SEDIMENTOLOGY

GGY 4031

LECTURE 1b

SEDIMENTOLOGY

GENERAL PROPERTIES OF SEDIMENTARY ROCKS

- **TEXTURE:** refers to the size, shape and three-dimensional arrangement of the particles that make up sediment or a sedimentary rock.
- **STRUCTURE:** Depositional forms in sediments that are preserved in the rock record, e.g. bedding or stratification, ripple marks
- **COMPOSITION:** Rock or organic particles that make up a sediment

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Texture comprises of:

- Grain-Size
- Sorting
- Skewness
- Kurtosis
- Sphericity
- Roundness
- Surface texture
- Fabric
- Maturity

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- **Grain size** is a fundamental attribute of siliciclastic sedimentary rocks.
- The sizes of particles in a particular deposit reflects different processes such as:
- **Weathering** and **erosion**

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Nomenclature of Grain-Sizes

Udden-Wentworth scale: This scale is based on the following relationship: Ø = -log2 d (where d= diameter)

Sediment is divided into 4 main classes:

- Gravel: > 2mm
- Sand: 2 - $\frac{1}{16mm}$
- Silt: $\frac{1}{16mm}$ - $\frac{1}{256mm}$
- Clay: < $\frac{1}{256mm}$

		U.S. standard sieve mesh	Millimeters		Phi (ϕ) units	Wentworth size class
			4096		−12	
			1024		−10	Boulder
			256	256	−8	
			64	64	−6	Cobble
GRAVEL			16		−4	Pebble
		5	4	4	−2	
		6	3.36		−1.75	
		7	2.83		−1.5	Granule
		8	2.38		−1.25	
		10	2.00	2	−1.0	
		12	1.68		−0.75	
		14	1.41		−0.5	Very coarse sand
		16	1.19		−0.25	
		18	1.00	1	0.0	
		20	0.84		0.25	
		25	0.71		0.5	Coarse sand
		30	0.59		0.75	
		35	0.50	1/2	1.0	
		40	0.42		1.25	
SAND		45	0.35		1.5	Medium sand
		50	0.30		1.75	
		60	0.25	1/4	2.0	
		70	0.210		2.25	
		80	0.177		2.5	Fine sand
		100	0.149		2.75	
		120	0.125	1/8	3.0	
		140	0.105		3.25	
		170	0.088		3.5	Very fine sand
		200	0.074		3.75	
		230	0.0625	1/16	4.0	
		270	0.053		4.25	
		325	0.044		4.5	Coarse silt
			0.037		4.75	
			0.031	1/32	5.0	
	SILT		0.0156	1/64	6.0	Medium silt
			0.0078	1/125	7.0	Fine silt
MUD			0.0039	1/256	8.0	Very fine silt
			0.0020		9.0	
			0.00098		10.0	Clay
	CLAY		0.00049		11.0	
			0.00024		12.0	
			0.00012		13.0	
			0.00006		14.0	

Udden-Wentworth scale

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Sorting: is a measure of the range of grain sizes present and the magnitude of the spread or scatter around the mean size/ refers to the size range of grains in the sediment or rock

- **Well sorted :** a single sized range. (e.g. all fine sand + little or no matrix)
- **Poorly sorted :** broad range of grain sizes (e.g. combinations of boulders, gravel and find sand + substantial matrix)

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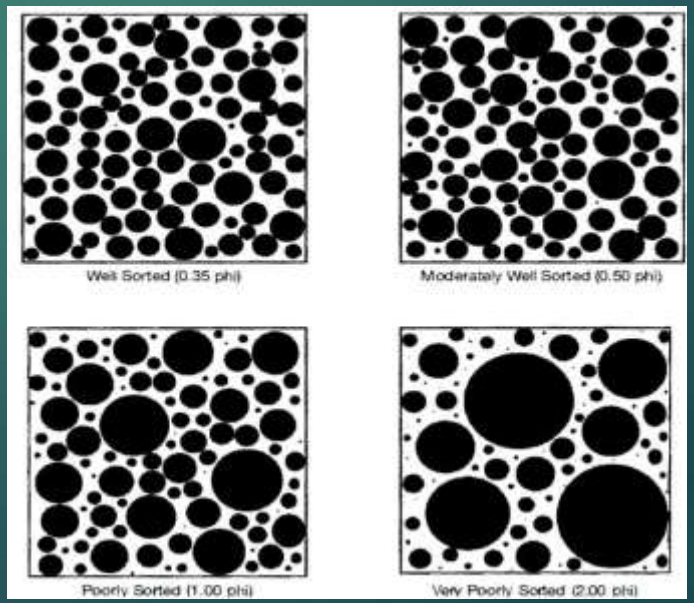
Measurements of sorting

- ✓ field or laboratory by use of a hand lens
- ✓ microscope and reference to a visual estimation chart below



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Measurements of sorting

- ✓ Mathematical expression = standard deviation

$$\sigma = \frac{\emptyset_{84} - \emptyset_{16}}{4} + \frac{\emptyset_{95} - \emptyset_{5}}{6.6}$$

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STANDARD DEVIATION	
$< 0.35\emptyset$	Very well sorted
$0.35 - 0.5\emptyset$	Well sorted
$0.5 - 0.7\emptyset$	Moderate well sorted
$0.7 - 1.0\emptyset$	Moderately sorted
$1.0 - 2.0\emptyset$	Poorly sorted
$2.0 - 4\emptyset$	Very poorly sorted
$> 4.0\emptyset$	Extremely poorly sorted

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Significance of Sorting

- ✓ Reflects the nature and duration of the depositional processes
- ✓ Reflects the size range supplied from the parent material by weathering or reworking

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Skewness - measures the degree to which a cumulative curve approaches symmetry.

- ✓ Fine material are positively skewed
- ✓ Coarse material are negatively skewed

SKEWNESS			
From	To	Mathematically	Graphically
+1.0	+0.1	positively skewed	Negative Ø *values* – *coarse*
+0.1	-0.1	Near symmetrical	Symmetrical
-0.1	-1.0	Negative skewed	Positive Ø *values* – *coarse*

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Significance of Skewness

❑ ***Source and transport process***

- Single source: sediments show normal distribution
- Mixed source: sediments show skewness
- ***Beach sands:*** negatively skewed because finer sediment is removed from beach environment by winnowing
- ***River sand:*** positively skewed because some of the larger amount of silt and clay carried in suspension in most rivers is deposited among coarser grains

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SPHERICITY: refers to how close the particle approaches the shape of a sphere

Zings Classification of sphericity

- *Equant grains:* (Spheroidal) have 3 subequal axes, and highest sphericity
- *Prolate grains:* (Roller/Rods) have 1 long axis, and 2 shorter subequal axes
- *Oblate grains:* (Discs) have 1 short axis, and 2 longer subequal axes and intermediate sphericity
- *Bladed grains:* have 3 unequal axes and the lowest sphericity

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Significance of Sphericity

- Determine provenance of rocks
- Determine the transport distance

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Roundness: the abrasion of the particles during transport

- ✓ The longer a grain is actively transported, the rounder the edges become.
- ✓ Faster flows round grains more quickly because collisions between grains are more forceful. Often, sand sized soft minerals are broken into microscopic particles.

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Significance of Roundness

- Detrmine source rocks
- Determine the transport distance

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Surface texture: Grain surfaces may become polished, frosted or etched as a result of weathering and transport processes

Fabric: Fabric is the spatial arrangement and orientation of the grains. E.g., elongated pebbles, gravel or cobbles tend to stack up **(imbricate)** in a position that is the most hydrodynamically stable

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Imbrication

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Grain supported sediments: have larger grains in contact with (supporting) each other, commonly representing 2-stage deposition, with deposition of supporting grains first followed by finer grains.

Grain-supported rocks: tend to be deposited when sediments are either well sorted or the proportion of large grains is high relative to small grains.

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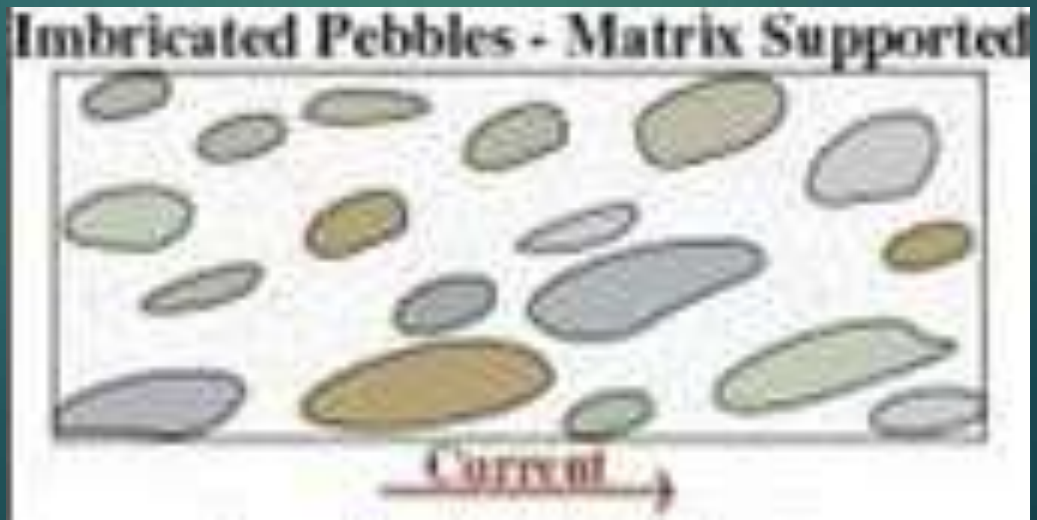
Matrix-supported sediments: larger grains are not generally in contact but are supported by finer matrix. Represent 1-stage deposition, with grains and matrix deposited simultaneously.

Matrix-supported rocks: poorly sorted, deposited in quiet water environments or from flows with very high concentrations of fine grained sediment like mud flows.



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Maturity: describes the *texture* and *composition* of grains resulting from different amounts of sediment transport. Texture: describes how rounded and sorted the sample is while composition describes how much the composition trends towards stable minerals.

- ✓ A sediment is mature when the grains in sediment become well-sorted and well-rounded

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Textural maturity: shows a high degree of sorting. The longer the time and distance of transportation, the better the rounding and the degree of sorting.

- ✓ Rapid deposition over a short distance from the source area facilitates preservation of rock fragments and unstable minerals. These are therefore usually also *texturally immature*.

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Composition maturity is indicated by abundant durable mineral grains, e.g. quartz

Composition immaturity is indicated by ferro-magnesian minerals that are extremely likely to undergo chemical dissolution during transport and are rare in sedimentary rocks