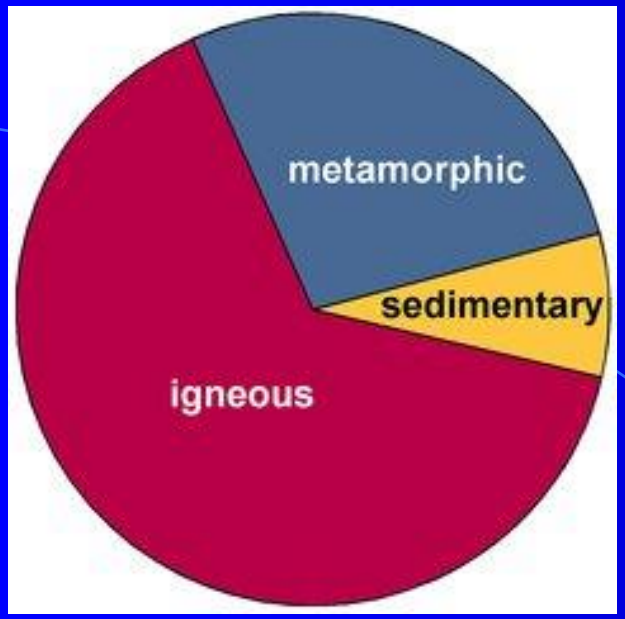
Sedimentary Rock Classification, Occurrence, and Plate Tectonic Significance

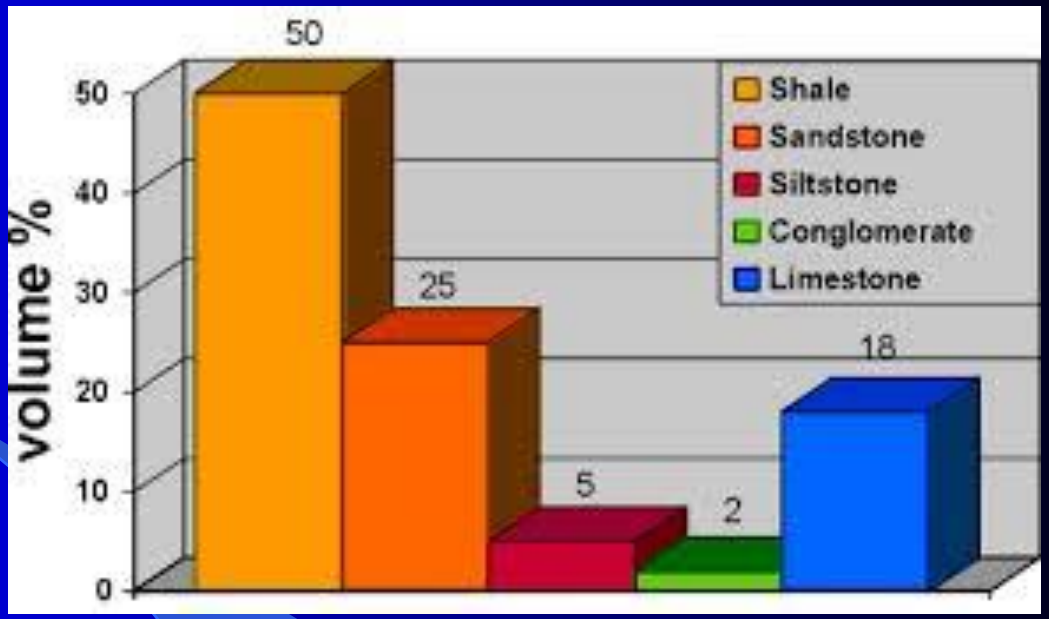
Siliciclastic sedimentary rocks
- Mudrocks
- Sandstones
- Conglomerates

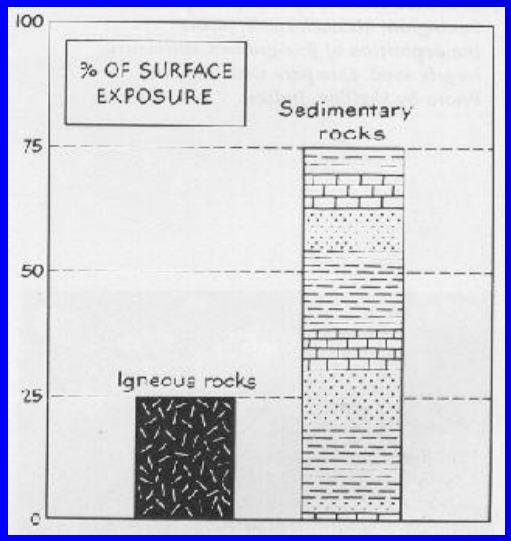
Biogenic sedimentary rocks
- Carbonates
- Cherts
- Coals

Chemical sedimentary rocks
- Evaporites
- Carbonates
- Phosphorites
- Banded iron formation

Percent rock types in the Earth's Crust







Mudrocks

- Grain size <0.0625 mm
- 50% of all sedimentary rocks
- Claystone - grain size <0.004 mm
- Siltstone – grain size >0.004 mm
- Shales – mudrocks that show fissility
- Mineral components – quartz, clay minerals, micas
- Massive to thinly bedded (laminations)
- Bioturbation
- Kerogen – fossilized organic matter
- Color – gray to red – reflection of organic content and oxidation state of iron

Tectonic setting

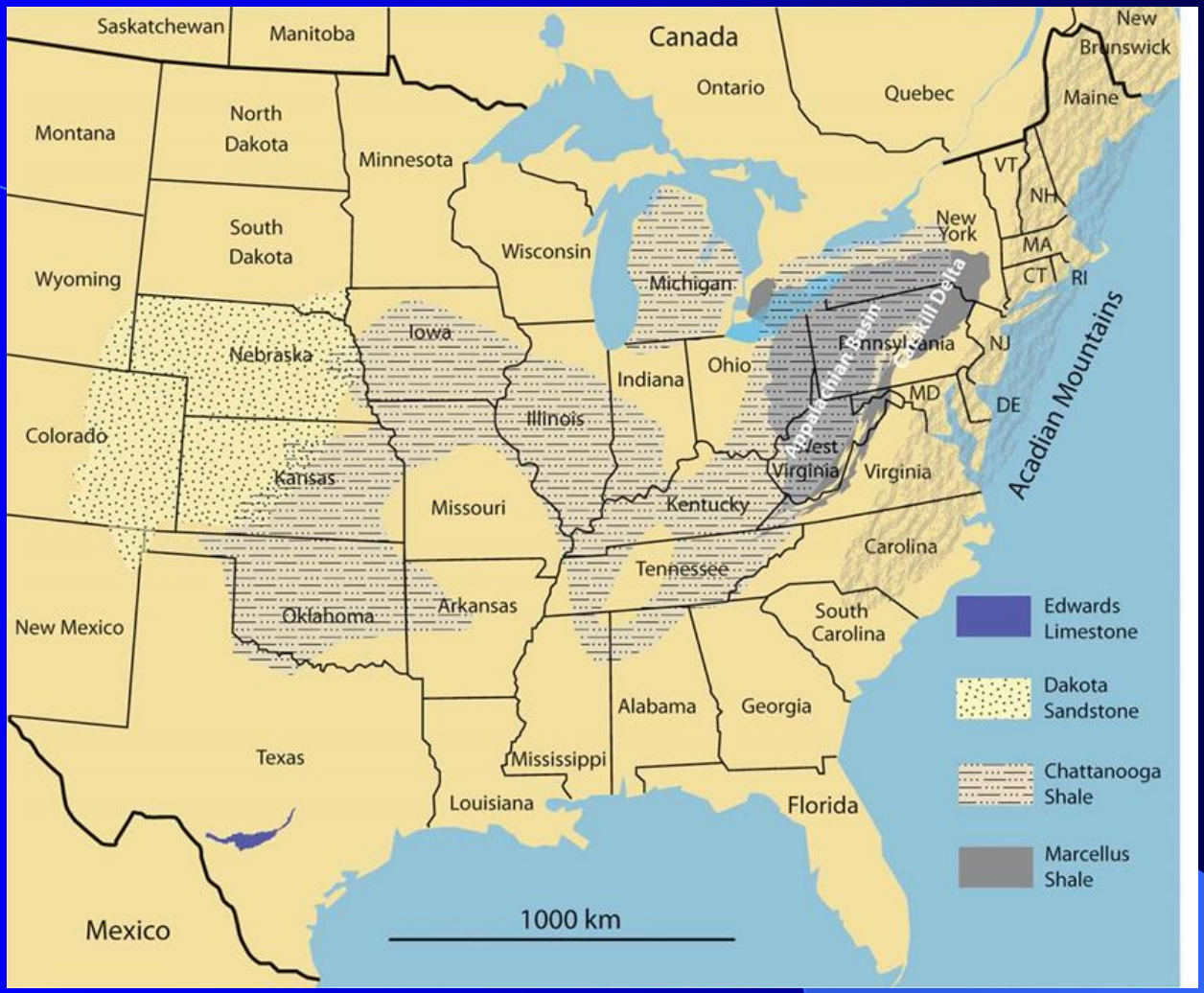
- Forearc basins – turbidity flows
- Foreland basins – deltaic sequences – example Catskill delta – Marcellus shale
- Epeiric seas – example Chattanooga shale
- Rift valleys and pull-apart basins

Bioturbation

Courtesy of Dawn Y. Sumner, Geology Department, University of California, Davis

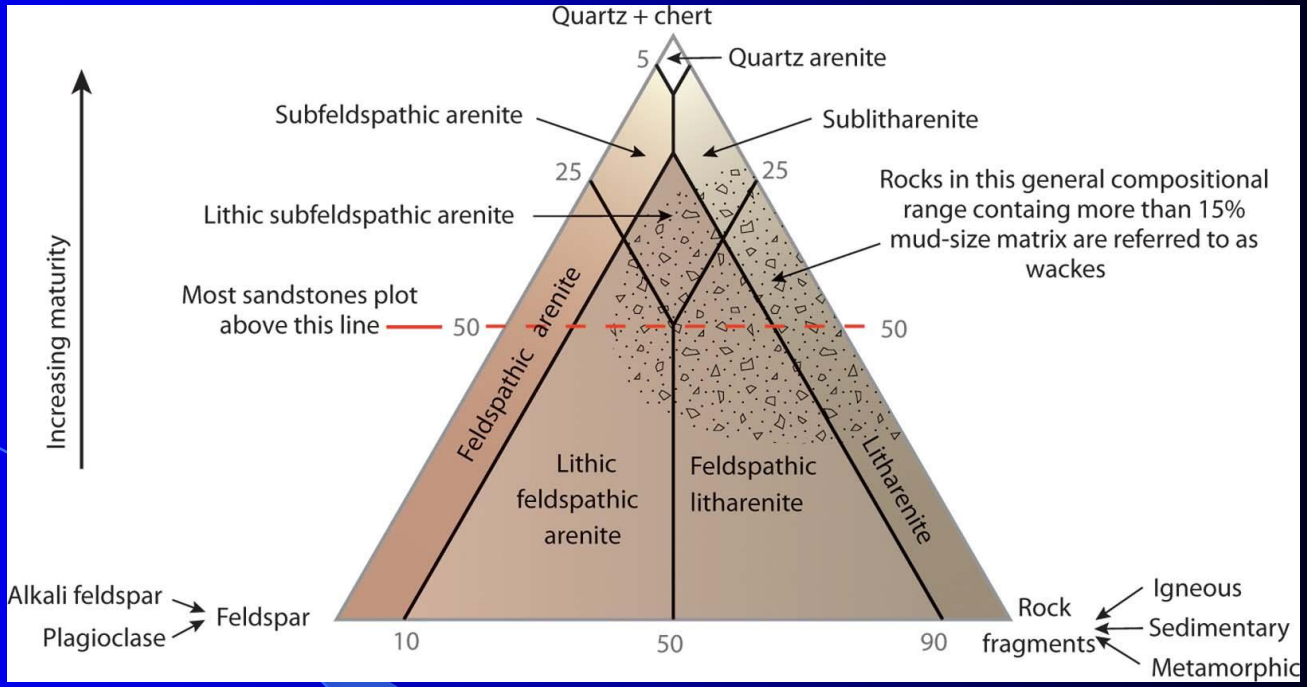
Marcellus shale

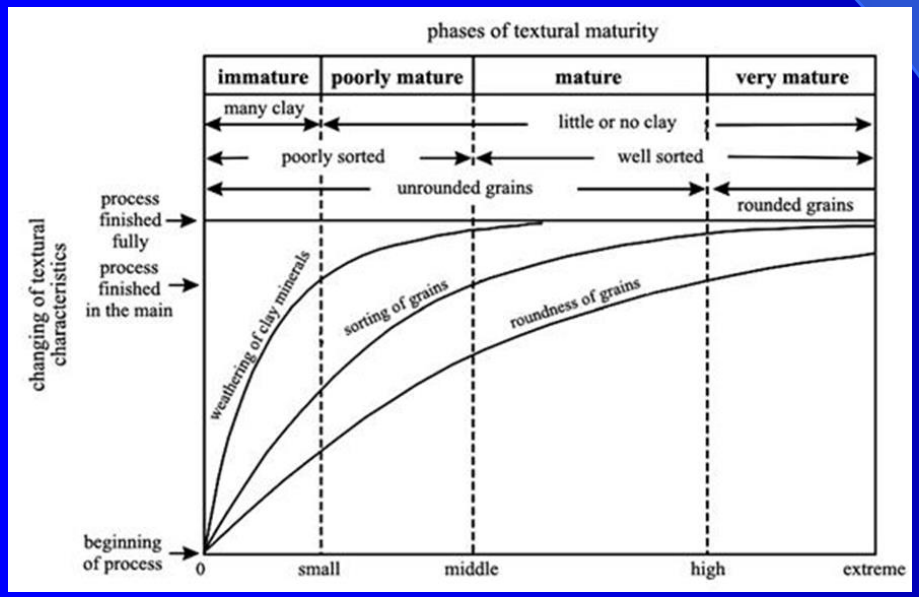
Mudstone – shale colors

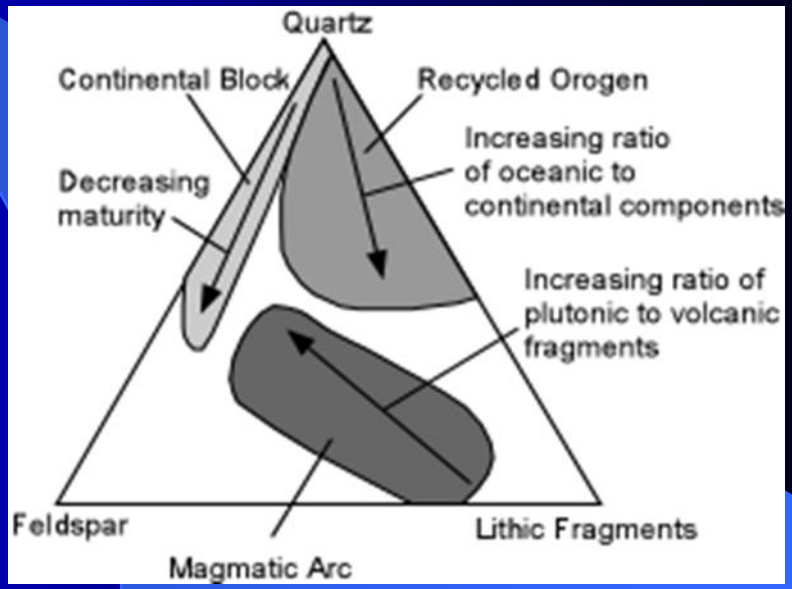

Saskatchewan
Manitoba
Canada
Ontario
Quebec
New Brunswick
Maine
Montana
North Dakota
Minnesota
VT
NH
South Dakota
Wisconsin
New York
MA
CT
RI
Wyoming
Michigan
Iowa
Nebraska
Pennsylvania
NJ
Indiana
Ohio
MD
DE
Illinois
Colorado
West Virginia
Virginia
Kansas
Missouri
Kentucky
Carolina
Tennessee
New Mexico
Oklahoma
Arkansas
South Carolina
Alabama
Georgia
Texas
Mississippi
Louisiana
Florida
Mexico
1000 km
Acadian Mountains
Edwards Limestone
Dakota Sandstone
Chattanooga Shale
Marcellus Shale

Sandstones

- Grain size – 0.0625 – 2.00 mm
- Quartz, feldspar, rock fragments
- Constitute 25% of all sediments
- Maturity



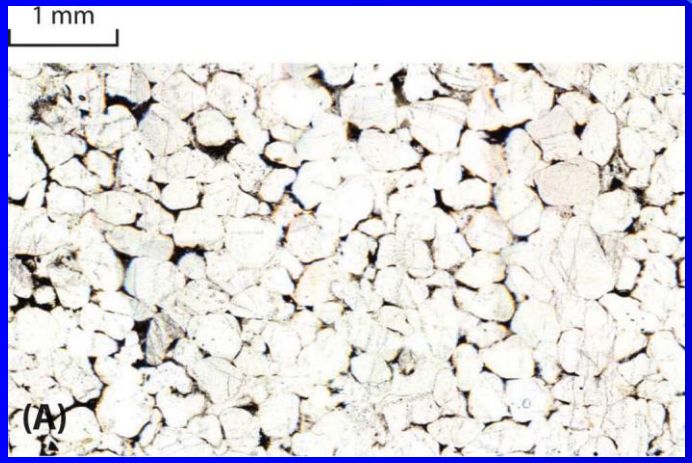


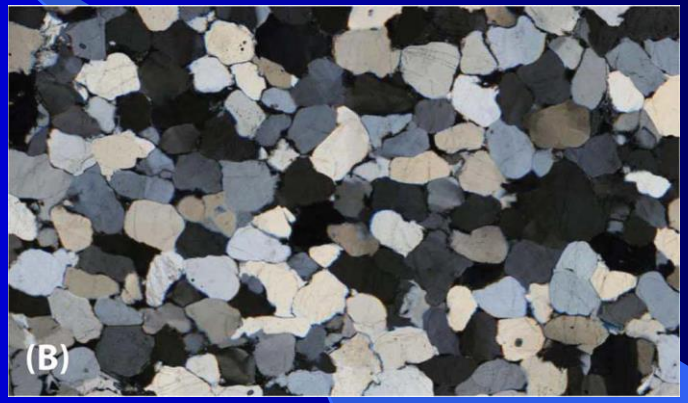


Quartz arenites (orthoquartzite)

- Beach and wind deposits
- Multicycle deposits
- Various types of cement

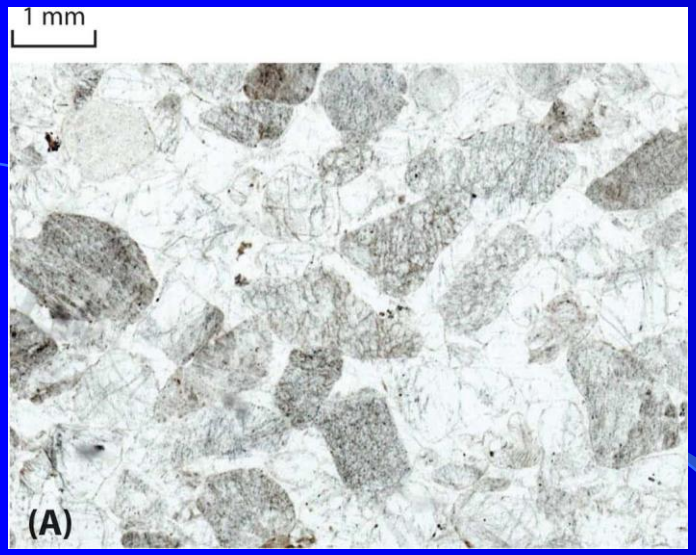
Well rounded, sorted, and frosted quartz grains, Ordovician St. Peter Sandstone, IL

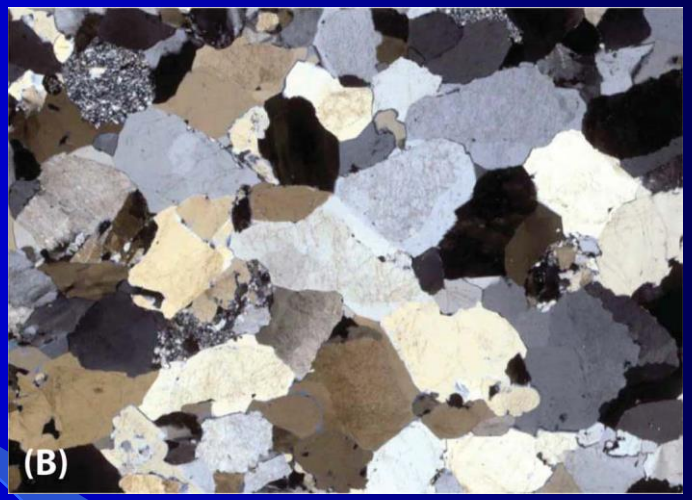




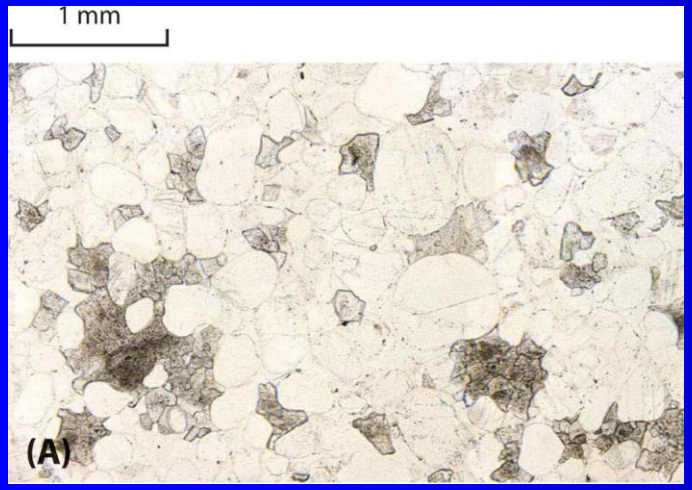
Potsdam sandstone – fine-grained siliciclastic matrix (clay and iron oxide)

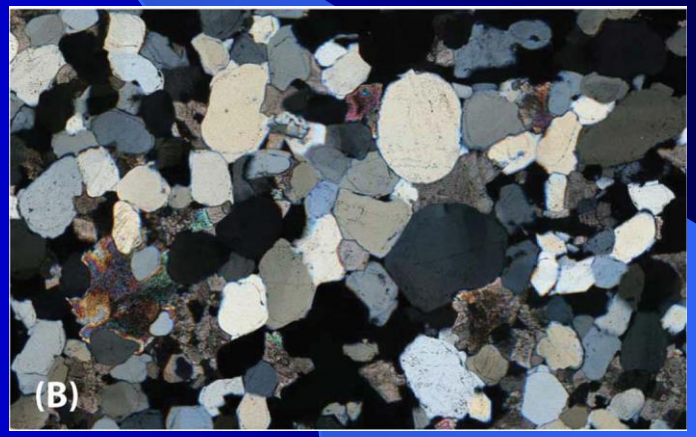
Cementation





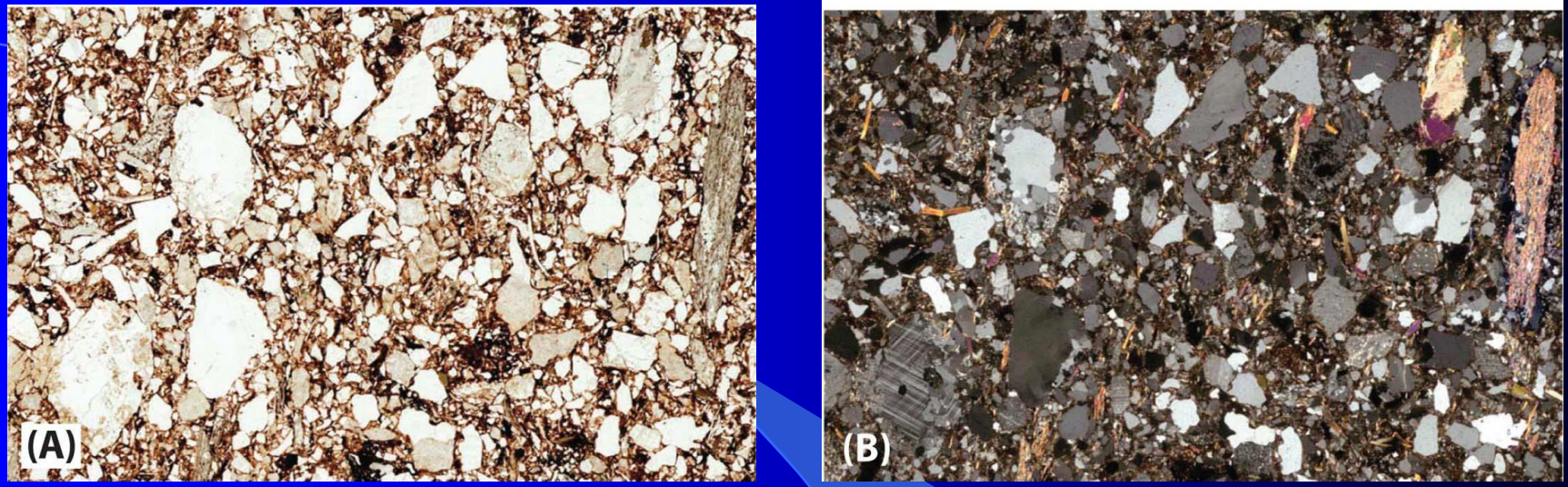
Silica cement





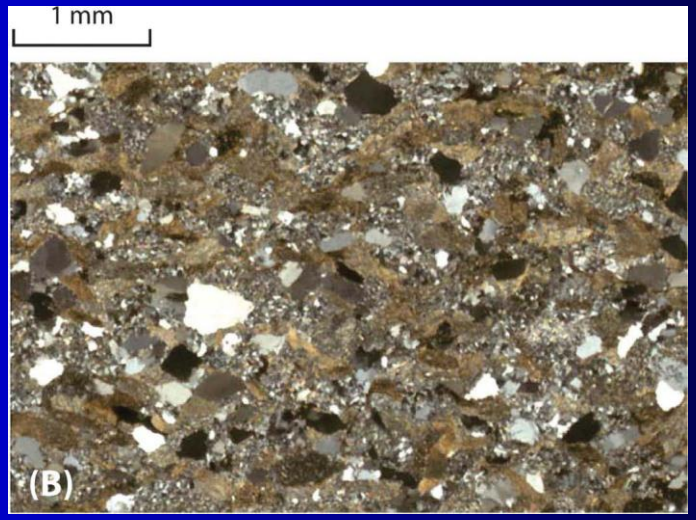
Carbonate cement

Feldspathic arenite (arkose)



Lithic arenite (subgraywacke)

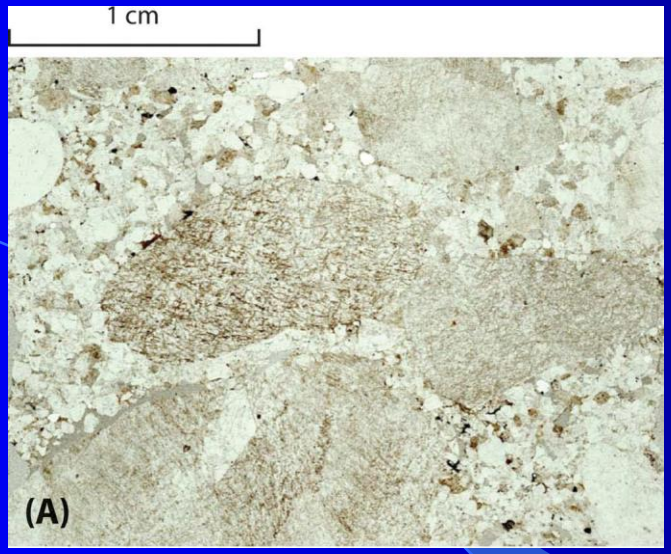
Wackes (Graywackes)



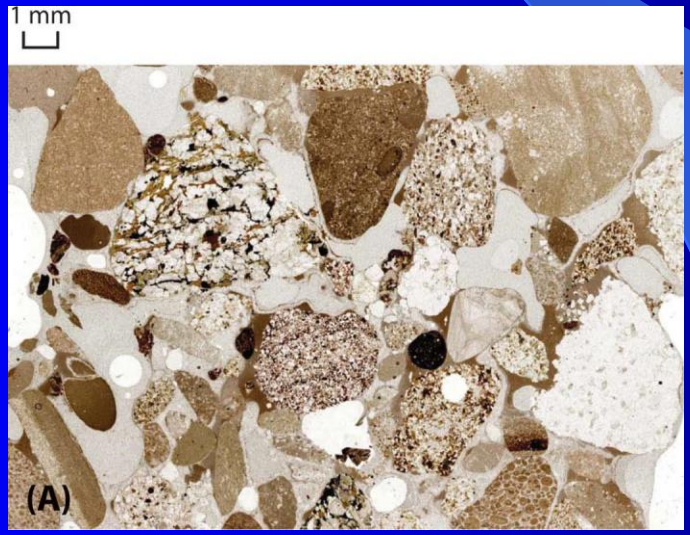
Martinsburg formation

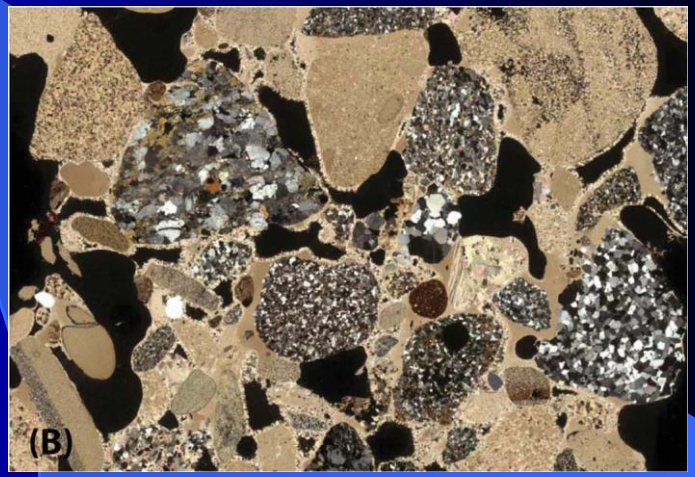
Clast-supported conglomerates

Oligomictic

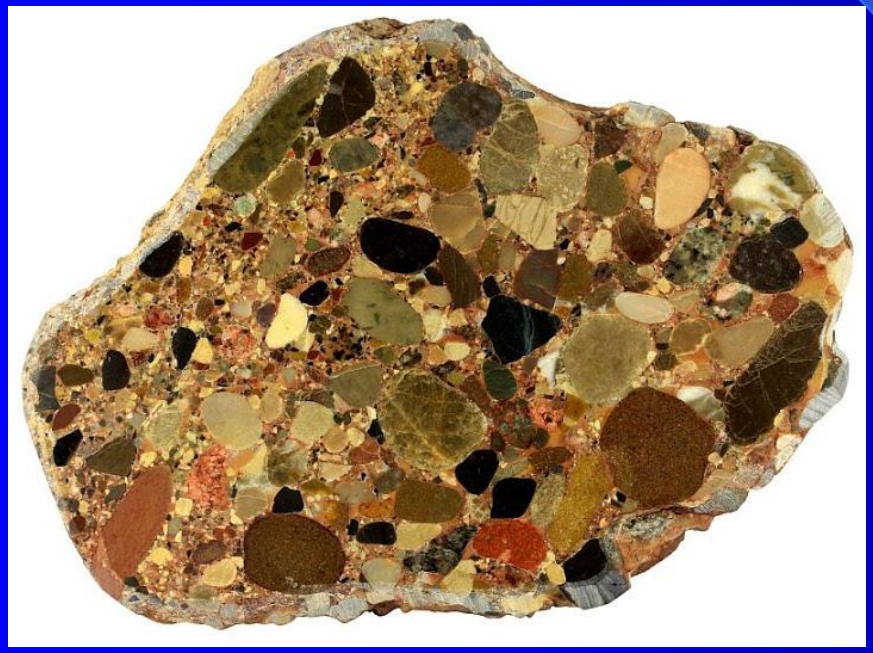


Polymictic





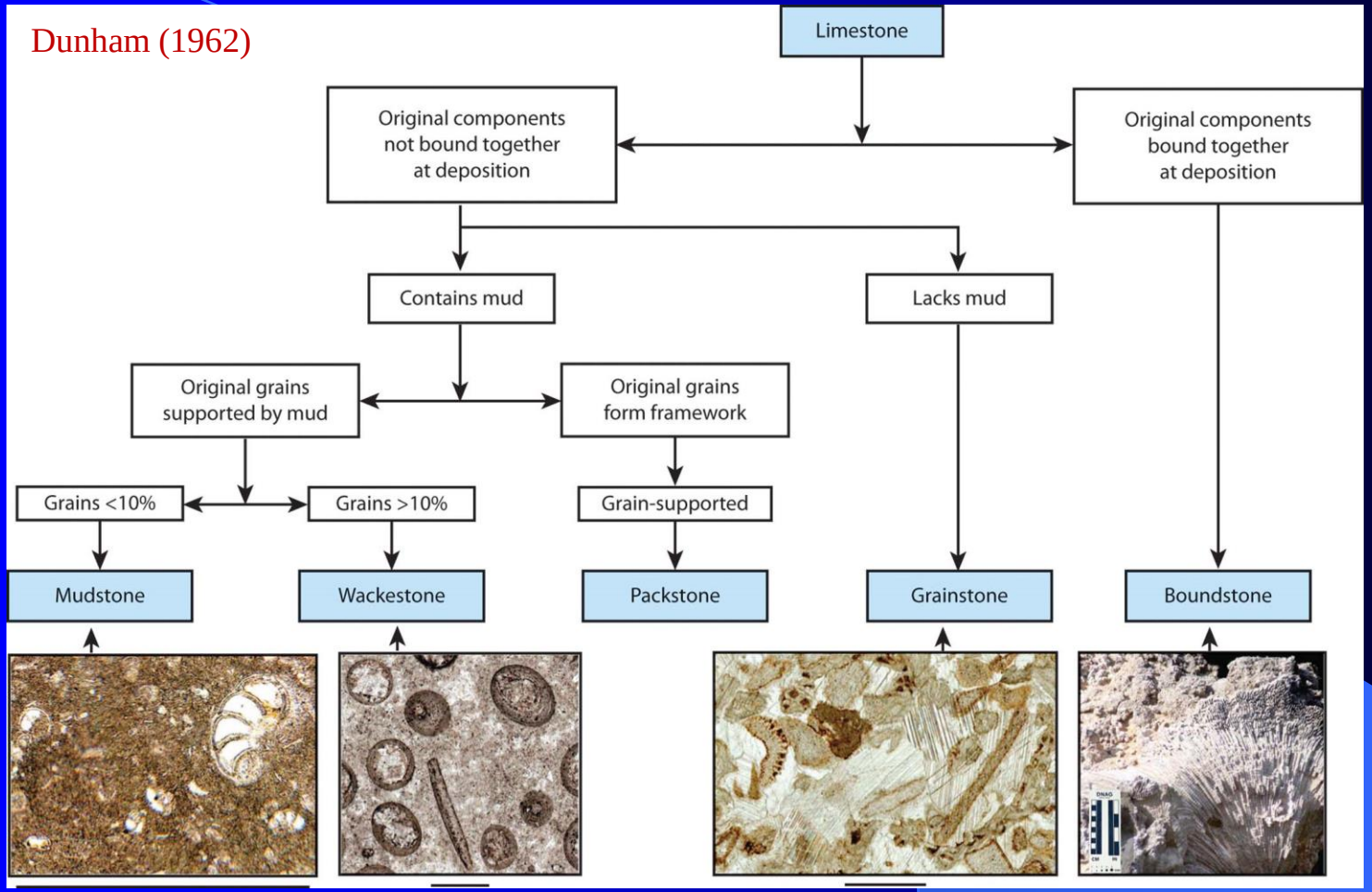
Matrix supported conglomerate



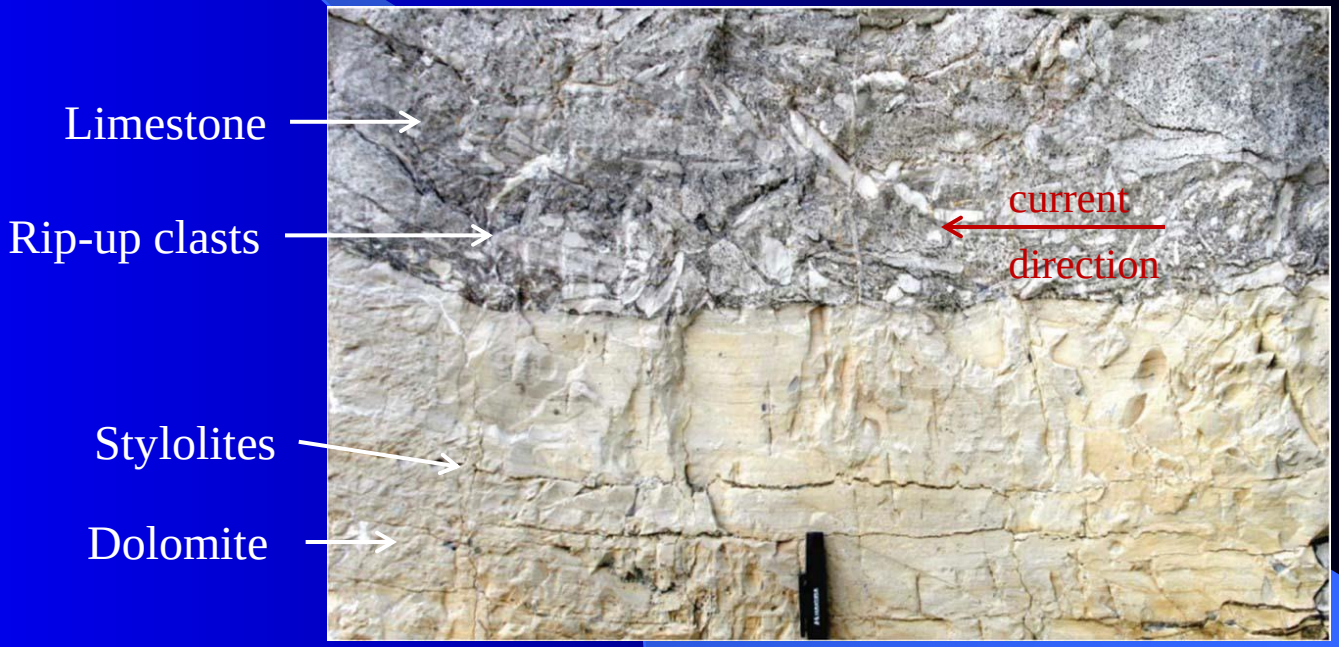
Limestones and Dolostones

Components of carbonate rocks

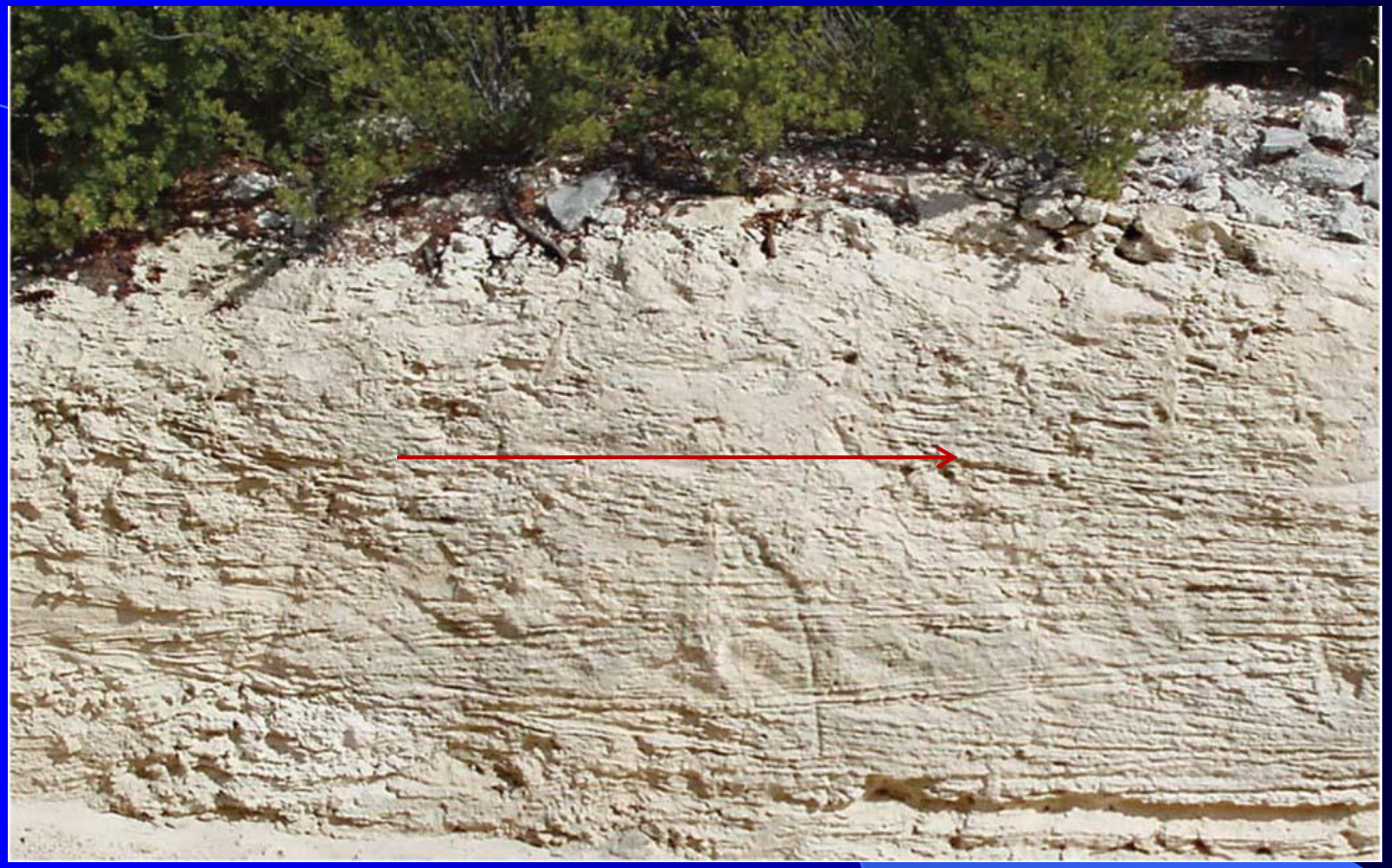
- Allochems – primary carbonate grains
- Micrite – fine-grained carbonate mud matrix
- Spar – coarse-grained carbonate cement




(A)
Dolomite
Limestone

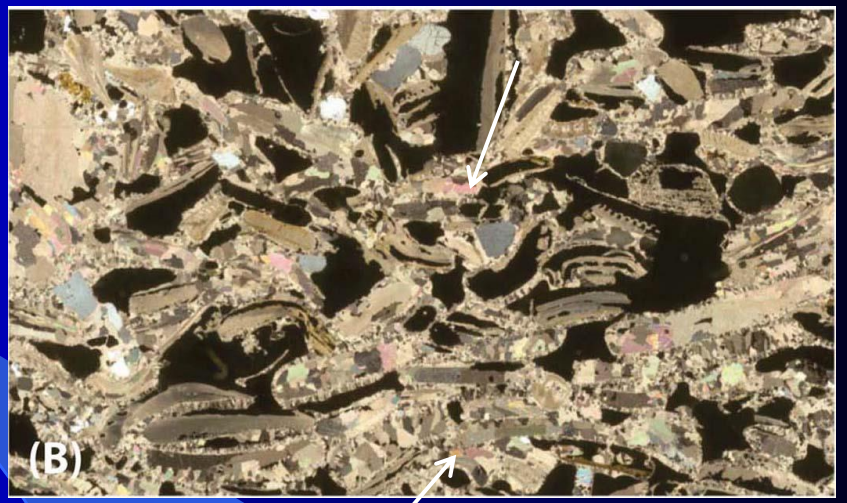

Limestone
Rip-up clasts
current
direction
Stylolites
Dolomite

Cross-bedded Grainstone

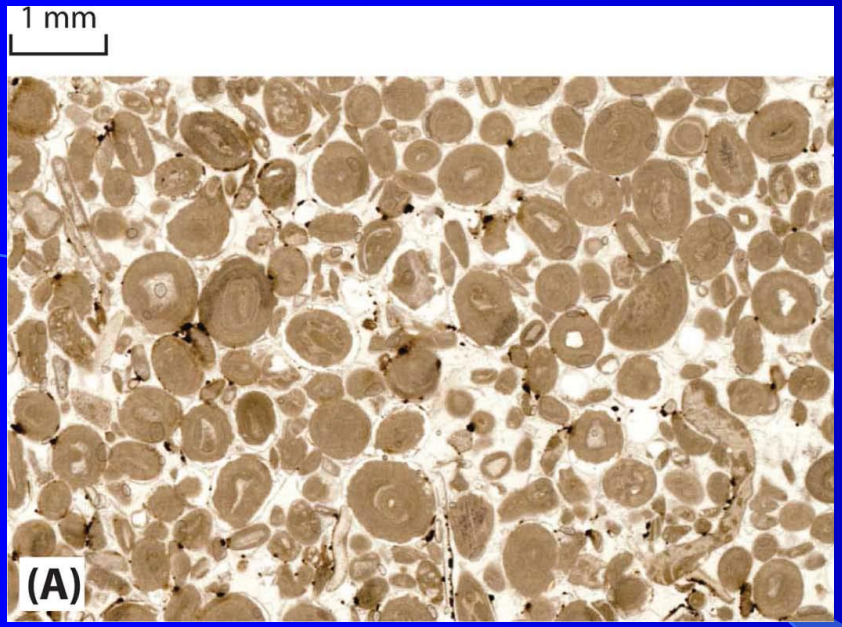


Coarse-grained Grainstone

Pore space

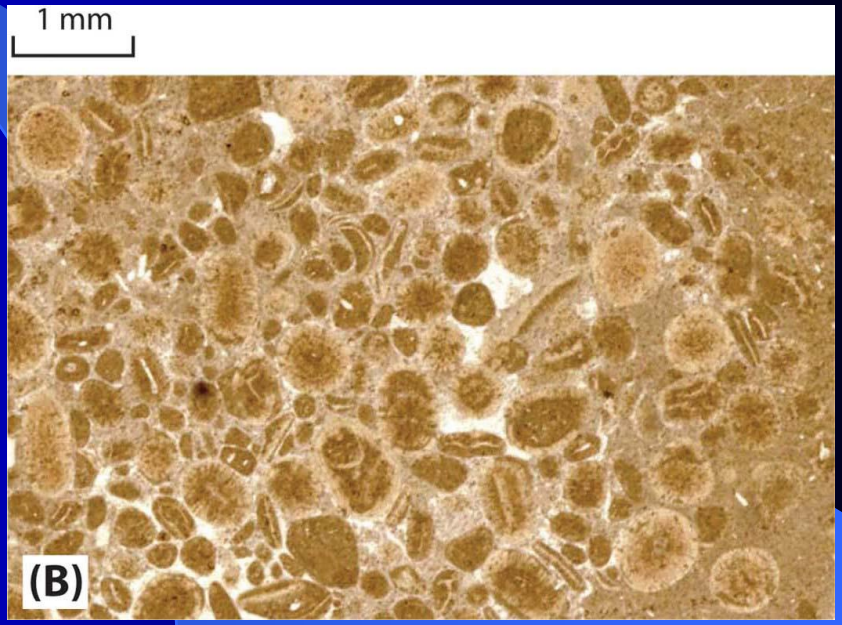


Calcite cement

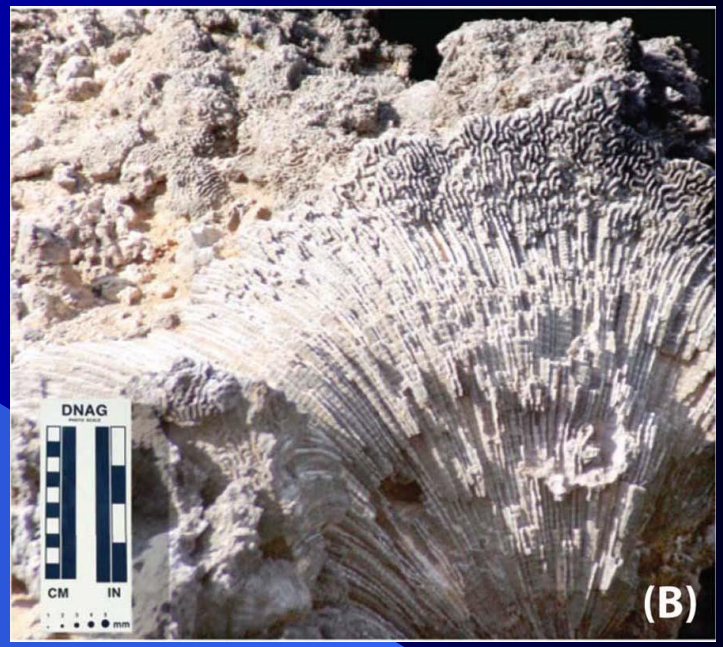


Grainstone – ooids cemented by calcite

Packstone – ooids in a mud matrix



Boundstones – coral reefs



Stromatolites

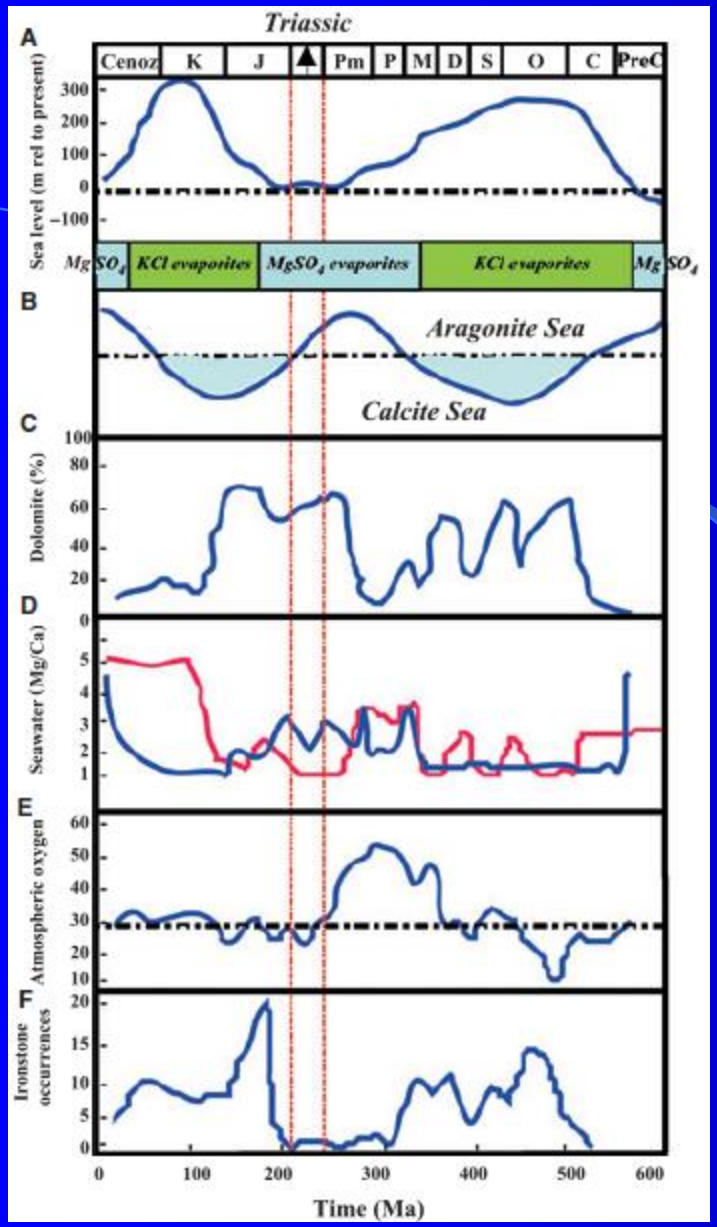
The Pink Member of the Claron Formation is largely composed of easily eroded and relatively soft limestone. Carbonic acid in rain water slowly dissolves the limestone. It is this process that rounds the edges of hoodoos and gives them their lumpy and bulging profiles.
Over 200 freeze/thaw cycles occur each year in Bryce Canyon. The frost wedging exploits and widens the nearly vertical joint planes that divide the Pink Member of the Claron Formation.
Internal layers of mudstone, conglomerate and siltstone interrupt the limestone horizontally. These layers are more resistant to attack by carbonic acid and they can therefore act as protective capstones. Many of the more durable hoodoos are capped with dolomite. The dolomite dissolves at a much slower rate, and consequently protects the weaker limestone underneath. (modified from Wikipedia)

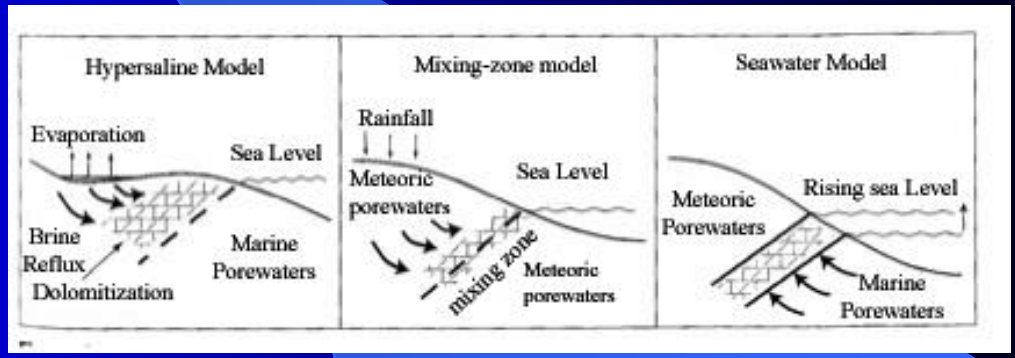
Tufa – formed when supersaturated spring water reaches the surface

Travertine – formed at hot springs (Mammoth hot springs, Yellowstone, NP)

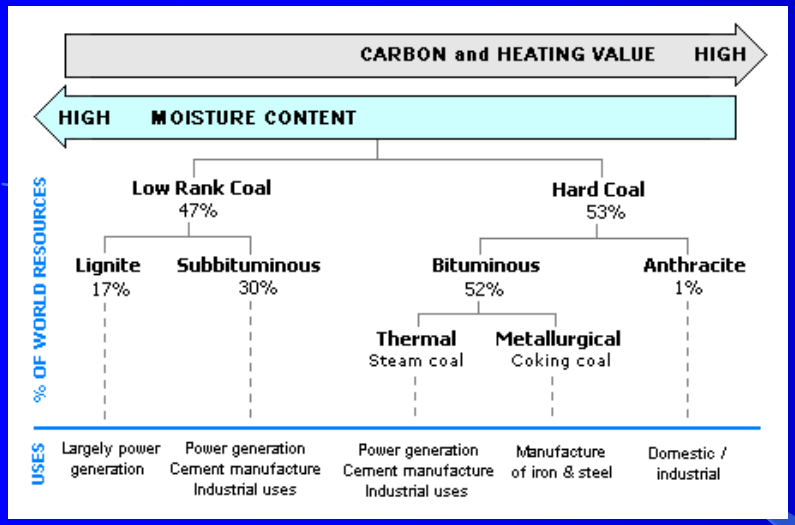
Caliche – direct precipitation from groundwater in arid and semiarid climates

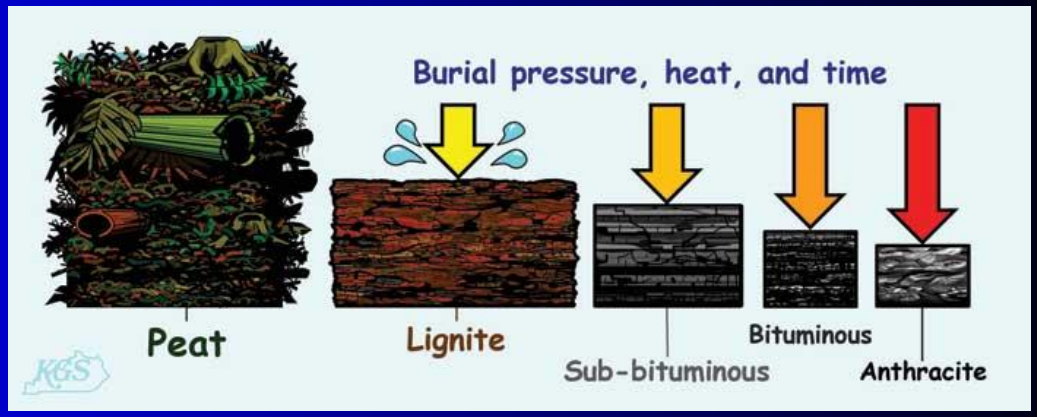
The Dolomite *Problem*





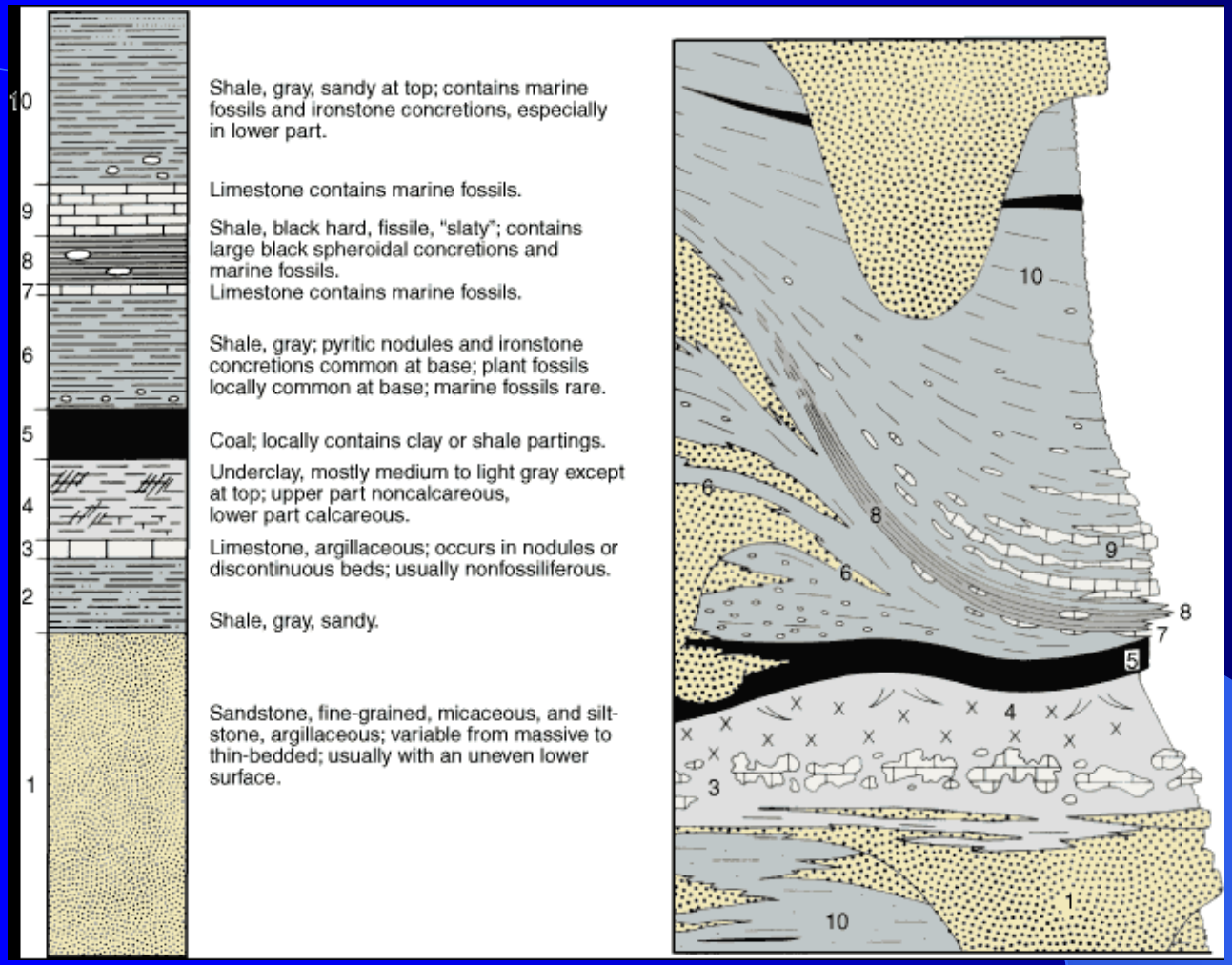
Coal

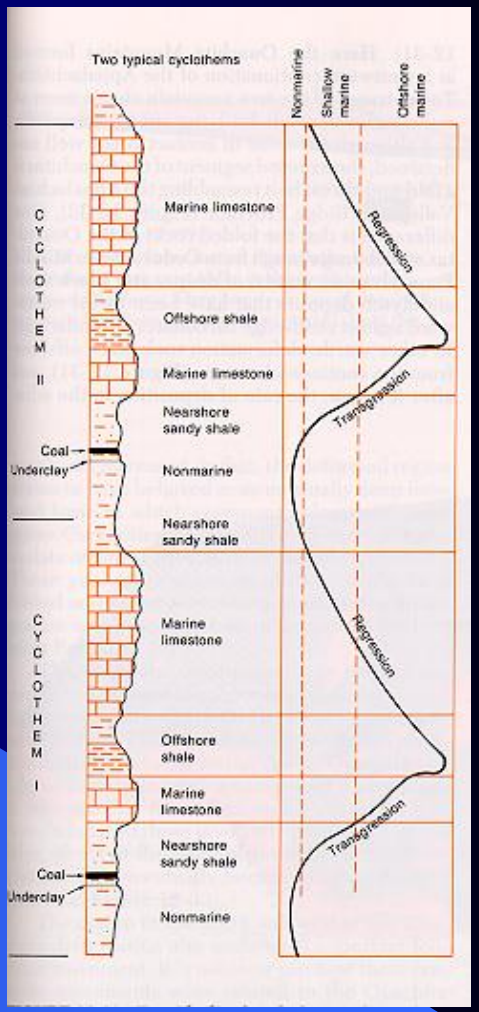




Coal Types and Peat					Total Water Content (%)	Energy Content af* (KJ/kg)	Energy Content (kcal/kg) nar	Volatiles maf** (%)	Vitrinite Reflection in oil (%)
UN - ECE	USA (ASTM)	Germany (DIN)							
Peat	Peat	Torf			75	6,700	1,600		
Ortho-Lignite	Lignite	Weichbraunkohle							
Meta-Lignite	Subbiuminous Coal	Mattbraunkohle			35	16,500	3,950		0.3
Subbitum. Coal		Glanzbraunkohle			25	19,000	4,500		0.45
Bituminous Coal	Hight Volatile Bituminous Coal	Flammkohle	Steinkohle	HARTKOHLE	10	25,000	6,000	45	0.65
		Gasflammkohle						40	0.75
	Medium Vol. Bitumin. Coal	Gaskohle				36,000	8,600	35	1
		Fettkohle			Kokskohle			28	1.2
	Low Vol. Bitumin. Coal	Esskohle						19	1.6
Anthracite	Semi-Anthracite	Magerkohle						14	1.9
	Anthracite	Anthrazit			3	36,000	8,600	10	2.2

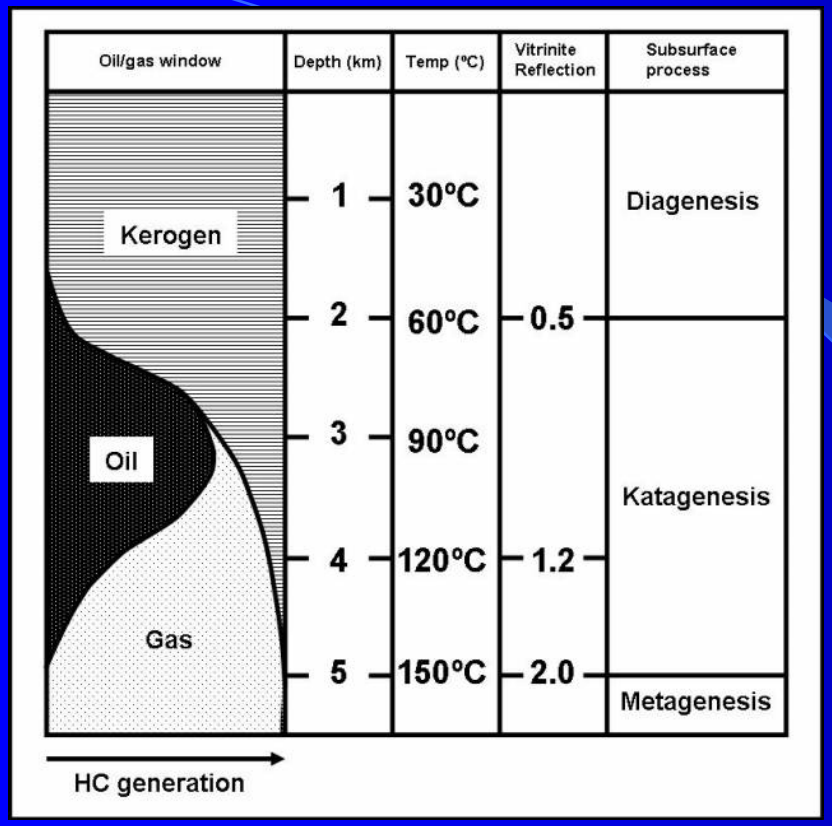
Cyclothems

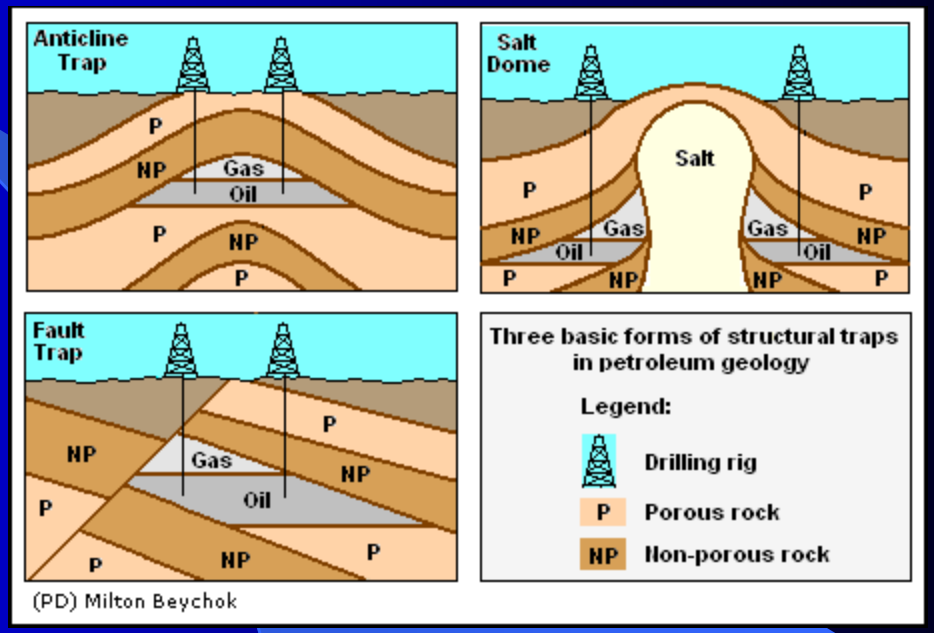

10
9
8
7
6
5
4
3
2
1
Shale, gray, sandy at top; contains marine fossils and ironstone concretions, especially in lower part.
Limestone contains marine fossils.
Shale, black hard, fissile, "slaty"; contains large black spheroidal concretions and marine fossils.
Limestone contains marine fossils.
Shale, gray; pyritic nodules and ironstone concretions common at base; plant fossils locally common at base; marine fossils rare.
Coal; locally contains clay or shale partings.
Underclay, mostly medium to light gray except at top; upper part noncalcareous, lower part calcareous.
Limestone, argillaceous; occurs in nodules or discontinuous beds; usually nonfossiliferous.
Shale, gray, sandy.
Sandstone, fine-grained, micaceous, and siltstone, argillaceous; variable from massive to thin-bedded; usually with an uneven lower surface.

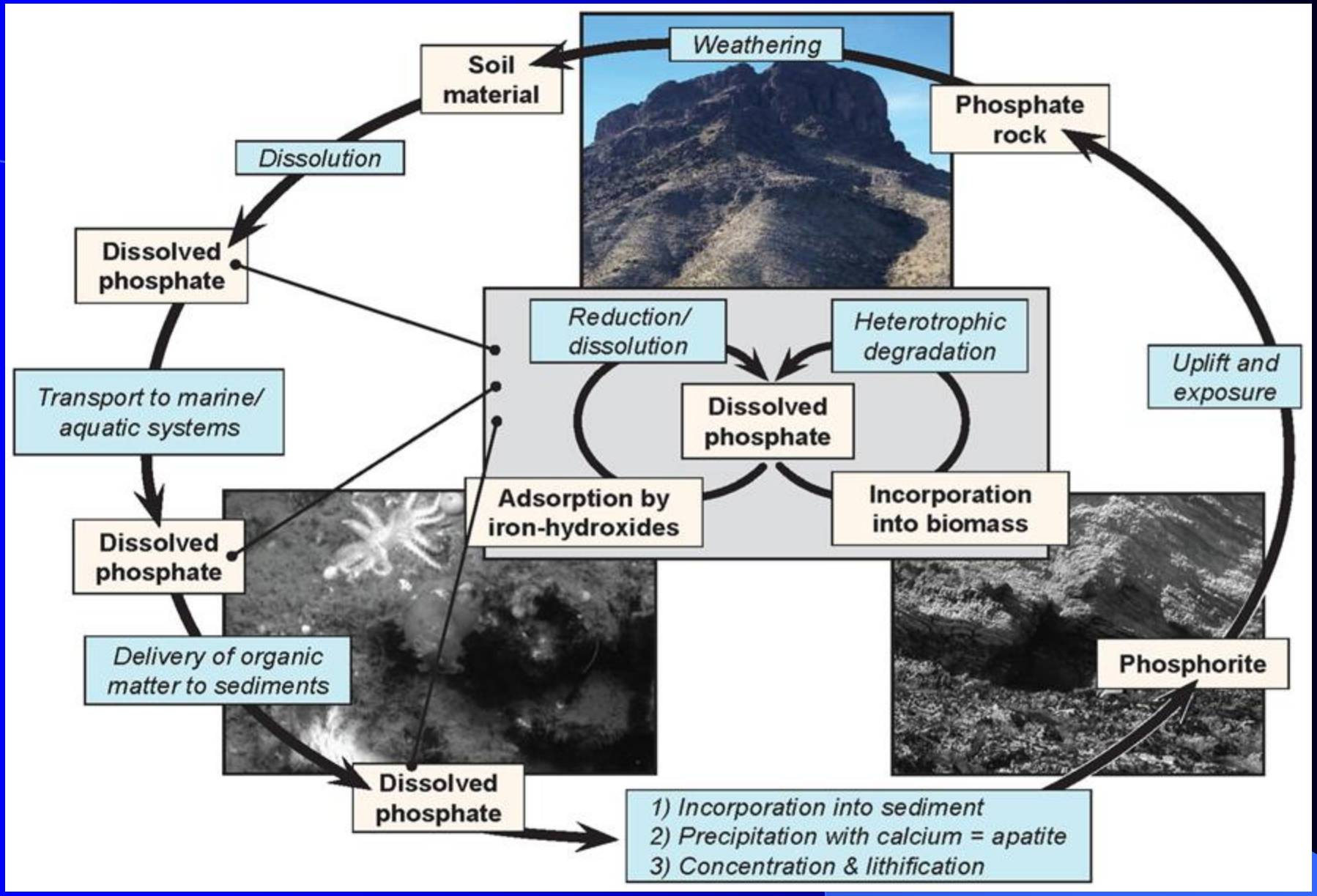

Two typical cyclothems
Nonmarine
Shallow marine
Offshore marine
CYCLOTHEM II
Marine limestone
Regression
Offshore shale
Marine limestone
Transgression
Nearshore sandy shale
Coal
Underclay
Nonmarine
Nearshore sandy shale
CYCLOTHEM I
Marine limestone
Regression
Offshore shale
Marine limestone
Transgression
Nearshore sandy shale
Coal
Underclay
Nonmarine

Formation of Petroleum

- Source rock
- Reservoir rock
- Trap






Weathering
Soil material
Phosphate rock
Dissolution
Dissolved phosphate
Reduction/ dissolution
Heterotrophic degradation
Uplift and exposure
Transport to marine/ aquatic systems
Dissolved phosphate
Adsorption by iron-hydroxides
Incorporation into biomass
Dissolved phosphate
Delivery of organic matter to sediments
Phosphorite
Dissolved phosphate
1) Incorporation into sediment
2) Precipitation with calcium = apatite
3) Concentration & lithification