UNIVERSITY OF SOUTH ALABAMA

GY 111: Physical Geology

Lecture 13: Sedimentary Rocks Part 1: Classification and Structures

Instructor: Dr. Douglas W. Haywick

Lecture Test One Results (10%)

2015 (n=65)	2016 (n=38)
A: 9	A: 4
B: 15	B: 10
C: 12	C: 13
D: 10	D: 8
F: 5	F: 2
Average: 76.7	Average: 75.9
Top Grade: 97.5%	Top Grade: 94%

UNIVERSITY OF SOUTH ALABAMA

GY 111: Physical Geology

Lecture 13: Sedimentary Rocks Part 1: Classification and Structures

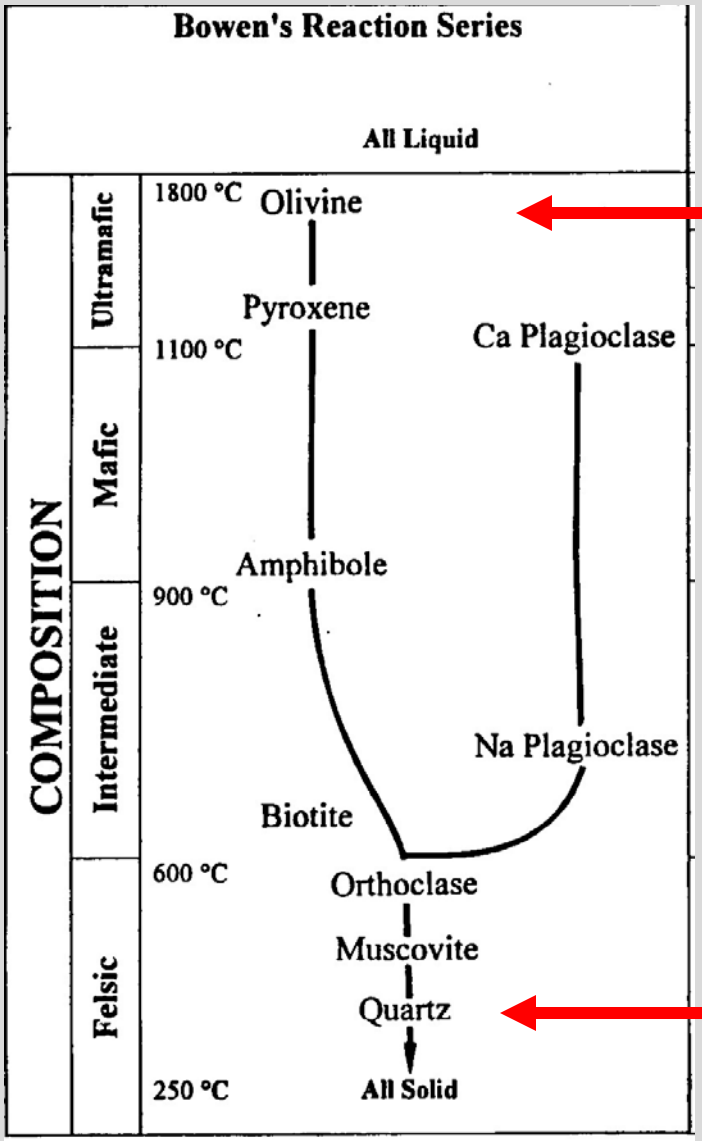
Instructor: Dr. Douglas W. Haywick

Last Time

1) Mineral Stability
2) Types of weathering (Physical, Chemical, Biological)
3) Chemical weathering reactions
4) Soils

Web notes 12a (weathering)
Web notes 12b (soils)

Mineral Stability



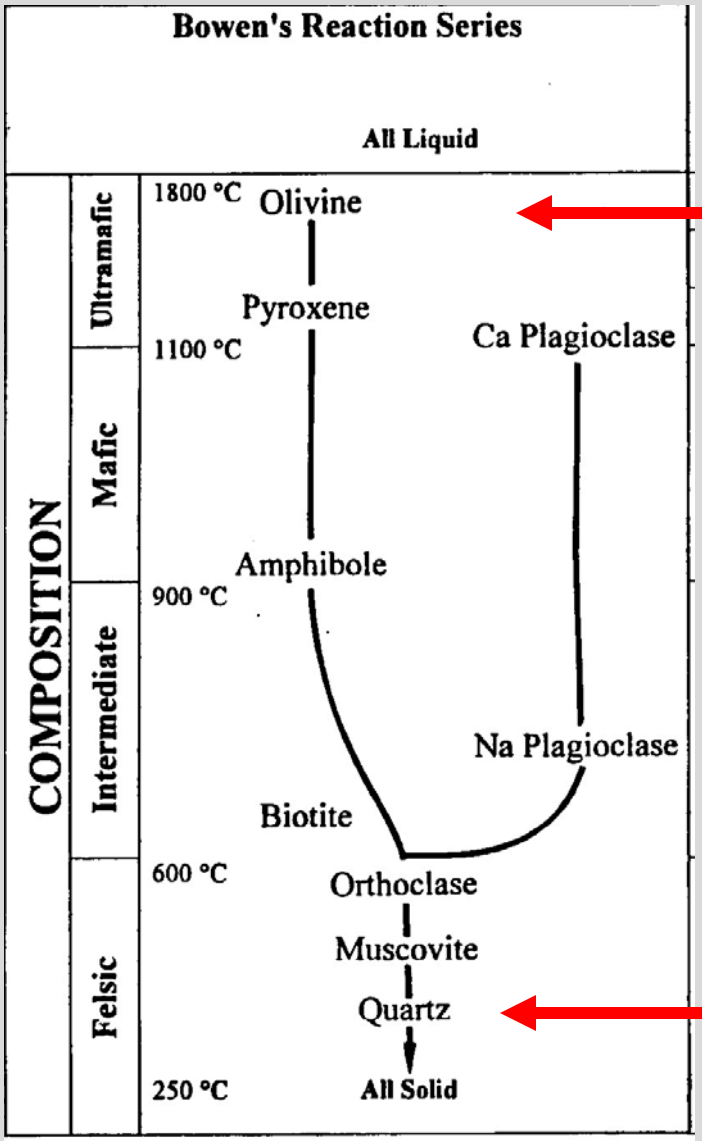
Bowen's Reaction Series

First to form (most stable at high temperature)

Consider what happens when these minerals are exposed at the surface of the Earth (low temp, low pressure, rain fall)

Last to form (most stable at low temperature)

Mineral Stability

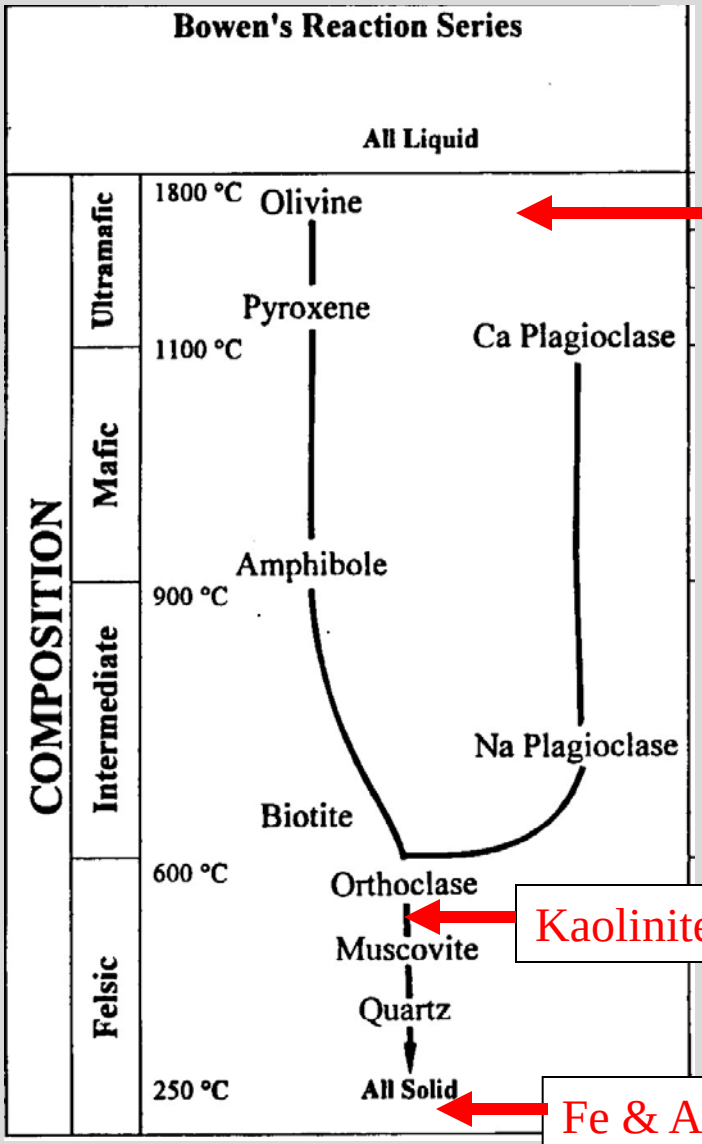


Bowen's Reaction Series

Least stable at the surface

Most stable at the surface

Mineral Stability



Bowen's Reaction Series

Least stable at the surface

Kaolinite (clay)

Most stable at the surface

Fe & Al-oxides (hematite, limonite, bauxite)

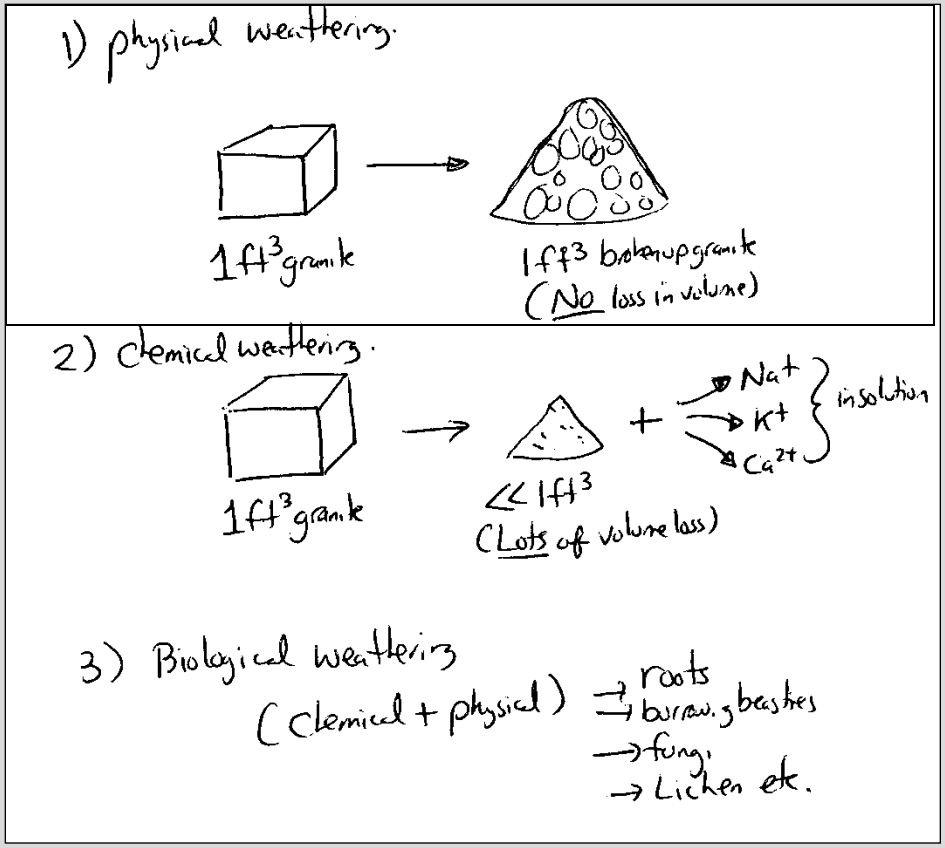
Weathering

Weathering: the breakdown of rocks at the surface of the Earth. There are 3 types of weathering:

1) Physical – mechanical reduction in the size of rock components.

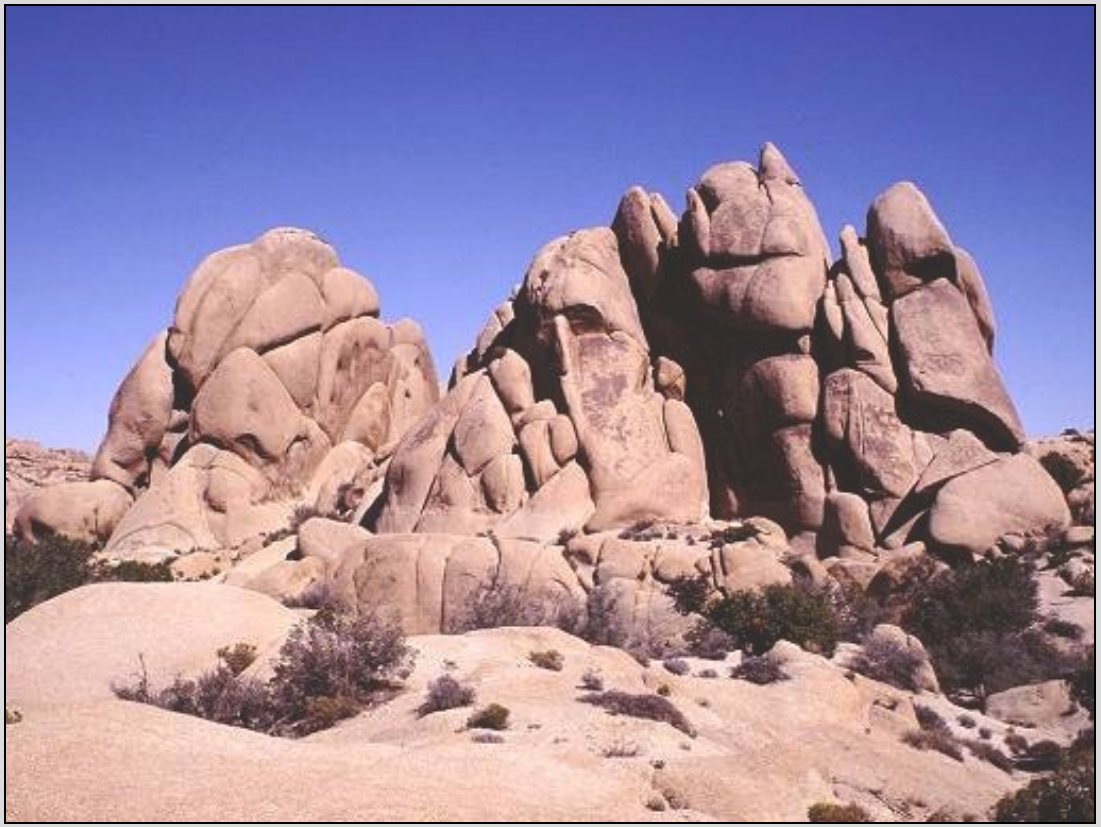
2) Chemical – chemically-induced changes in the composition of rock.

3) Biological – a bit of both



Physical Weathering

Exfoliation – sheet weathering of granite by heating/cooling cycles (also known as spherical weathering)

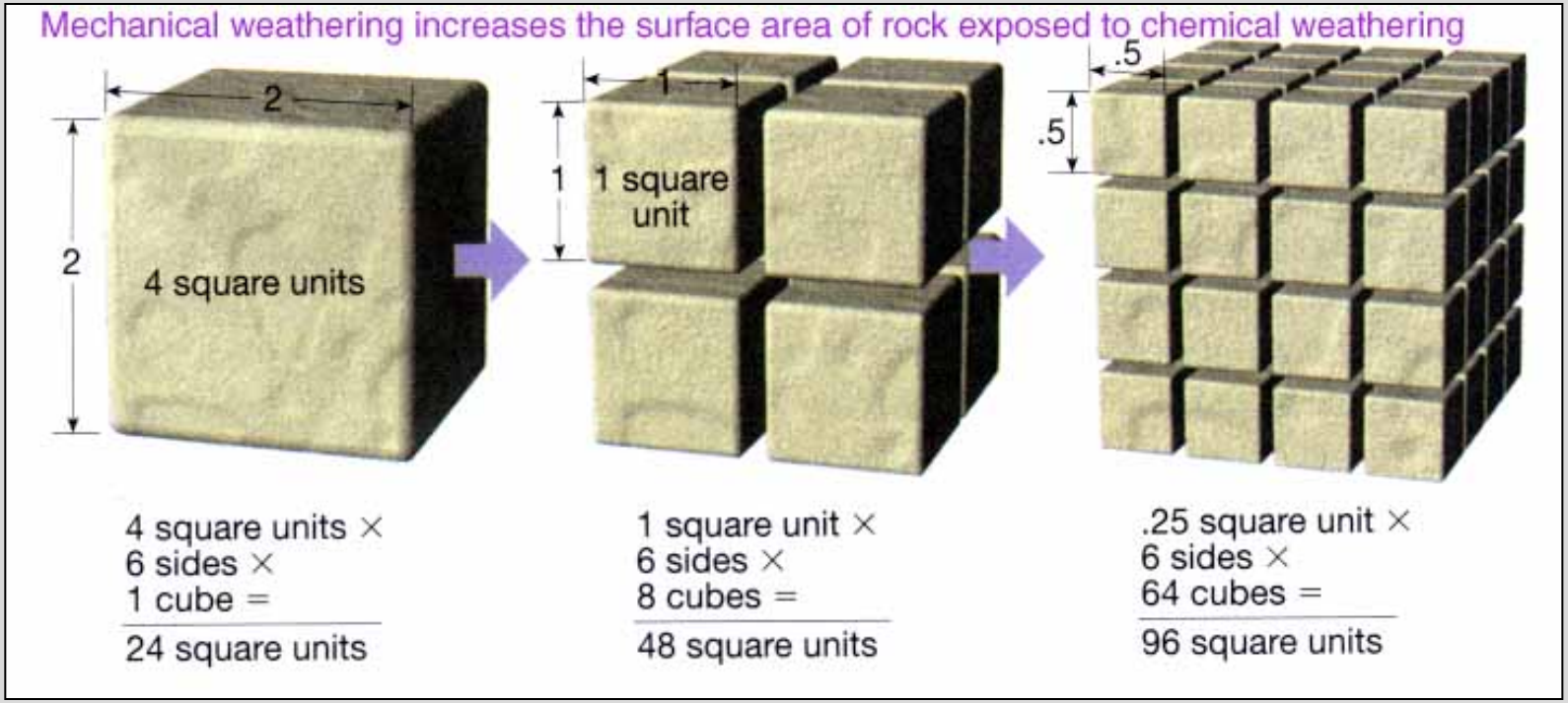


Physical Weathering

Frost heaving – weathering by alternating freeze-thaw cycles

Physical Weathering

Physical weathering increases the surface area of rocks which in turns speeds up chemical weathering.



Chemical Weathering

Chemical weathering occurs in three different ways:

1) Dissolution
2) Oxidation
3) Hydrolysis

1) Dissolution/Solution

$NaCl \xrightarrow{H_2O} Na^+ + Cl^-$
(Halite)

$CaCO_3 \xrightarrow{H_2O} Ca^{2+} + HCO_3^-$
(calcite)

2) Oxidation (reaction with oxygen)

$FeS_2 \xrightarrow{O_2} Fe_2O_3 + SO_2$
(pyrite). (hematite)

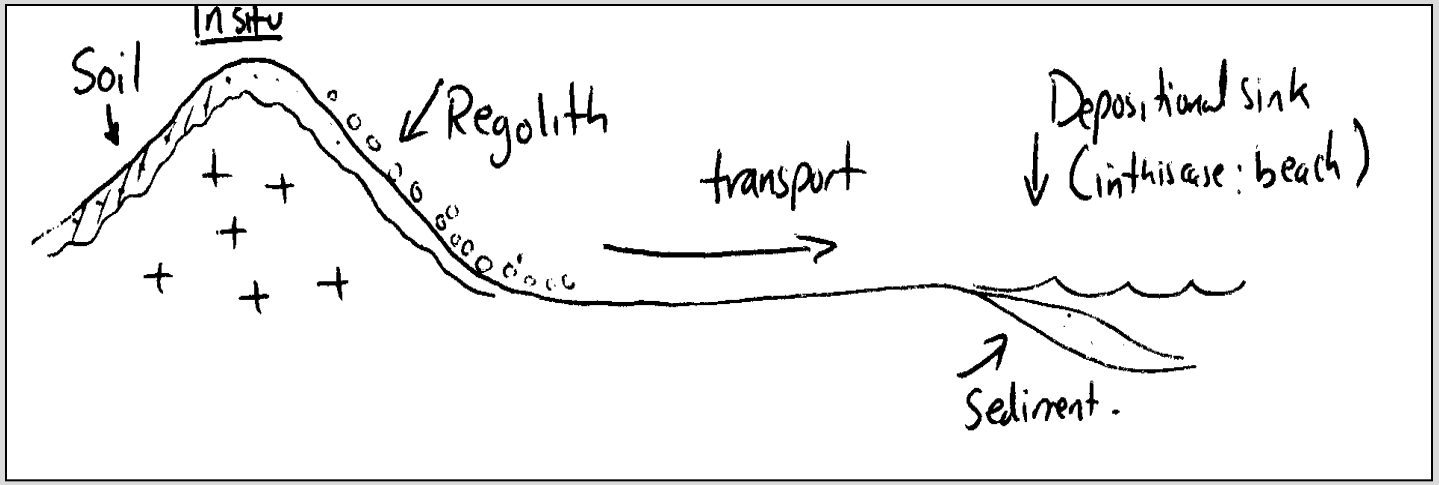
3) Hydrolysis (reaction with water)

$FeS_2 + H_2O + O_2 \rightarrow FeOOH + 2H_2SO_4$
(pyrite) (Limonite) ↳ Sulfuric Acid (Acid rain).

$KAlSi_3O_8 + H_2O + CO_2 \rightarrow Al_2Si_2O_5(OH)_4$
(orthoclase) (kaolinite).

Soil

soil - (i) The unconsolidated mineral or organic material on the immediate surface of the earth



Regolith is broken up bits of rock and chemically altered rock (no organic stuff). Soil also contains organic material (including bacteria). We will regard it as being an *in situ* deposit.

Soil Profiles

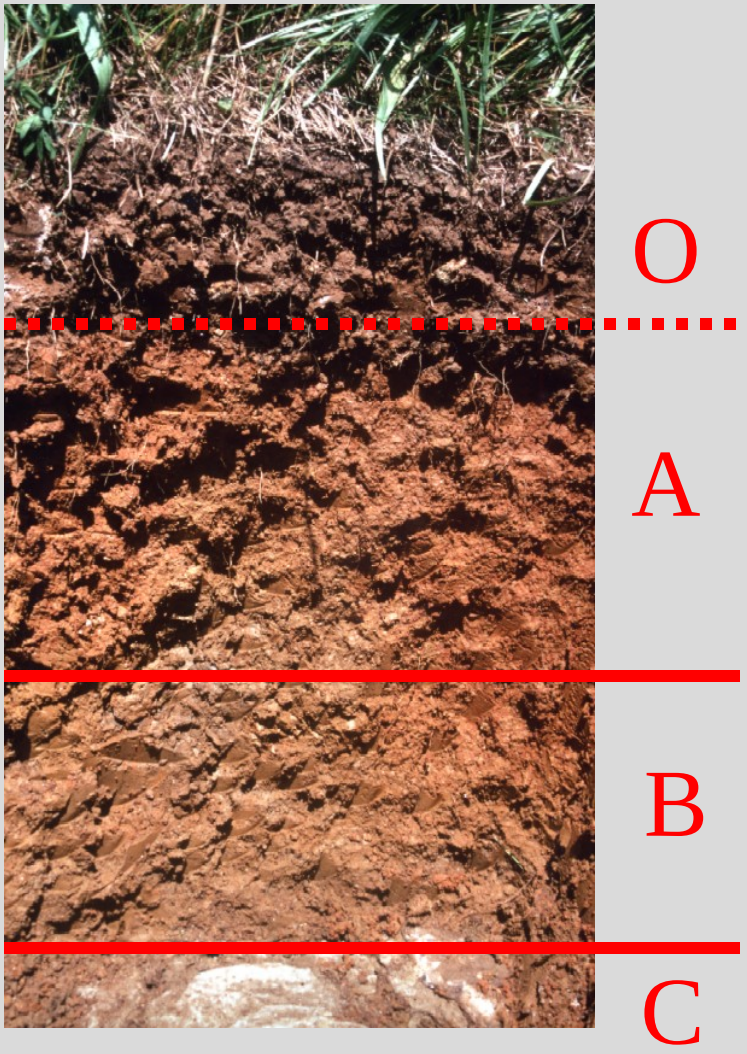
soil profile: A vertical section through a soil that shows its horizontal structure (e.g., Soil horizons; A, B, C)

A- Zone of Leaching

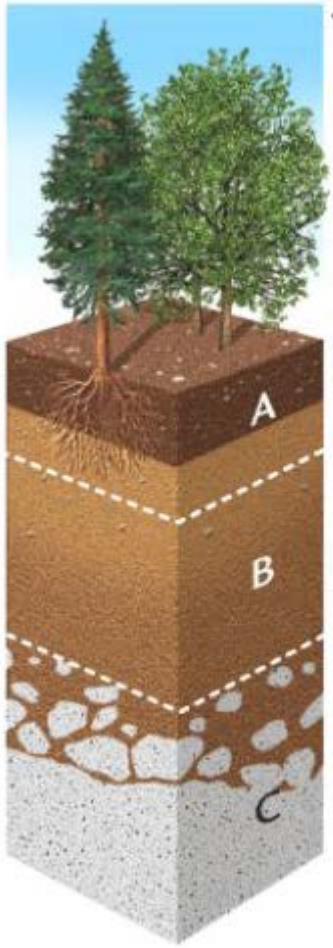
B- Zone of Accumulation

C- Zone of Altered Bedrock

O- Topsoil or humus (subdivision of A-Horizon)



Types of Soils



Temperate climate

PEDALFER

Humus and leached soil (quartz and clay minerals present)

Some iron and aluminum oxidesprecipitated; all soluble materials, such as carbonates, leached away

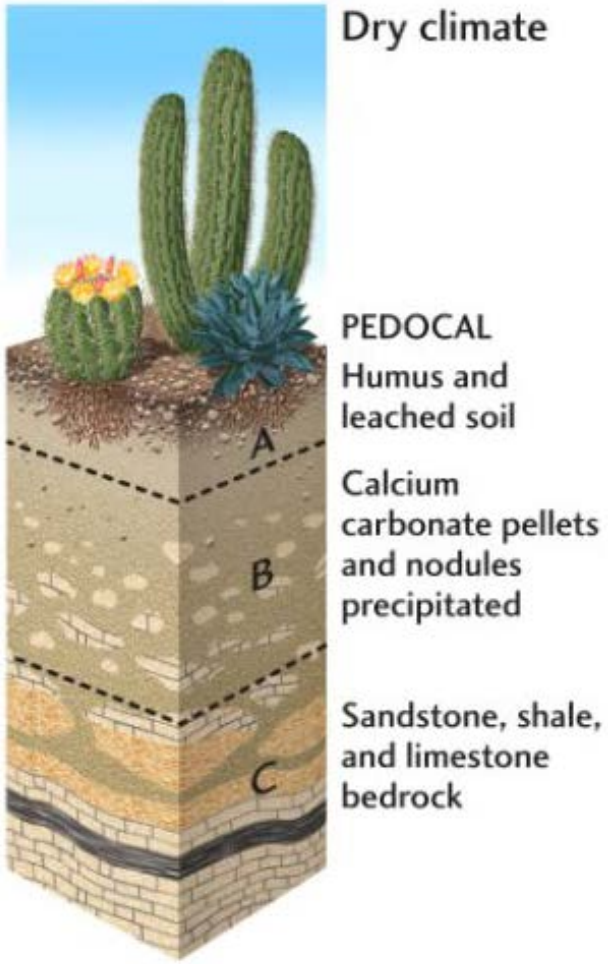
Granite bedrock

Soils come in many different flavors, but Geology students in GY 111 only have to worry about 3 types.

Pedalfer

alfe = aluminum and iron (e.g. iron oxides)

Types of Soils

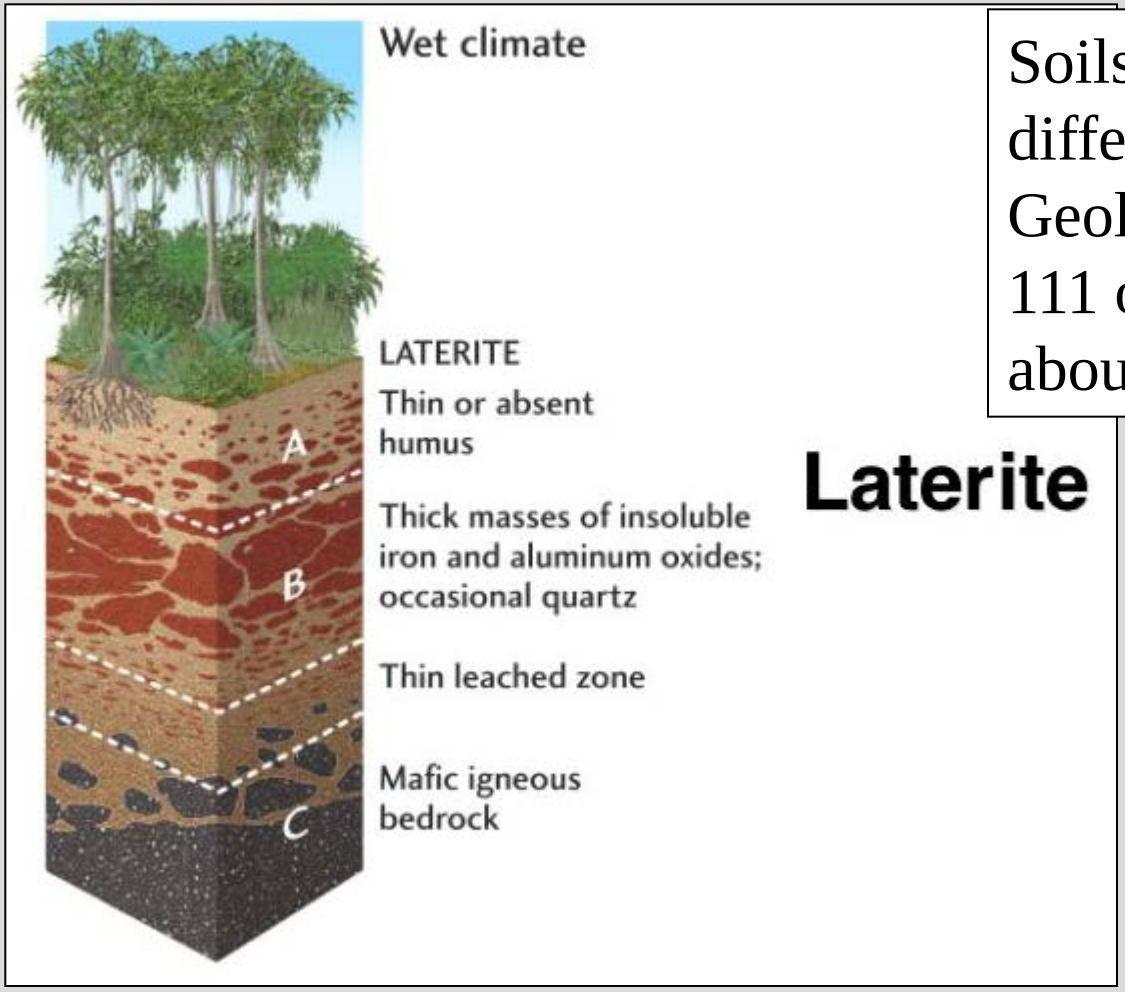


Soils come in many different flavors, but Geology students in GY 111 only have to worry about 3 types.

Pedocal

cal = calcium carbonate (e.g. calcite)

Types of Soils



Soils come in many different flavors, but Geology students in GY 111 only have to worry about 3 types.

Today's Agenda

1) Types of Sediment
2) Sedimentary Rock Classification
3) Sediment Transport

Web notes 13

GY 111 Lab Manual Chapter 3

Types of Sedimentary Rocks

Types of Sedimentary Rocks

1) siliciclastic

Types of Sedimentary Rocks

1) siliciclastic
2) biochemical (also called bioclastic)

Types of Sedimentary Rocks

1) siliciclastic
2) biochemical
3) chemical

Types of Sedimentary Rocks

1) siliciclastic
2) biochemical
3) chemical
4) organic

Classification of Sediment and Sedimentary Rocks

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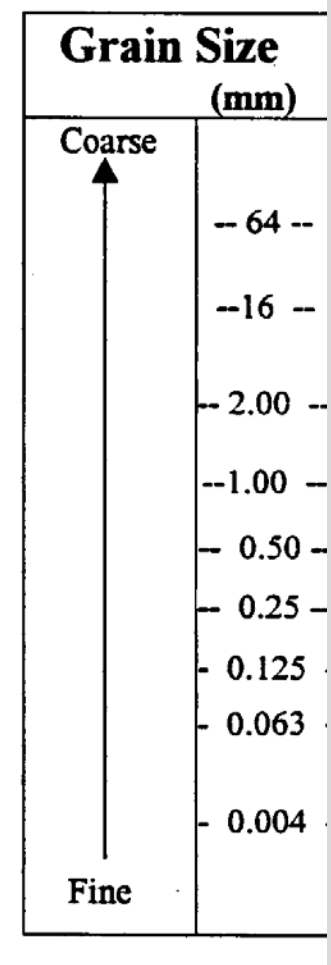
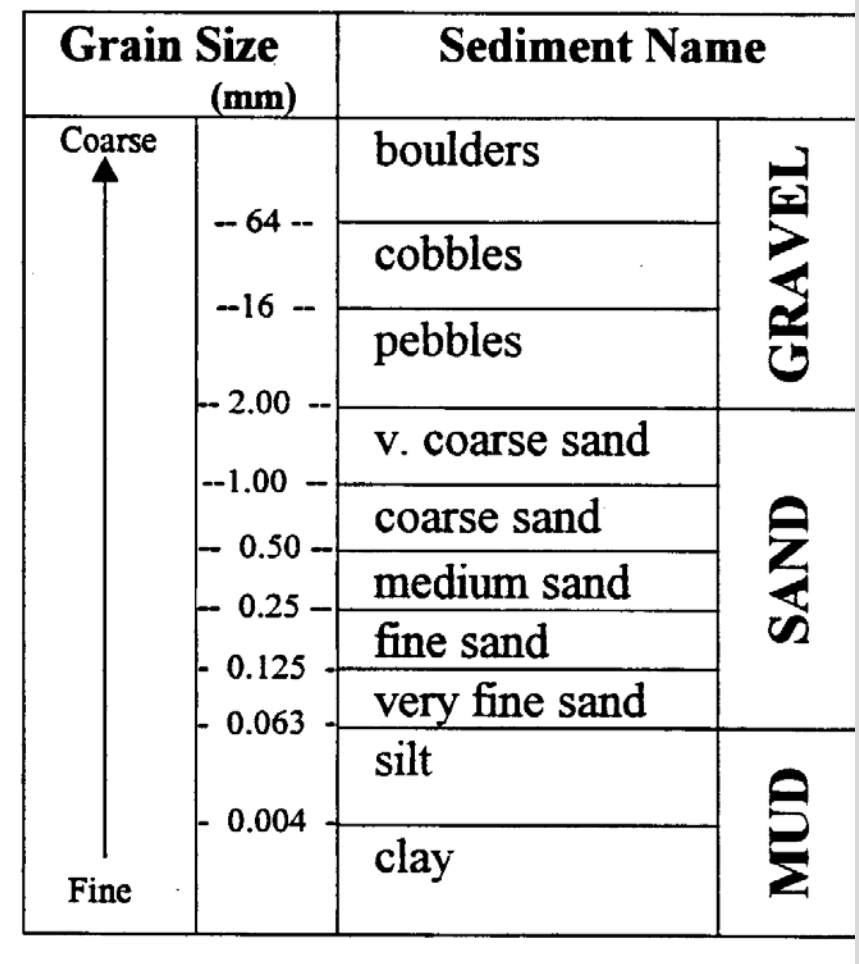


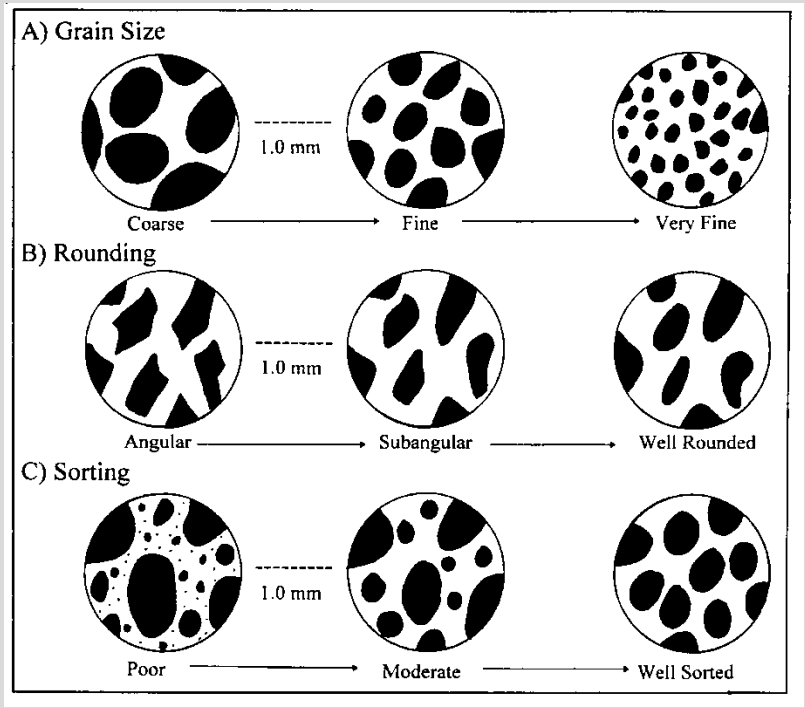
Classification of Sediment and Sedimentary Rocks



Classification of Sediment and Sedimentary Rocks

Grain Size (mm)		Sediment Name	
Coarse ▲	-- 64 --	boulders	GRAVEL
	--16 --	cobbles	
	-- 2.00 --	pebbles	
	--1.00 --	v. coarse sand	SAND
	-- 0.50 --	coarse sand	
	-- 0.25 --	medium sand	
	- 0.125 -	fine sand	
	- 0.063 -	very fine sand	
	- 0.004 -	silt	MUD
Fine		clay	

Grain size is one of 3 important descriptive parameters along with rounding and sorting.



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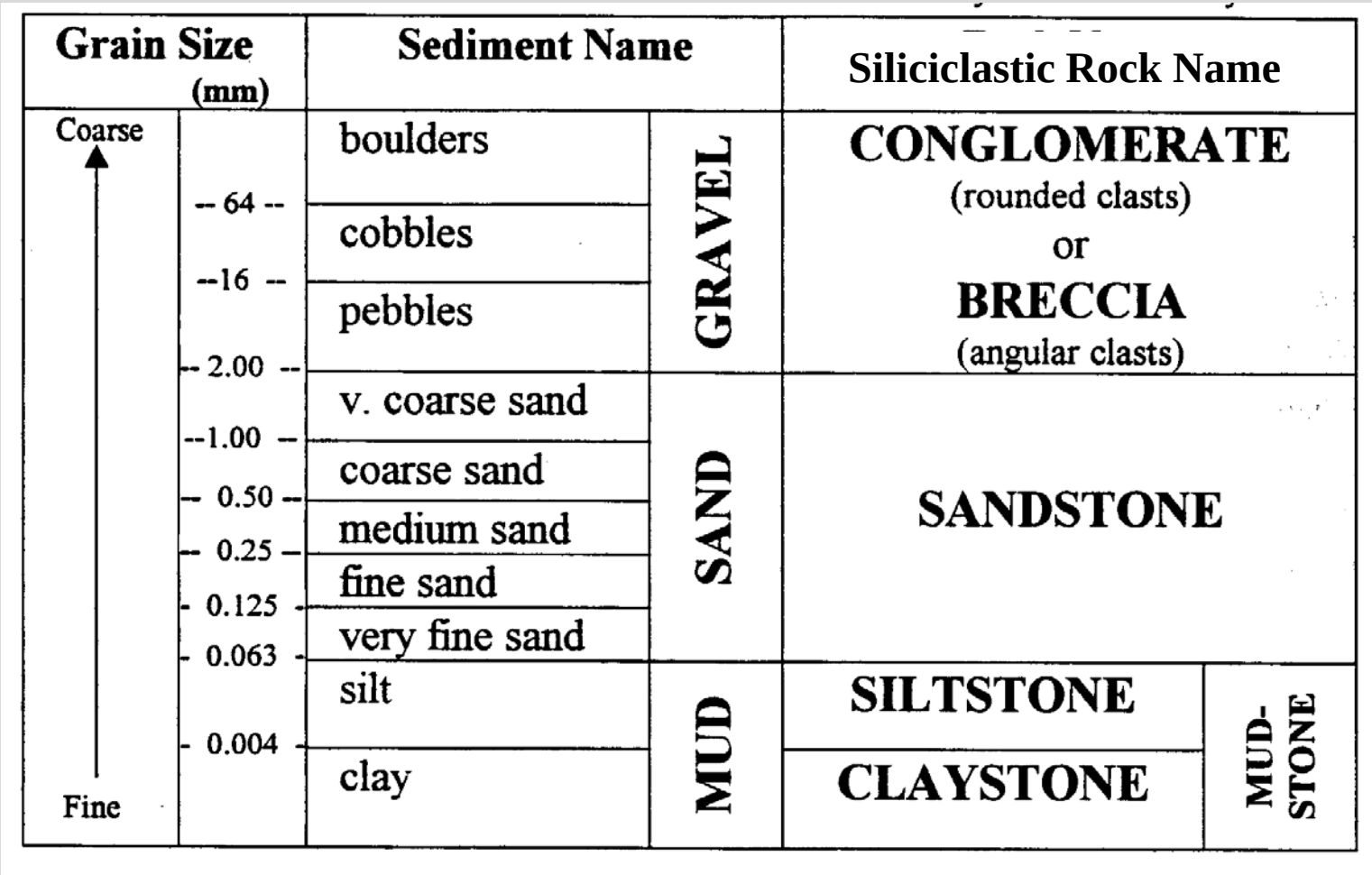
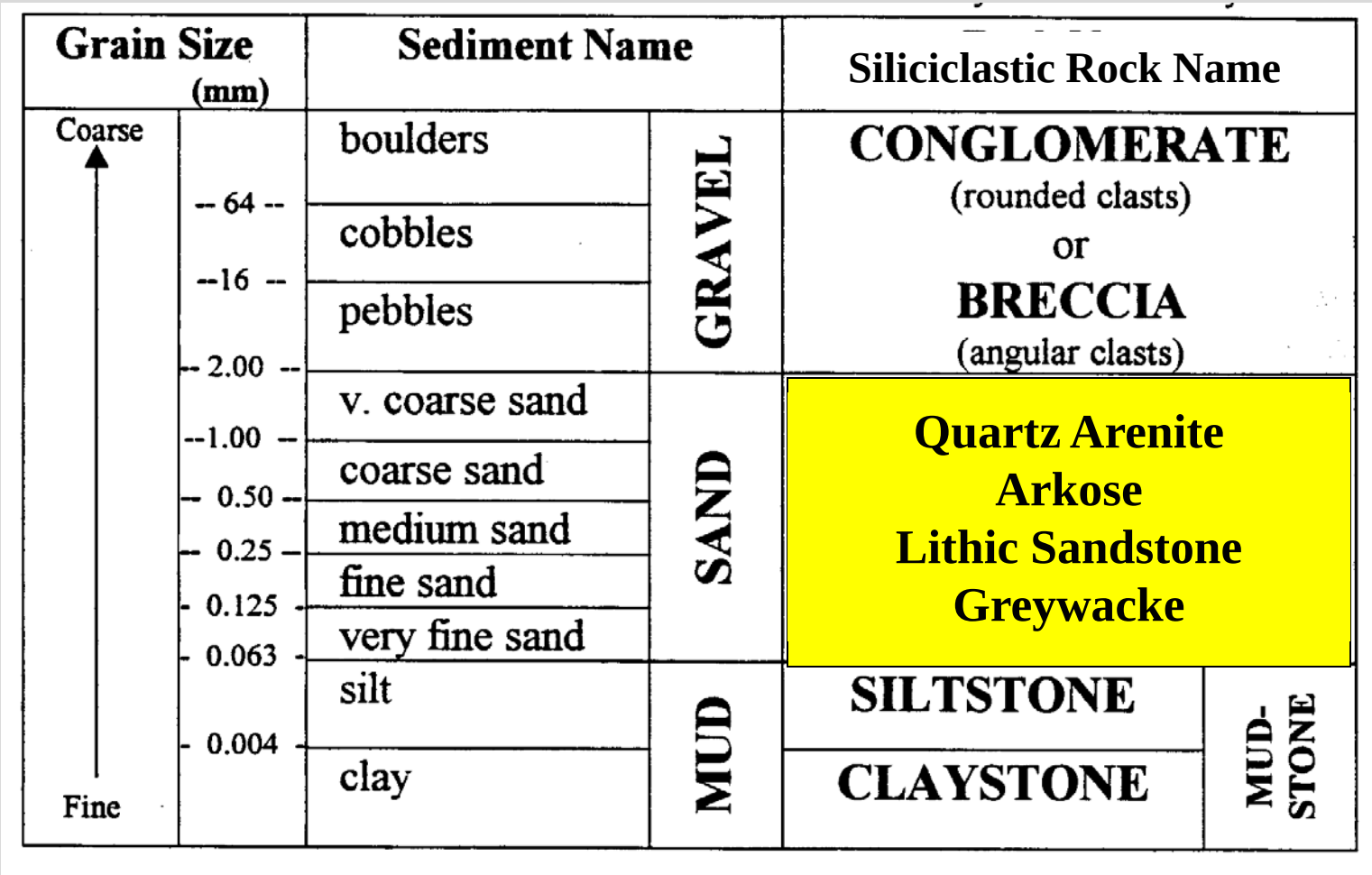


Grain Size (mm)		Sediment Name		Siliciclastic Rock Name	
Coarse ▲	-- 64 --	boulders	GRAVEL	CONGLOMERATE (rounded clasts) or BRECCIA (angular clasts)	
	--16 --	cobbles			
	-- 2.00 --	pebbles			
	--1.00 --	v. coarse sand	SAND	SANDSTONE	
	-- 0.50 --	coarse sand			
	-- 0.25 --	medium sand			
	- 0.125 -	fine sand			
	- 0.063 -	very fine sand			
	- 0.004 -	silt	MUD	SILTSTONE	MUD-STONE
▼ Fine		clay		CLAYSTONE	

Classification of Sediment and Sedimentary Rocks



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	-- 0.50 --	coarse sand			
	-- 0.25 --	medium sand			
	- 0.125 -	fine sand			
	- 0.063 -	very fine sand			
	- 0.004 -	silt	MUD	SILTSTONE	MUD-STONE
▼ Fine		clay		CLAYSTONE	

Sedimentary Rocks

Four distinct classes:

1) Siliciclastic

2) Biochemical

3) Chemical

4) Organic

Sediment Class	Grain size/ texture	Properties and Distinguishing Features	Sedimentary Rock Name
Siliciclastic	Gravel (grains > 2 mm)	Rounded rock and mineral fragments, usually in a finer sand matrix	Conglomerate
		Angular rock and mineral fragments, usually in a finer sand matrix	Breccia
	Sand (grains easily seen)	Rounded quartz grains, well sorted. Color white to red depending upon the type of cement. Commonly iron stained and may contain sedimentary structures	Quartz Arenite
		Rounded grains of quartz and other minerals. "salt & pepper appearance. Color tan to green or red due to iron oxide staining.	Lithic Sandstone
		Angular to sub-angular grains, abundant feldspar. Usually pink to gray in color and poorly sorted.	Arkose
		Various minerals and grains mixed with clay\mud matrix. Poorly sorted, may be laminated.	Greywacke
	Silt (grains can be felt)	Variable hardness (H = 2 to 7), and color. Grains cannot be seen, but may be "tasted". Commonly laminated.	Siltstone
	Mud (grains can't be seen)	Soft (H= 2 to 3), variably colored. Grains cannot be seen or "tasted". Laminated to fissile. Green color caused by reduced iron; red by oxidized iron; black by organics.	Shale
		Soft (H= 2 to 3), variably colored. Grains cannot be seen or "tasted". Massive (non-laminated). Same color range as exhibited by shale.	Mudstone
Biochemical Limestone	Gravel	Variably sized shells and other fossils in typically finer-grained matrix. Usually blue-gray to gray in color.	Fossiliferous Limestone
		entirely composed of abraded and rounded shell "hash". Contains little or no matrix. White to tan in color.	Coquina
	Sand	Spherical, very well-sorted grains with concentric layers (ooids). white to beige to grey-blue in color.	Oolite
	Mud-	Very fine-grained, soft (H = 1 to 2), white to gray limestone containing microscopic fossils. Strongly fizzes with acid.	Chalk
		Fine-grained, soft (H = 3), white to gray limestone devoid of obvious fossils. Fizzes with acid.	Non-fossilifeous limestone
Chemical	Evaporites	Fine to coarsely crystalline, pink, gray or brown. Usually lacks fossils. Does not fizz with HCl unless powdered	Dolostone (Dolomite)
		Crystalline, soft (H=2.5), white to gray. Tastes salty.	Halite
		Crystalline, soft (H=2), white to gray. Many contain sand.	Gypsum
	Others	Fine to coarsely crystalline, yellow to white, lacks fossils but does contain growth bands. Frequently stalactitic.	Travertine
		Red color. Highly variable hardness (H=1 - 6), S.G.=5.5. Earthy luster. Streak red.	Hematite
		Brown to ocher in color. H=1-3. S.G.=3.5. Earthy luster. Streak yellow brown..	Limonite
		White, beige, brown or reddish-yellow in color. H=1-5. S.G.=3. Earthy luster. Forms spherical or pisolitic aggregates.	Bauxite
		Hard (H=7), conchoidal fracture, variable color (gray to brown). Petrified wood variety displays cellular structure.	Chert
Organic	Fibrous, earthy, metallic or resinous appearance	Brown, visible plant fibers, very soft, light weight	Peat
		Brown to brown-black. Harder than peat. Rare plant fossils	Lignite
		Black, Earthy luster, no plant remains preserved	Bituminous Coal
		Steel gray to black, hard (H=4), metallic luster	Anthracite
		Yellow to orange, low S.G. and soft material. Resinous luster.	Amber

Sedimentary Rocks

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		Rounded grains of quartz and other minerals. "salt & pepper appearance. Color tan to green or red due to iron oxide staining.	Lithic Sandstone
		Angular to sub-angular grains, abundant feldspar. Usually pink to gray in color and poorly sorted.	Arkose
		Various minerals and grains mixed with clay\mud matrix. Poorly sorted, may be laminated.	Greywacke
	Silt (grains can be felt)	Variable hardness (H = 2 to 7), an color. Grains cannot be seen, but may be "tasted". Commonly laminated.	Siltstone
	Mud (grains can't be seen)	Soft (H= 2 to 3), variably colored. Grains cannot be seen or "tasted". Laminated to fissile. Green color caused by reduced iron; red by oxidized iron; black by organics.	Shale
		Soft (H= 2 to 3), variably colored. Grains cannot be seen or "tasted". Massive (non-laminated). Same color range as exhibited by shale.	Mudstone

Sedimentary Rocks

Biochemical	**Limestone**	**Gravel**	Variably sized shells and other fossils in typically finer-grained matrix. Usually blue-gray to gray in color.	Fossiliferous Limestone
			entirely composed of abraded and rounded shell "hash". Contains little or no matrix. White to tan in color.	Coquina
		Sand	Spherical, very well-sorted grains with concentric layers (ooids). white to beige in color	Oolite
		Mud-	Very fine-grained, soft (H = 1 to 2), white to gray limestone containing microscopic fossils. Strongly fizzes with acid.	Chalk
			Fine-grained, soft (H = 1 to 3), white to gray limestone devoid of obvious fossils. Fizzes with acid.	Non-fossilifeous limestone

Sedimentary Rocks

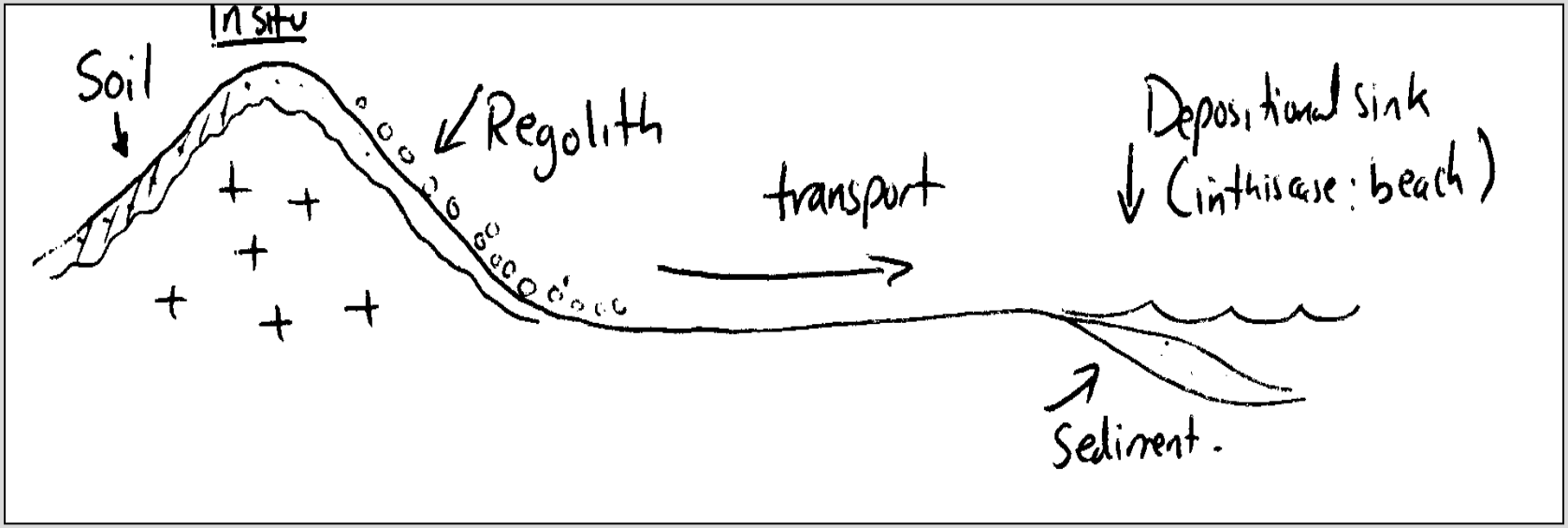
Chemical	**Evaporites**	Fine to coarsely crystalline, pink, gray or brown. Usually lacks fossils. Does not fizz with HCl unless powdered	Dolostone (Dolomite)
		Crystalline, soft (H=2.5), white to gray. Tastes salty.	Halite
		Crystalline, soft (H=2.5), red to white. Tastes bitter-salty.	Sylvite
		Crystalline, soft (H=2), white to gray. Many contain sand.	Gypsum
	Others	Fine to coarsely crystalline, yellow to white, lacks fossils but does contain growth bands. Frequently stalactitic.	Travertine
		Hard (H=7), conchoidal fracture, variable color (gray to brown). Petrified wood variety displays cellular structure.	Chert

Sedimentary Rocks

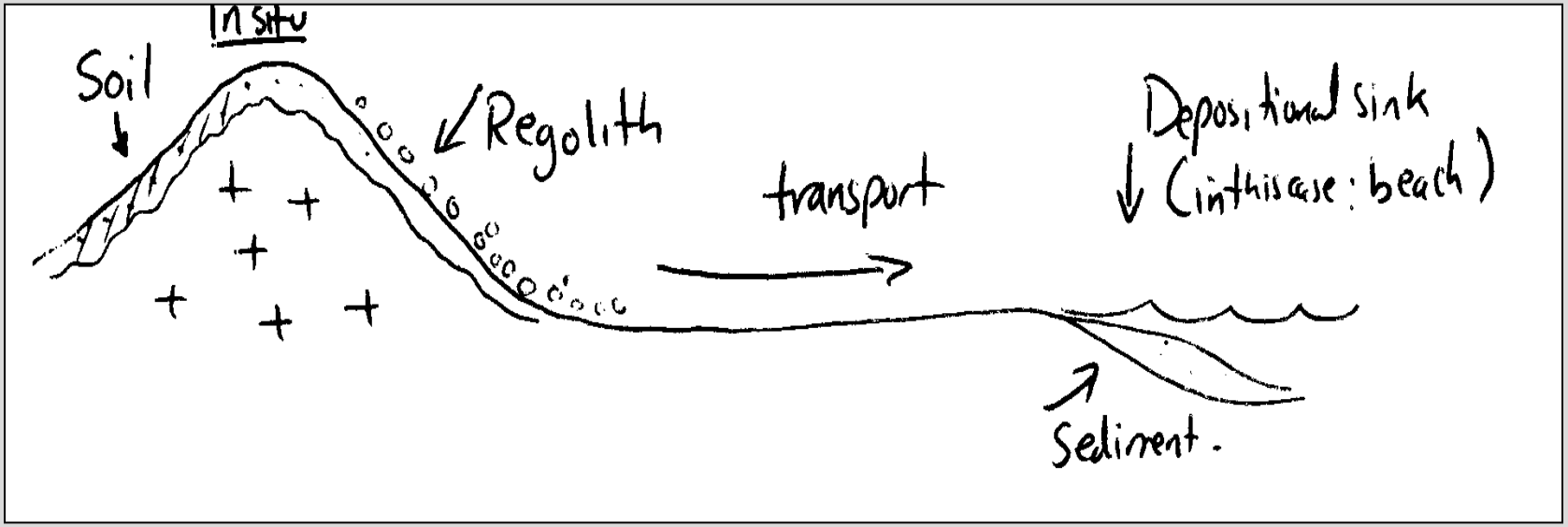
Organic	**Fibrous, earthy, metallic** or **resinous** appearance	Brown, visible plant fibers, very soft, light weight	Peat
		Brown to brown-black. Harder than peat. Rare plant fossils	Lignite
		Black, Earthy luster, no plant remains preserved	Bituminous Coal
		Steel gray to black, hard (H=4), metallic luster	Anthracite
		Yellow to orange, low Sp. G. and soft material. Resinous luster.	Amber

Sediment Transport

Sediment Transport



Sediment Transport



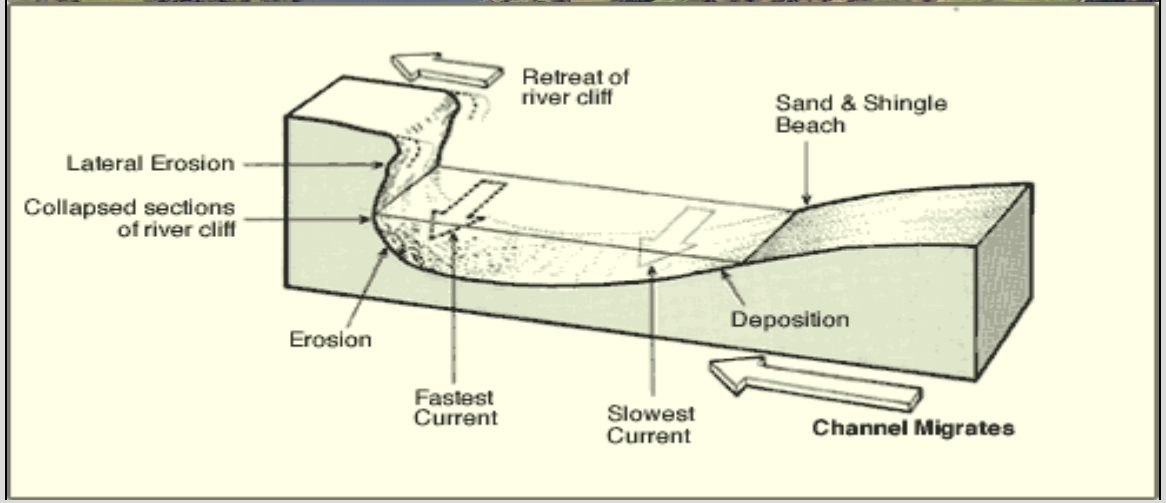
Source → Sink

transport

Sediment Transport

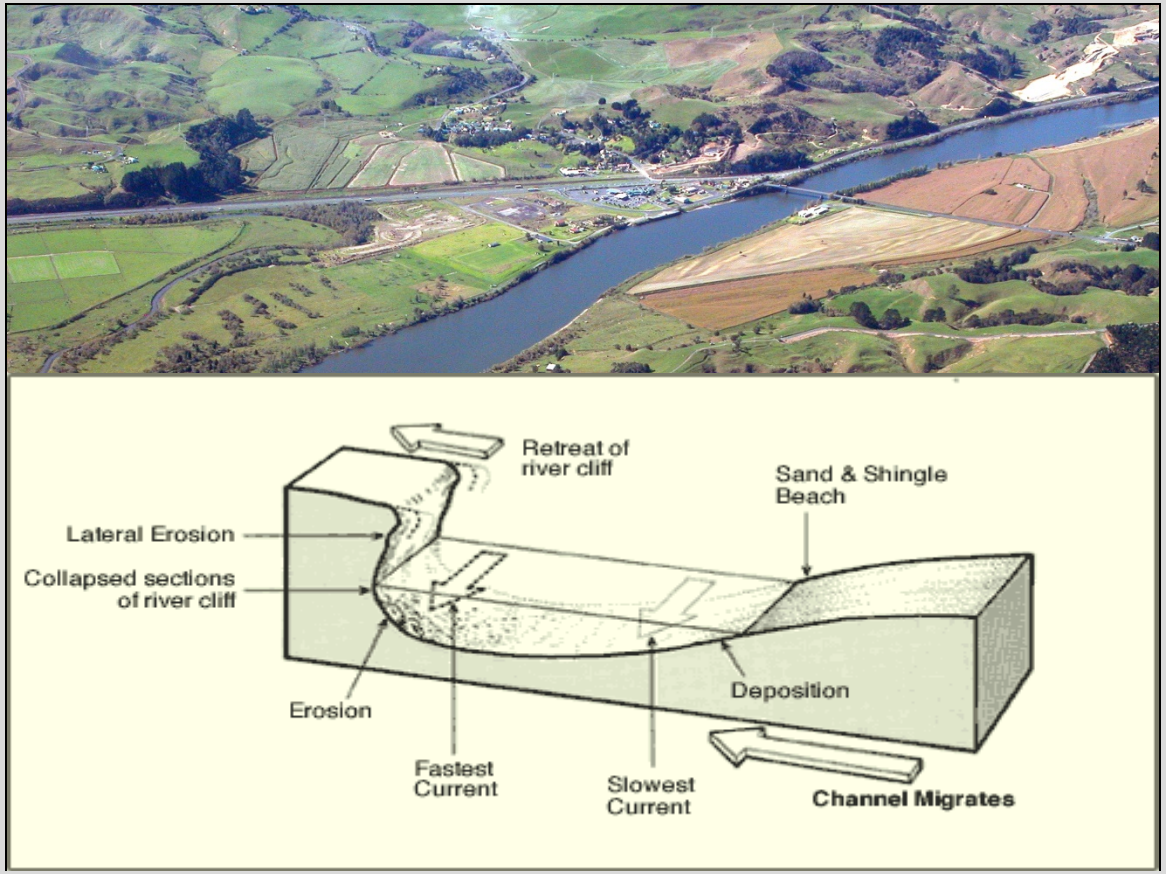
Sediment Transport

Sediment Transport



Bed load: sediment (sand and gravel) transported along the bed of a river

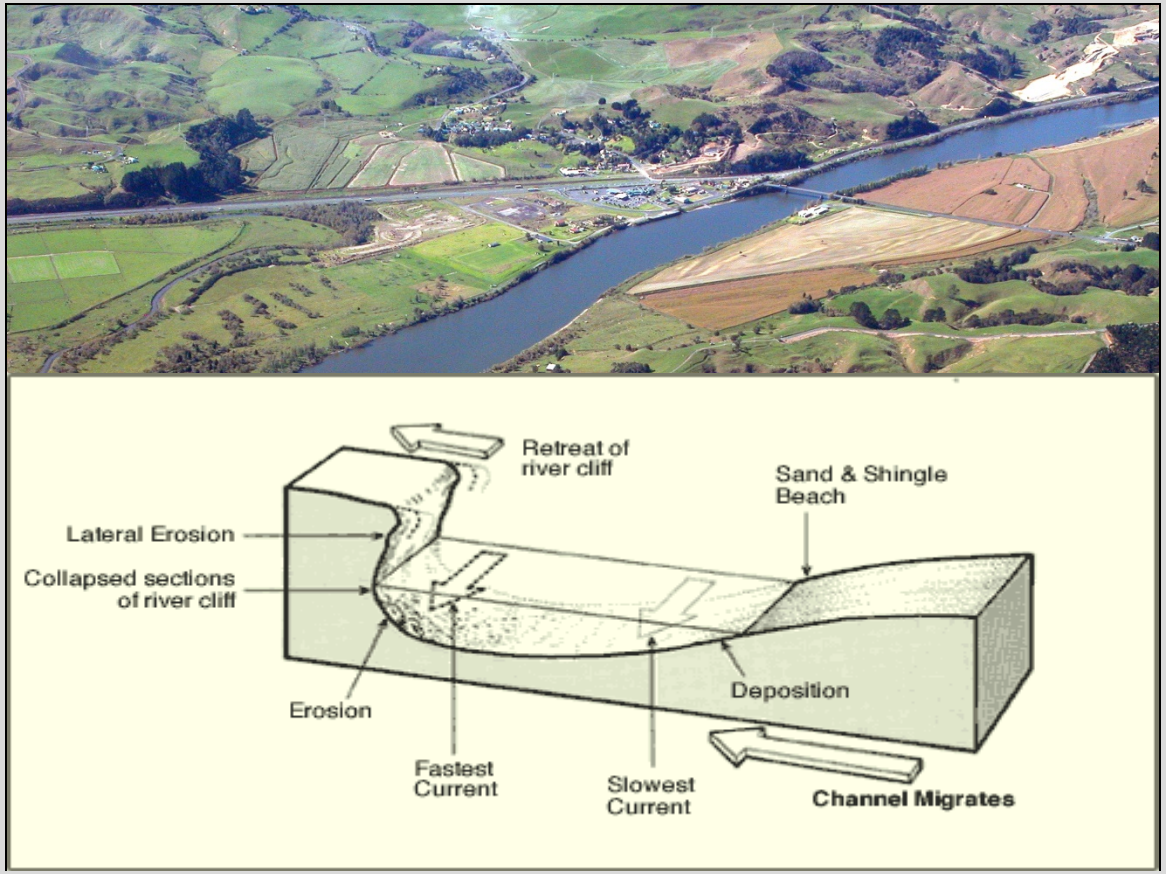
Sediment Transport



Bed load: sediment (sand and gravel) transported along the bed of a river

Suspended load: sediment (clay and silt) transported within the water column of a river

Sediment Transport



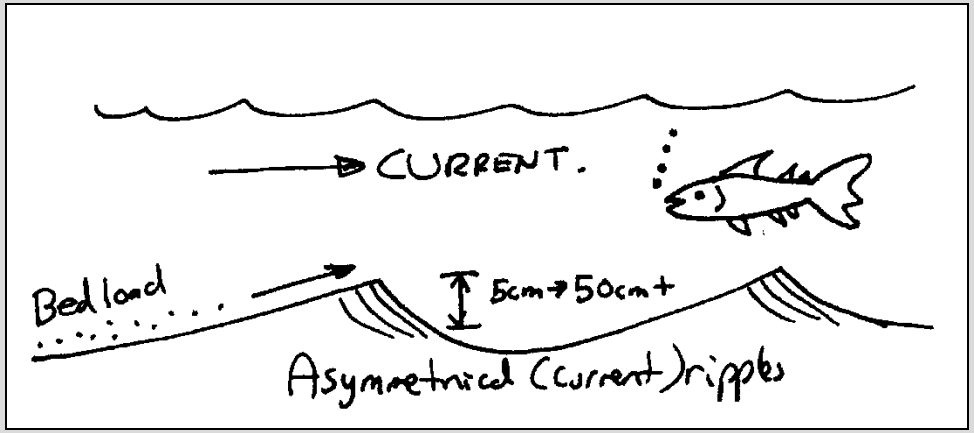
Bed load: sediment (sand and gravel) transported along the bed of a river

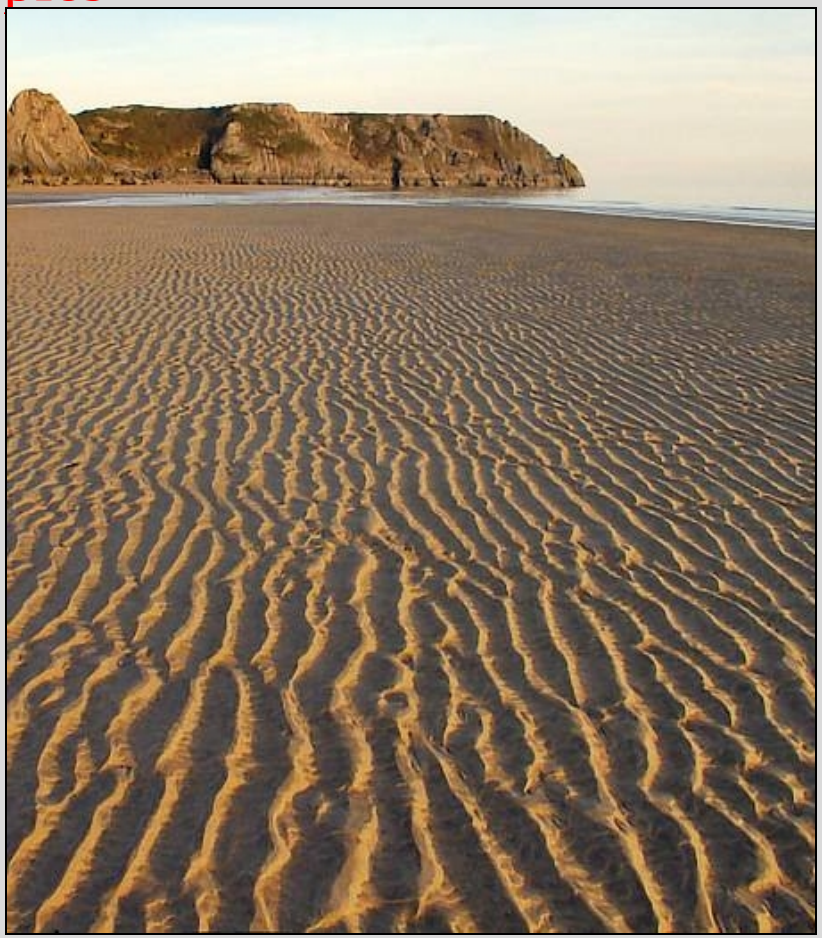
Suspended load: sediment (clay and silt) transported within the water column of a river

Solute load: dissolved minerals transported in a river

Sedimentary Structures

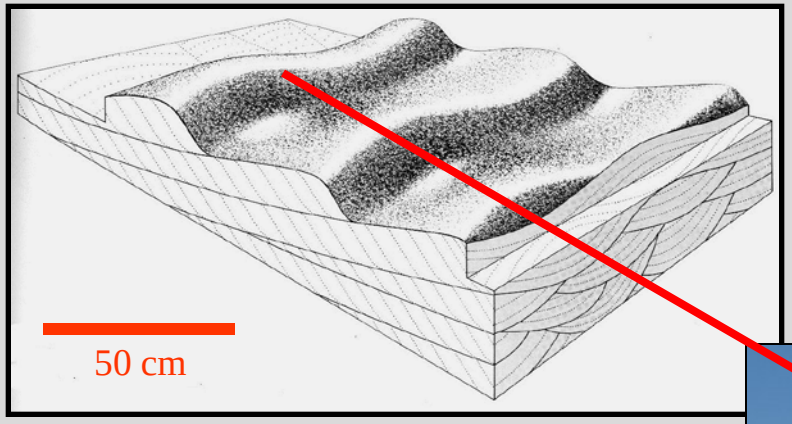
Current Ripples





http://www.wilderness-wales.co.uk/ww/october/october27.jpg

Sediment Transport



From Reineck, H.-E. and Singh, I.B. 1980. Depositional Sedimentary Environments. Springer-Verlag, Berlin. 549p.

Large current ripples

http://danny.oz.au/travel/mongolia/p/57086582-sand-dune-reflections.jpg

Today's Homework

1. Download and read Web Lecture 13
2. Assignment 1 (Due Thursday Oct 10)

Next Time

1) Quiz? (Your choice…..)

2) Sedimentary Environments part 1

GY 111: Physical Geology

Lecture 13: Sediment Classification and Structures

Instructor: Dr. Doug Haywick

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