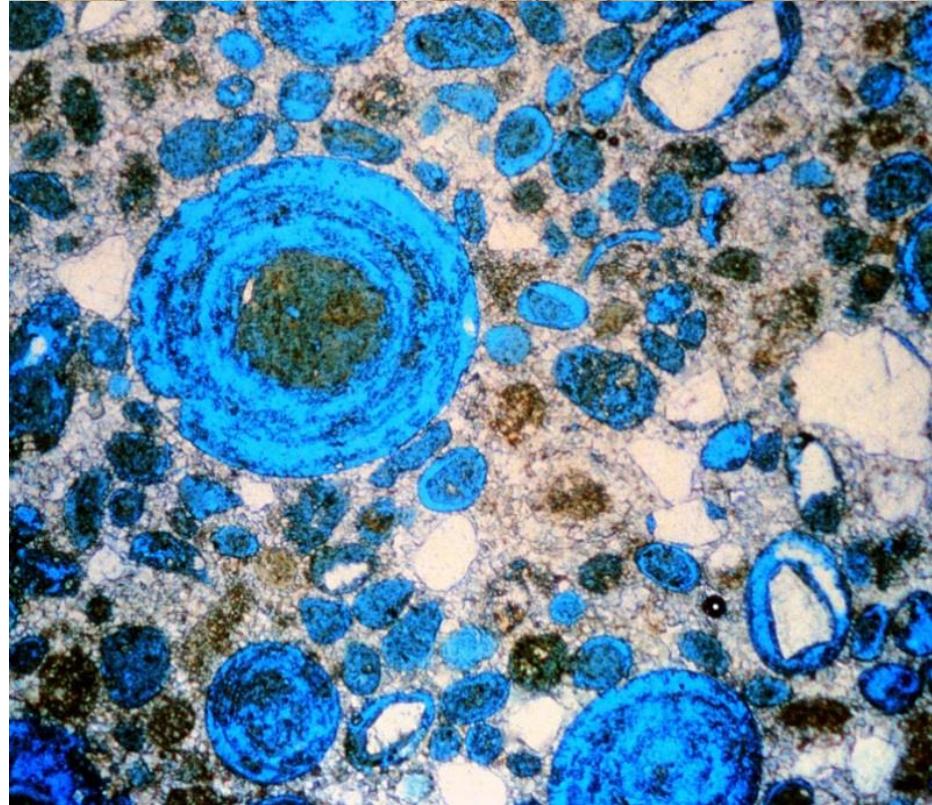
Low
Porosity



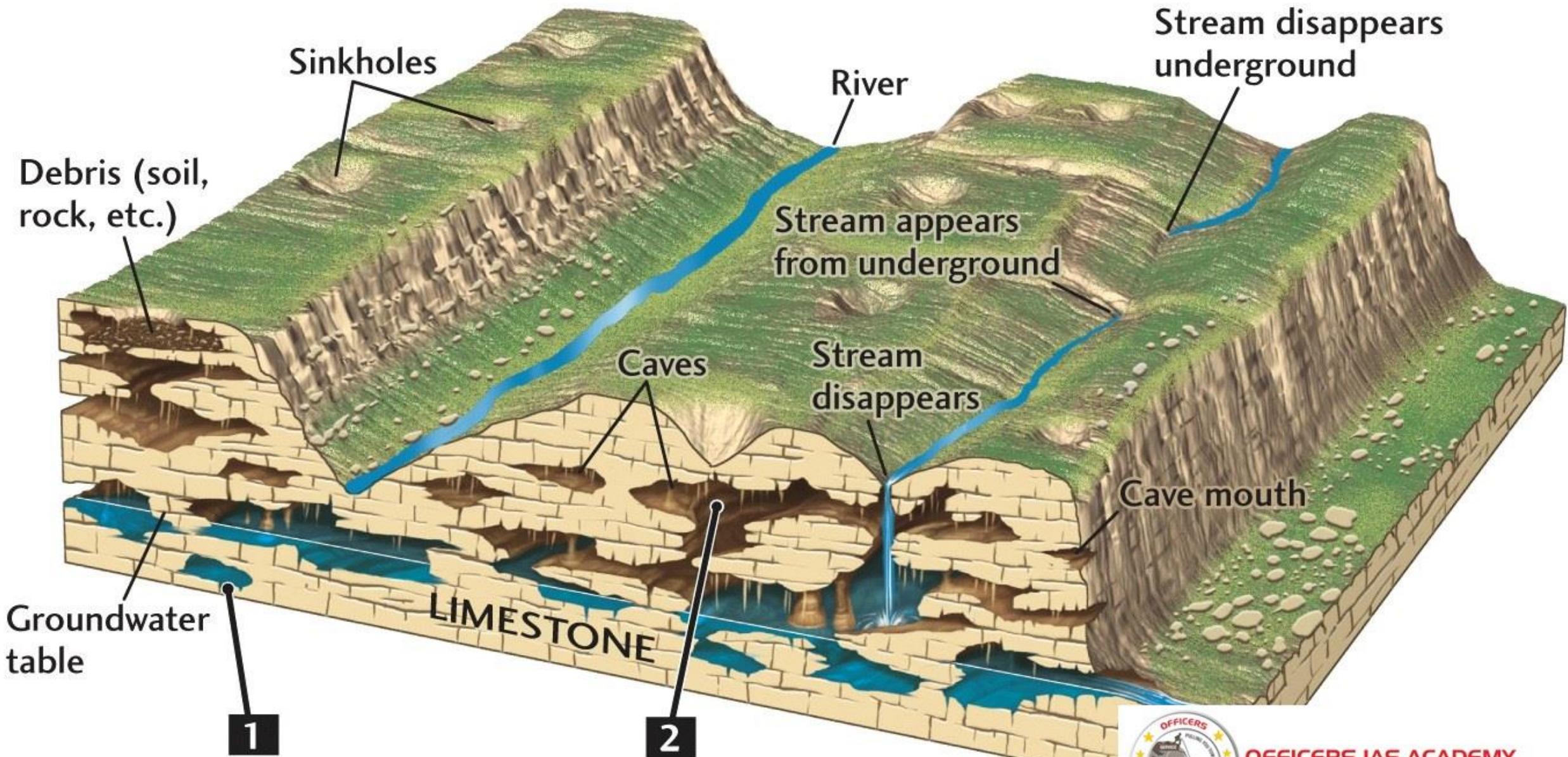
*Pumice or
Vesicular Basalt*

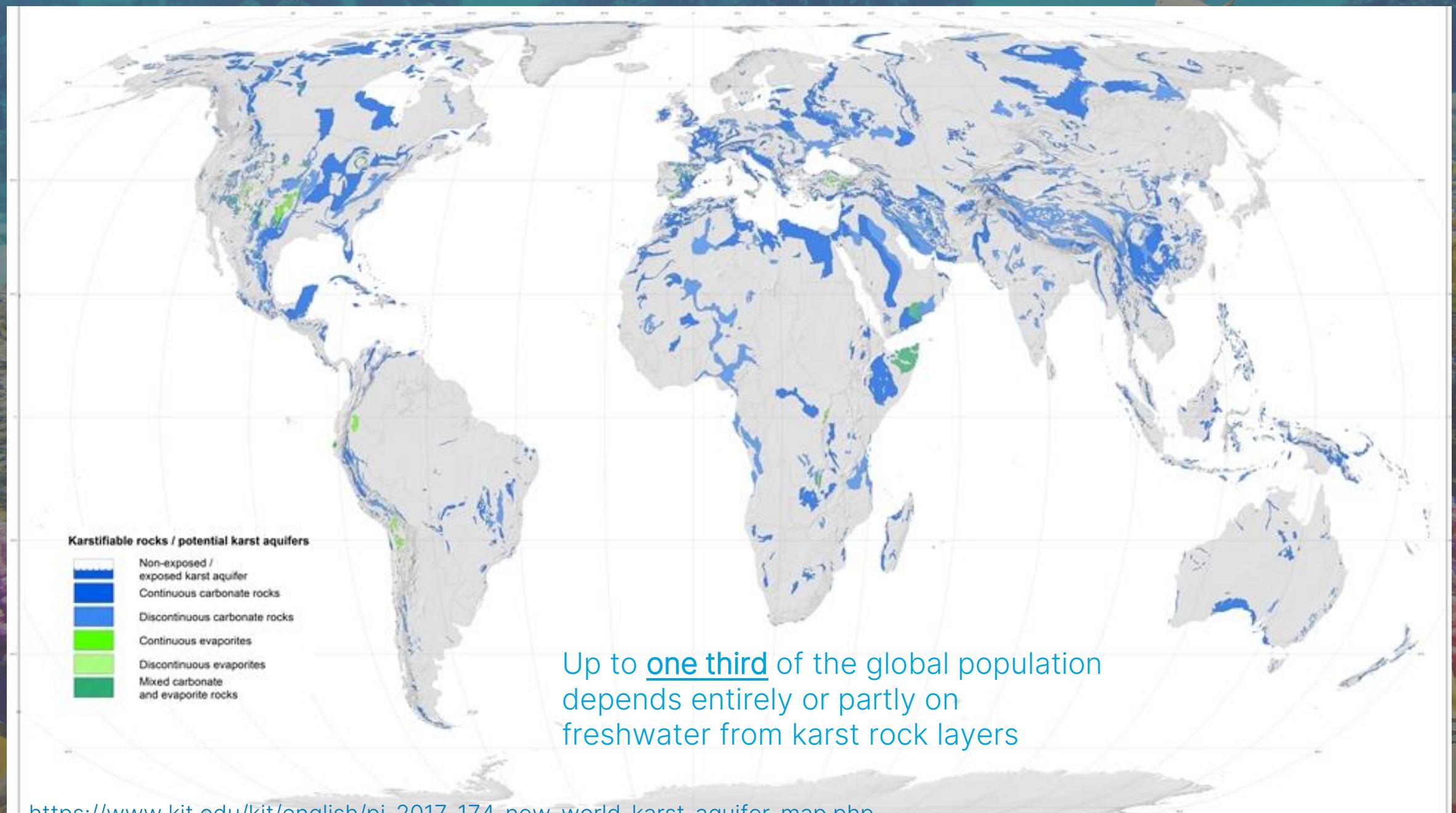


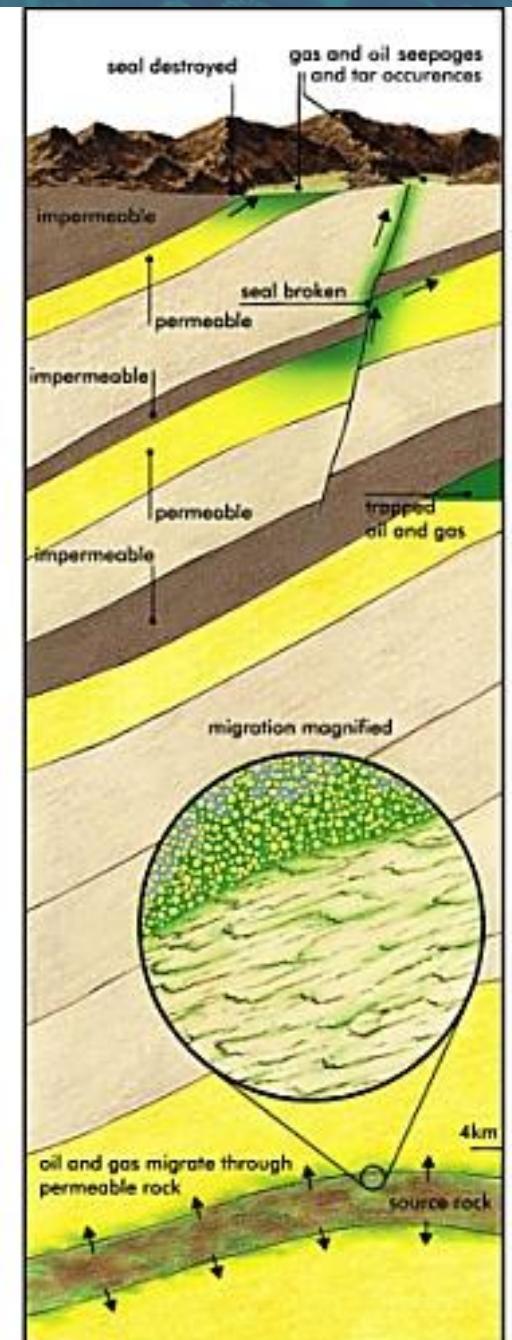
Sand and Gravel









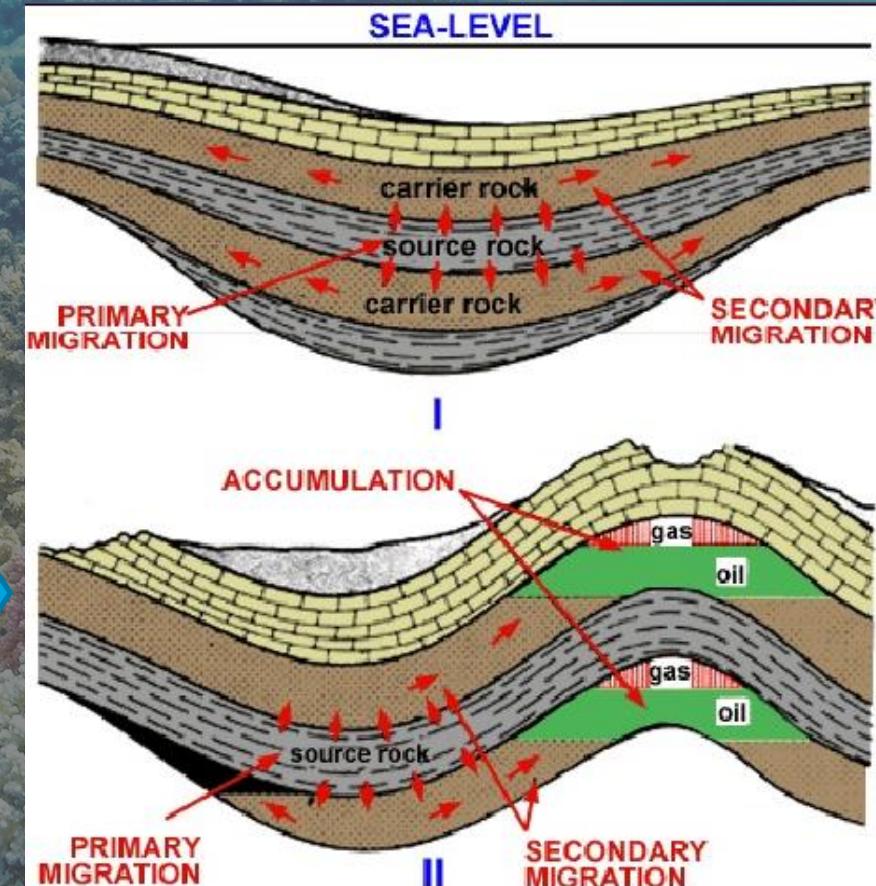


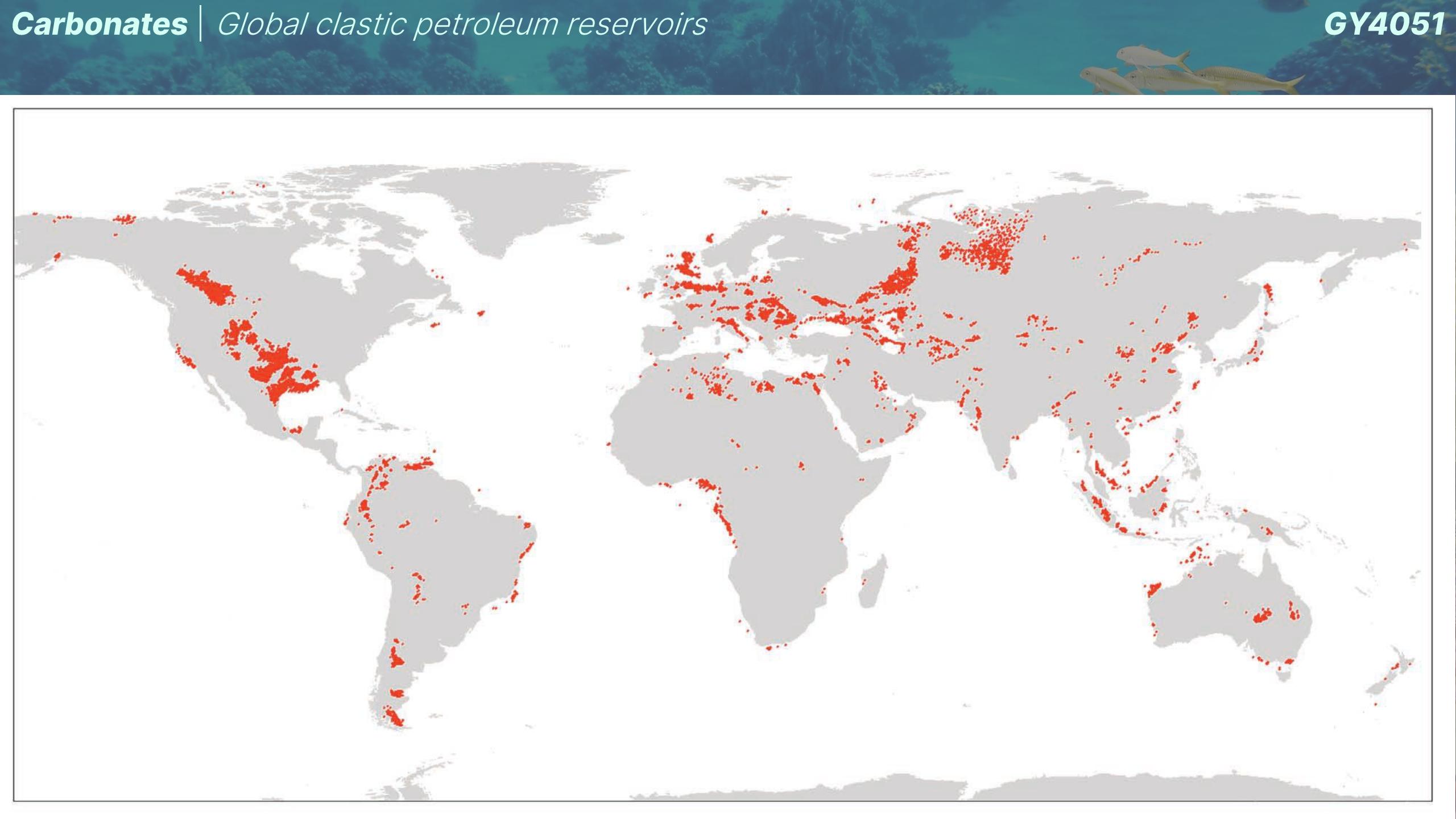
SEAL is mudrock or salt which is impermeable to oil, gas or water

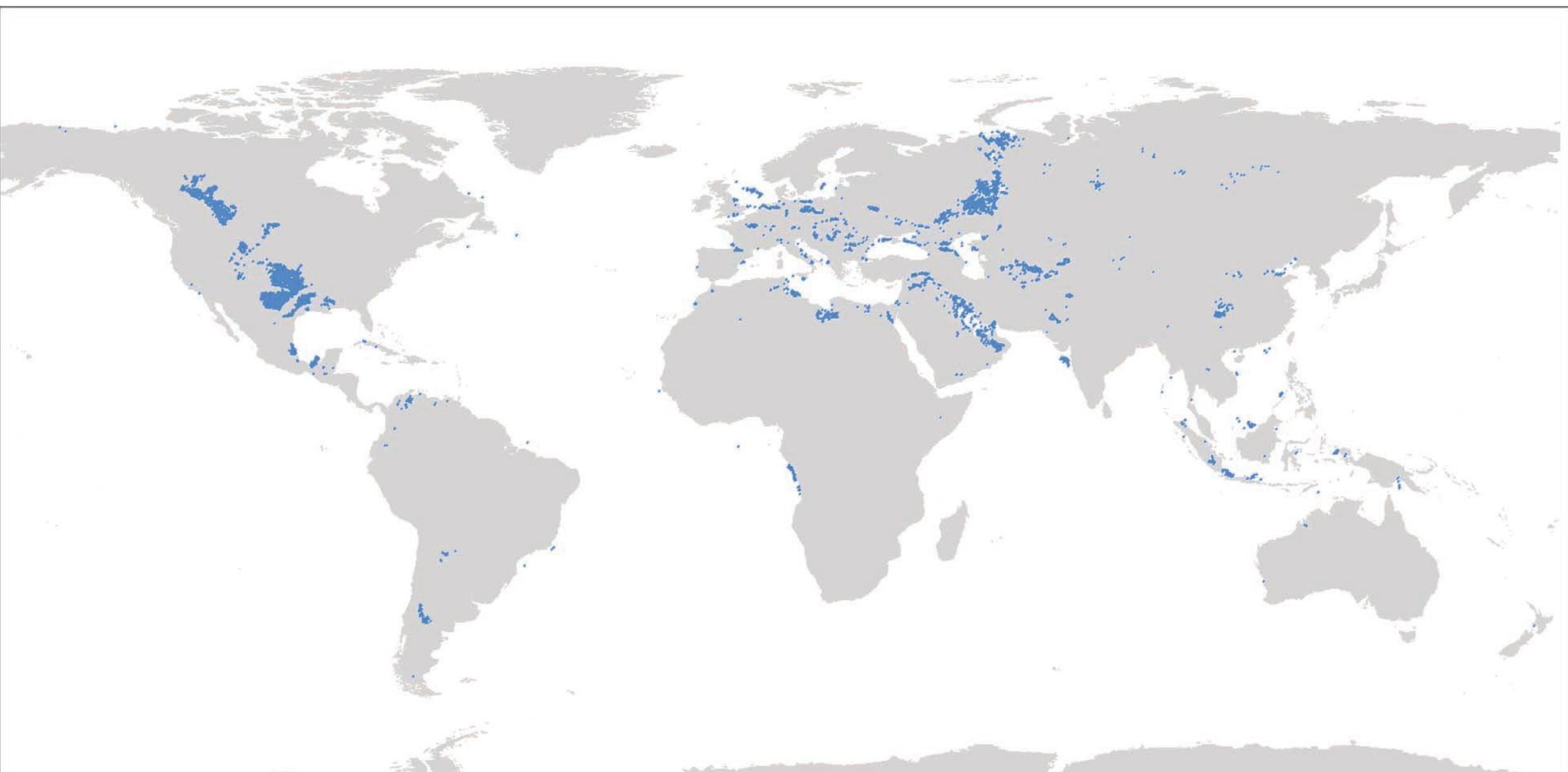
RESERVOIRS have many pores between sand or shell grains

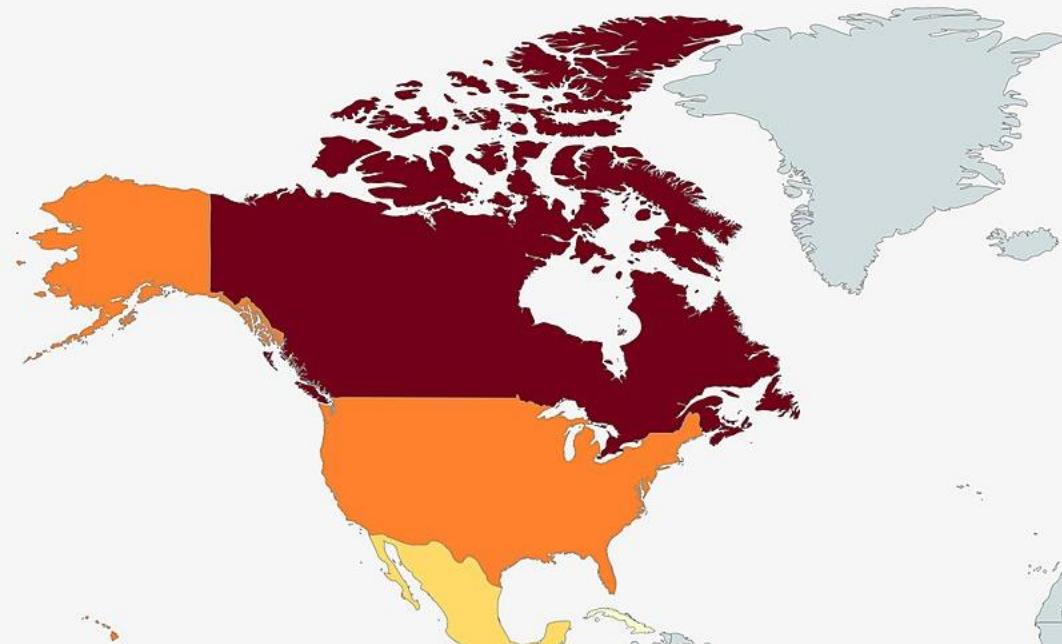
MIGRATION is the buoyant movement of oil or gas for 1 to 200km

SOURCE rocks are rich in fossil organic debris
Plant: gas,
Marine : oil









Map of countries with proven oil reserves

(in millions of barrels)

2017 - US EIA

- 200.000 - 300.000
- 100.000 - 200.000
- 50.000 - 100.000
- 10.000 - 50.000
- 1.000 - 10.000
- 100 - 1.000
- less than 100

