Sedimentary Textures

Oct. 3, 2007

Grain Size

- *Size*
  - *reflects a variety of things*
- *Sedimentologists are interested in 3 things*
  - *measurement + expression*
  - *presentation*
  - *what it means*

1) Measurement

- *Udden-Wentworth: used to classify sediment diameters*
  - *each successive size class is half as large as the previous*

granule/very-coarse sand boundary	*2 mm*	*2 A*	*The next larger class is twice the diameter*
very-coarse/coarse sand boundary	*1 mm*	*A*	*Have grain size class 'A'*
coarse/med sand boundary	*0.5 mm*	*1/2 A*	*The next finer class is half the diameter*

Phi-scale

ϕ *lower*	*d (mm)*	*class*
-8	*256*	*boulder*
-6	*64*	*cobble*
-2	*4*	*pebble*
-1	*2*	*granule*
4	*0.125*	*sand*
8	*0.0039*	*silt*
14	*0.00006*	*clay*

- $\phi = -log_2 d$

Measuring Size

- *pebbles -> boulders*

http://www.soil-net.com/album/Soils_Rocks/slides/Rock%20Conglomerate.jpg

http://www.wpclipart.com/tools/tape_measure_2.png

Measuring Size

- *Granule -> Silt*

http://rockyweb.cr.usgs.gov/frontrange/virtour/images/sieves.jpg

http://invam.caf.wvu.edu/methods/spores/extractions/small-sieves.jpg

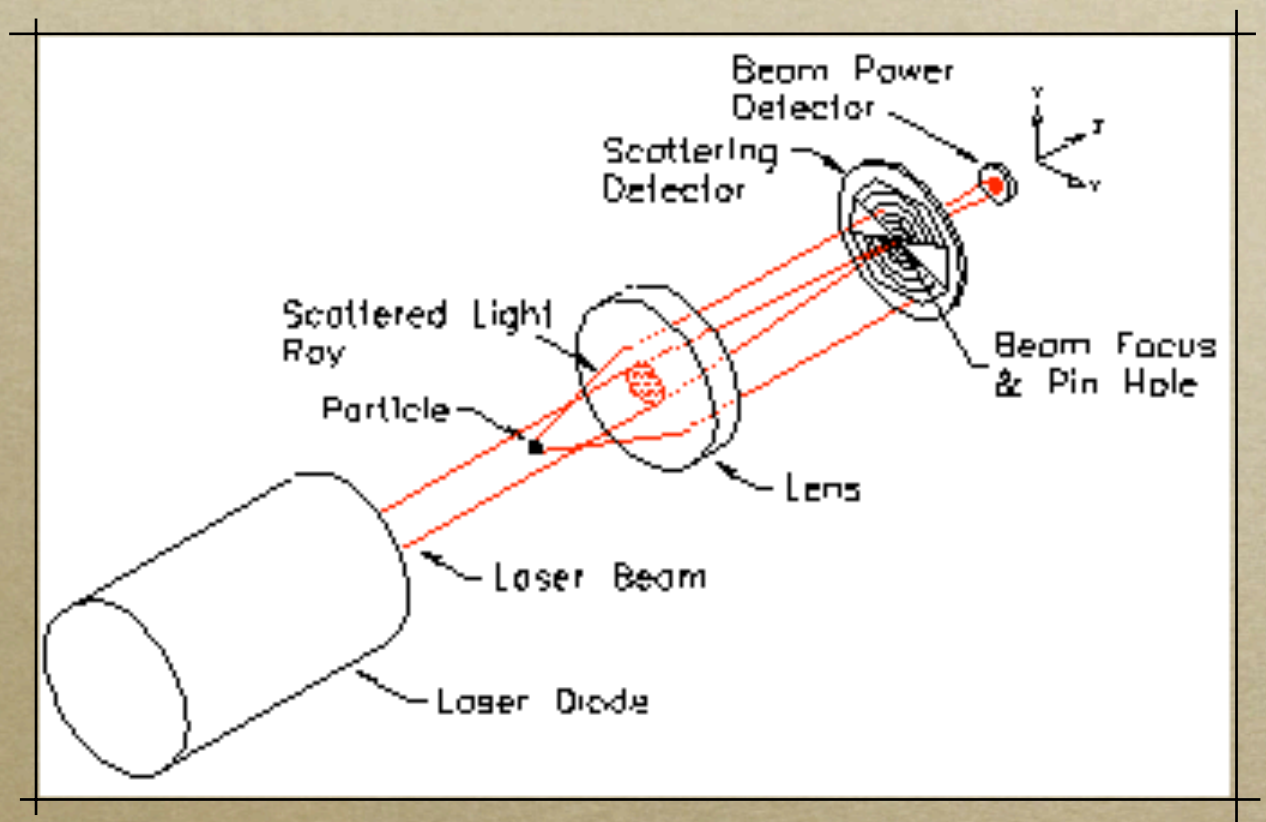
Measuring Size

Settling method

- *Silts & Clays*

http://www.uasb.org/discover/settling.jpg

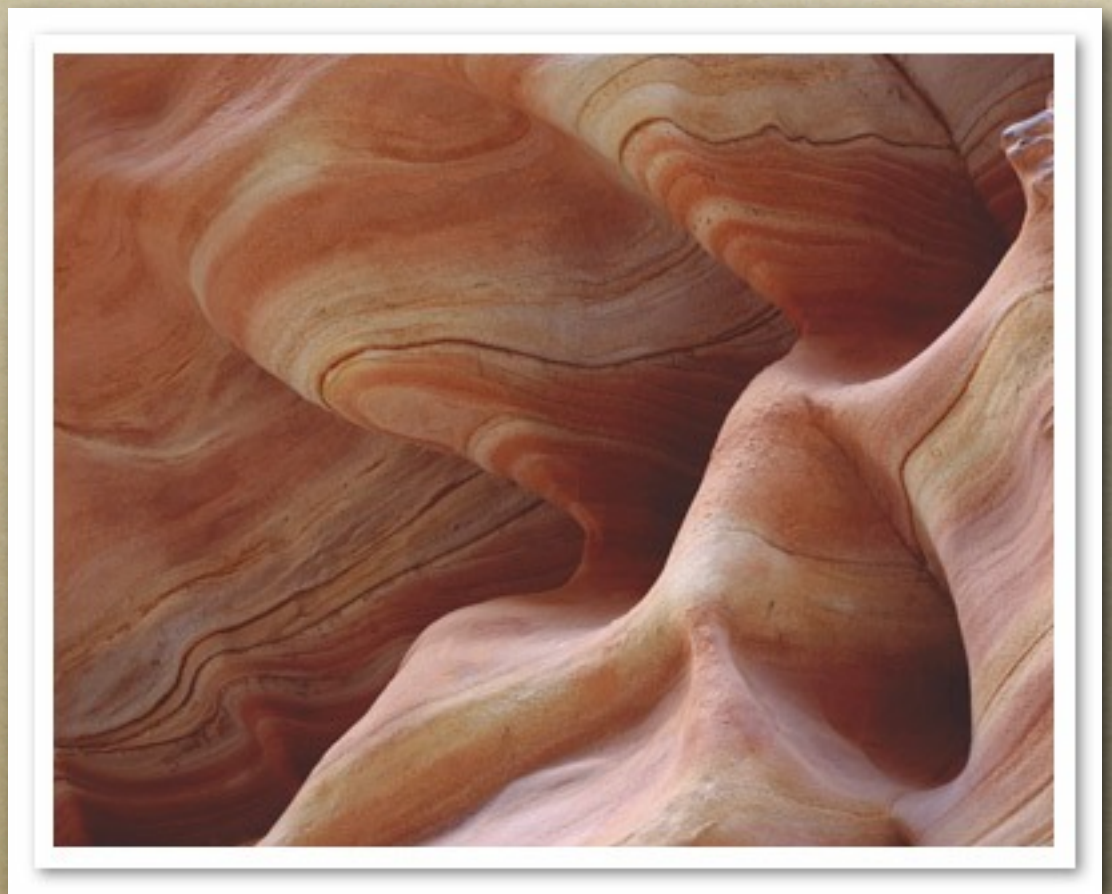
Measuring Size



- *Sophisticated method for fine sediments..*

http://www.malvern.com/ProcessEng/systems/laser_diffraction/technology/technology.htm

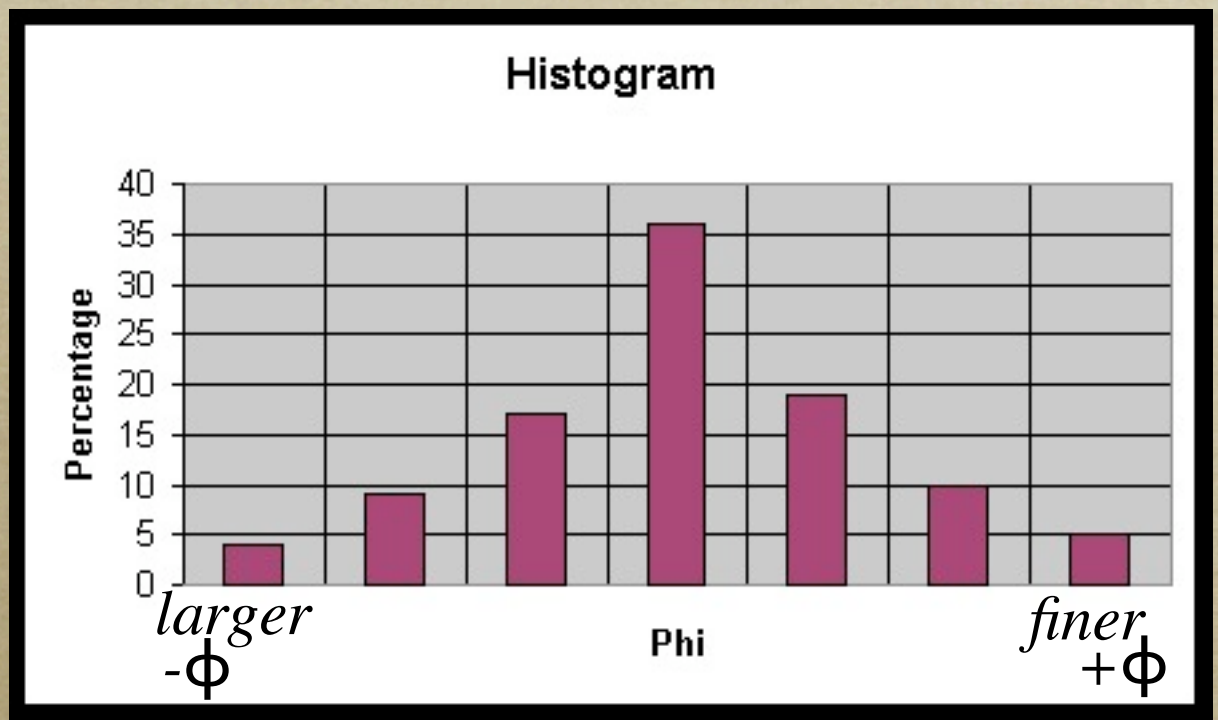
Rock?



- *not loose particles*

http://www.photo-mark.com/webpix/ds/Sandstone.jpg

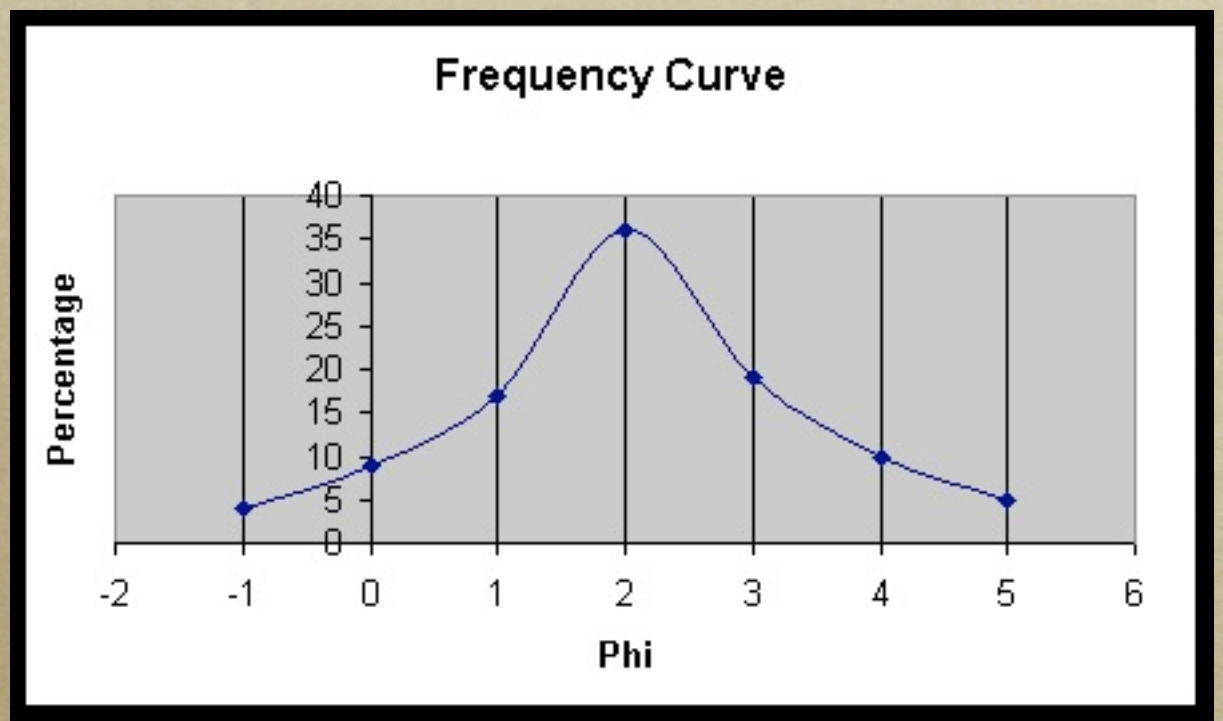
2) Presentation



- *Histogram: grain size vs weight %*

http://gpc.edu/~janderso/historic/labman/sievean.htm

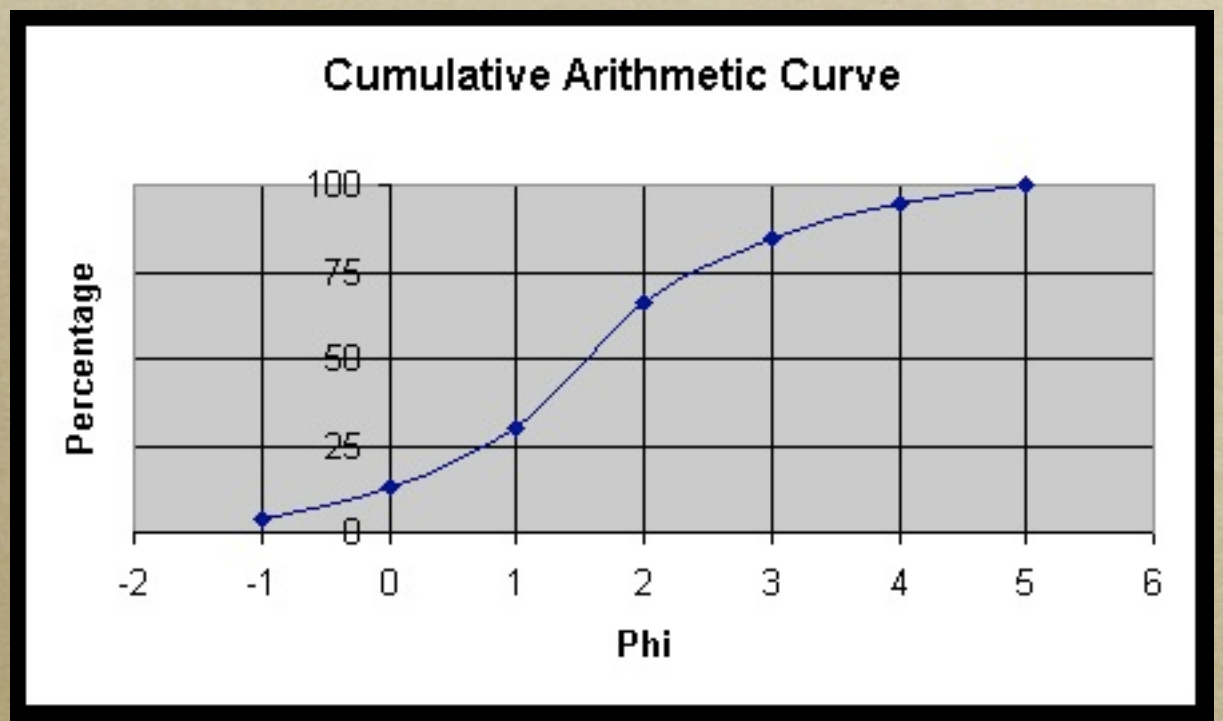
2) Presentation



- *Frequency curve*
- *smooth curve fitted to histogram*

http://gpc.edu/~janderso/historic/labman/sievean.htm

2) Presentation



- *cumulative arithmetic curve (cumulative weight %)*

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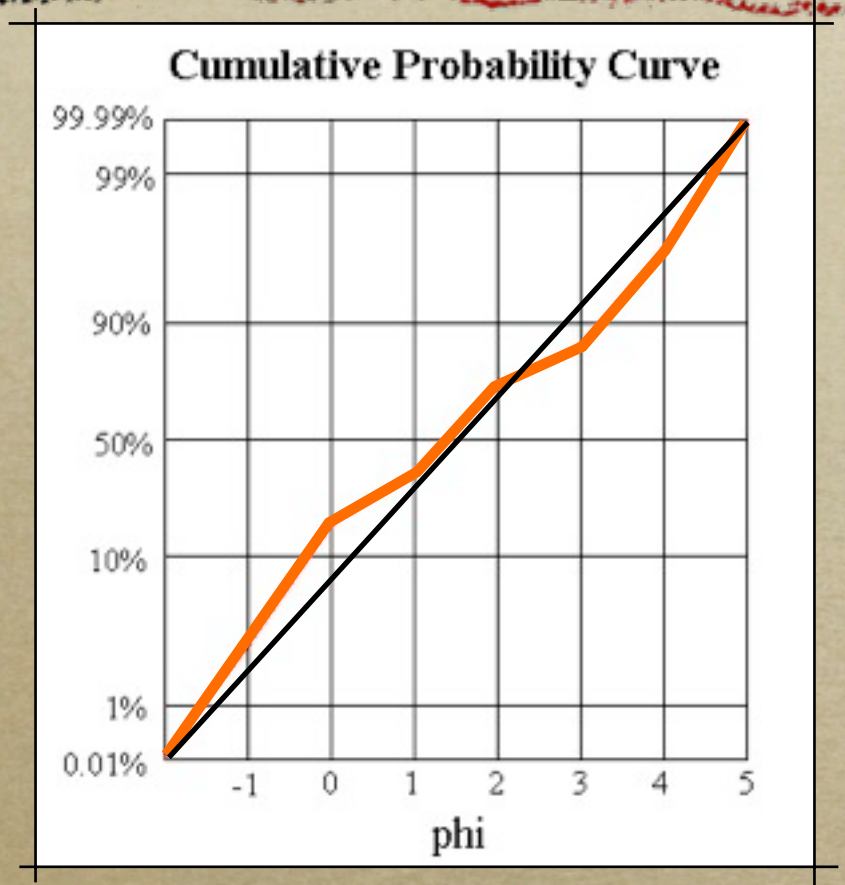
2) Presentation



black line = normal distribution

red line = plotted data can easily see how it deviates

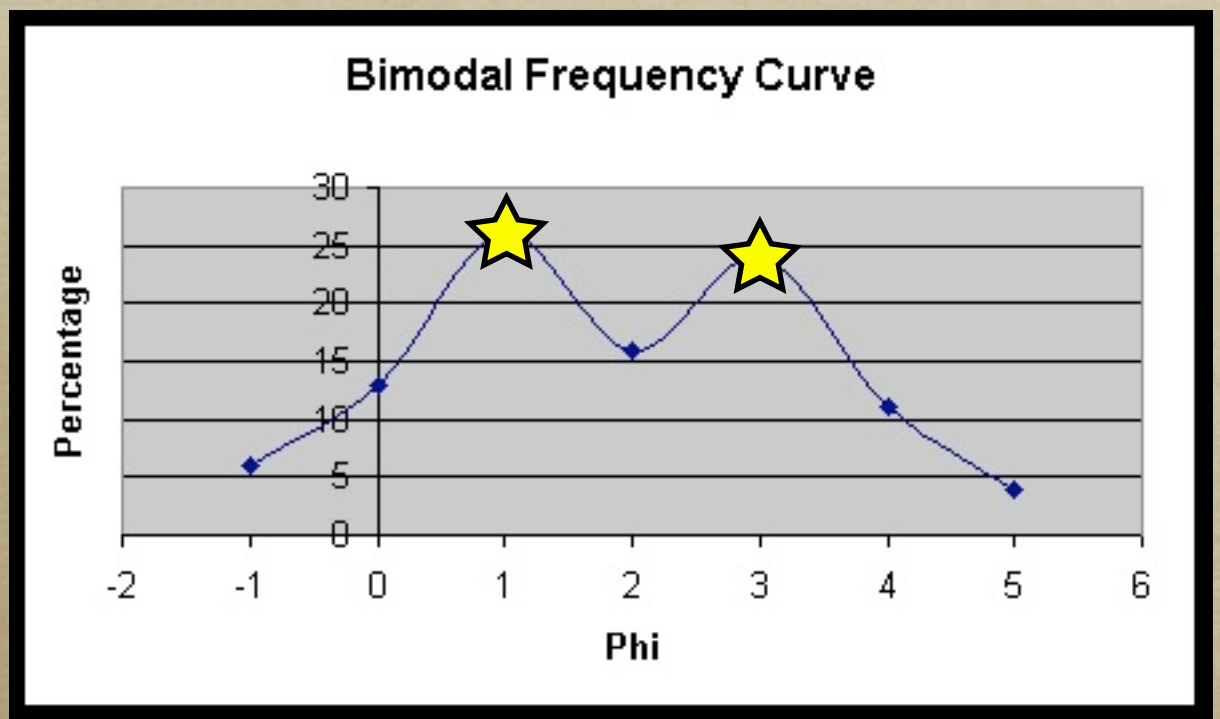
- *cumulative probability curve*
- *a normal distribution = straight line*

http://gpc.edu/~janderso/historic/labman/sievean.htm

2B) Mathematical Presentation

- *Lots of data = lots graphs*
- *Use mathematical methods instead*
  - *see Table 5.3, page 85 of text*

Grain Size

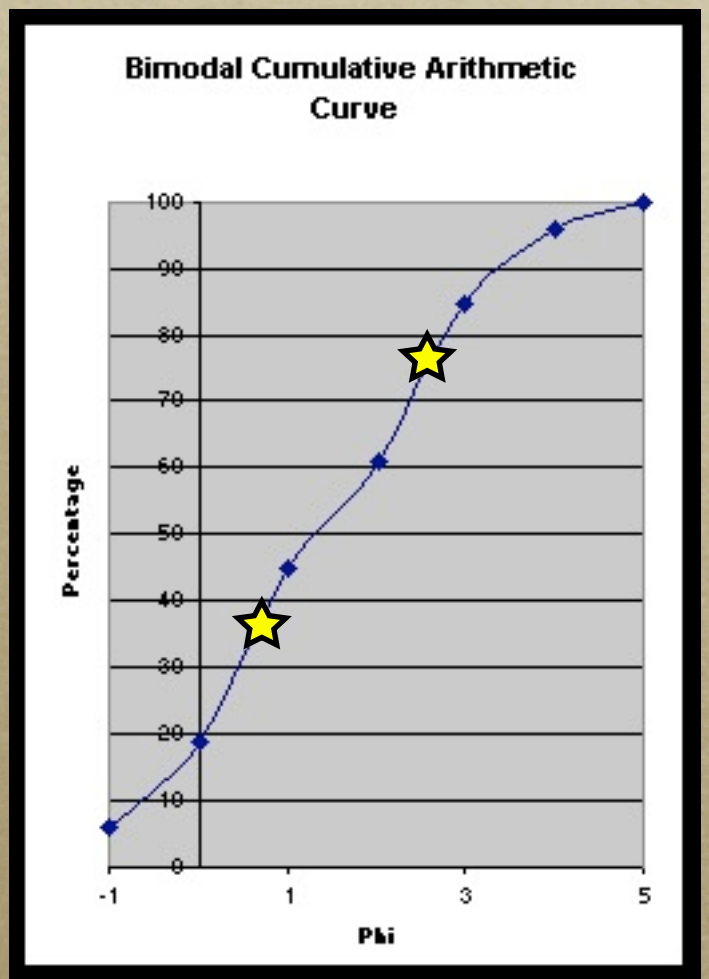


Modes identified with stars

- *Mode: most frequently occurring*
  - *This data is bimodal*

http://gpc.edu/~janderso/historic/labman/sievean.htm

Cumulative Frequency Curve

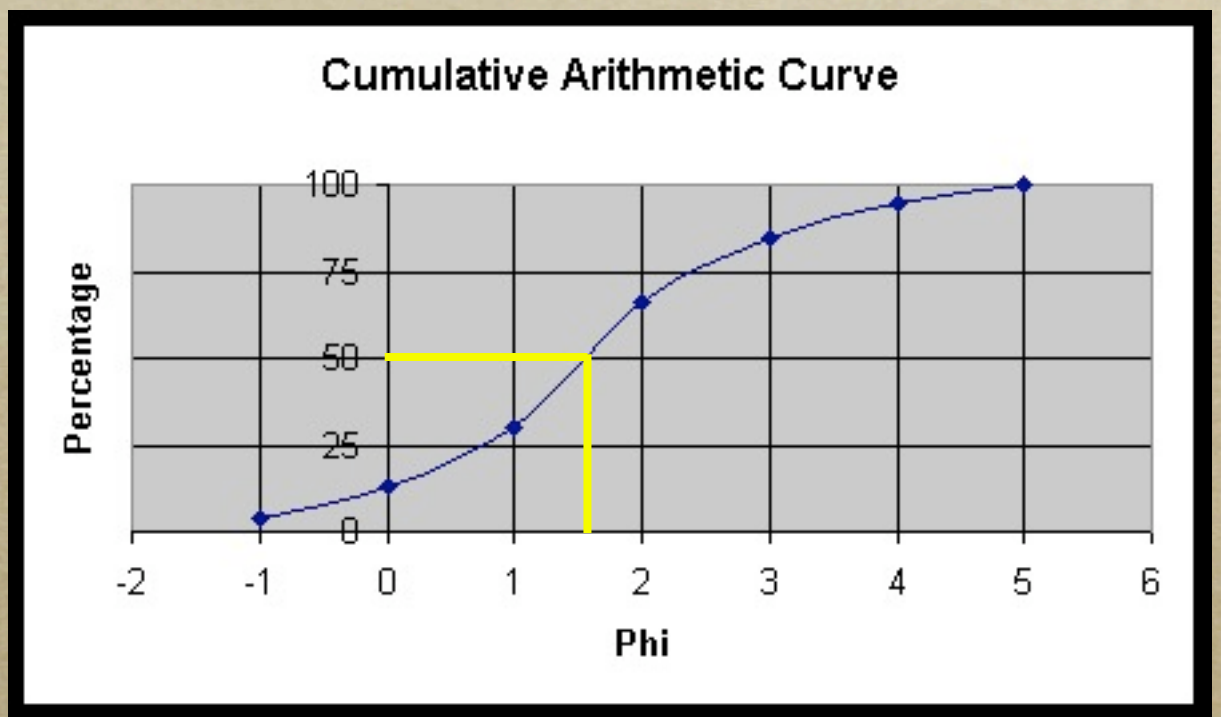


Same data as previous slide, but plotted differently

Here the steepest slopes of the curve represent the modes

Grain Size

- *Median Size*
  - *50% of sample is coarser than 1.5 phi*
  - *50% of sample is finer than 1.5 phi*



http://gpc.edu/~janderso/historic/labman/sievean.htm

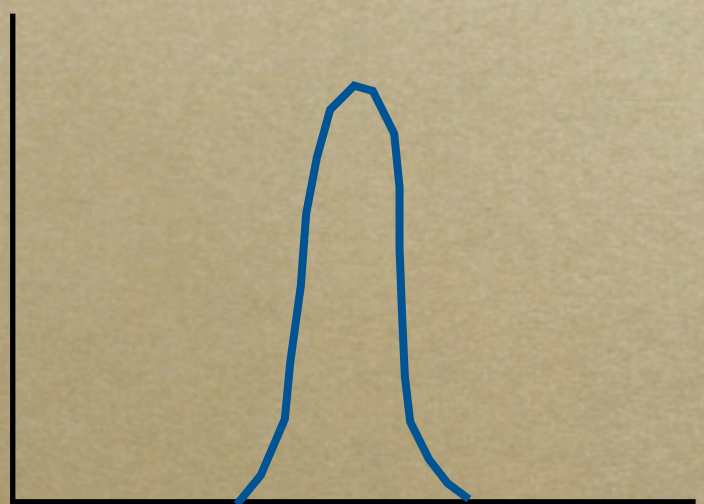
Grain Size

$$M = \frac{\phi 16 + \phi 50 + \phi 84}{3}$$

- *Mean (average) Size*
- *Mean, Median & Mode are only equal in a normal distribution*

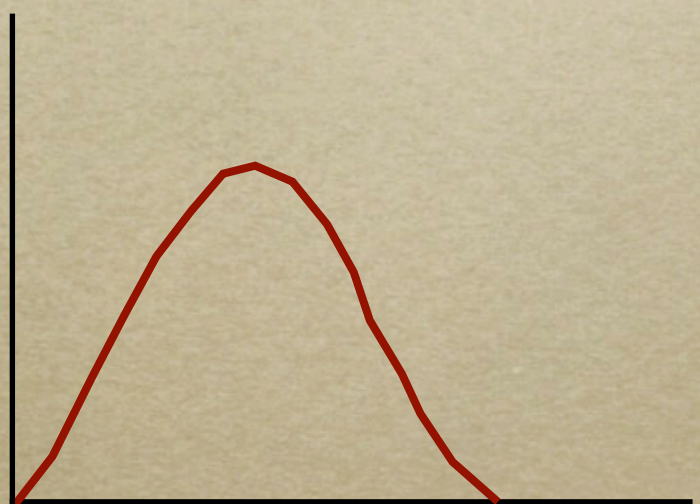
Sorting

$$\sigma_1 = \frac{\Phi_{84} - \Phi_{16}}{4} + \frac{\Phi_{95} - \Phi_{5}}{6.6}$$



Well Sorted

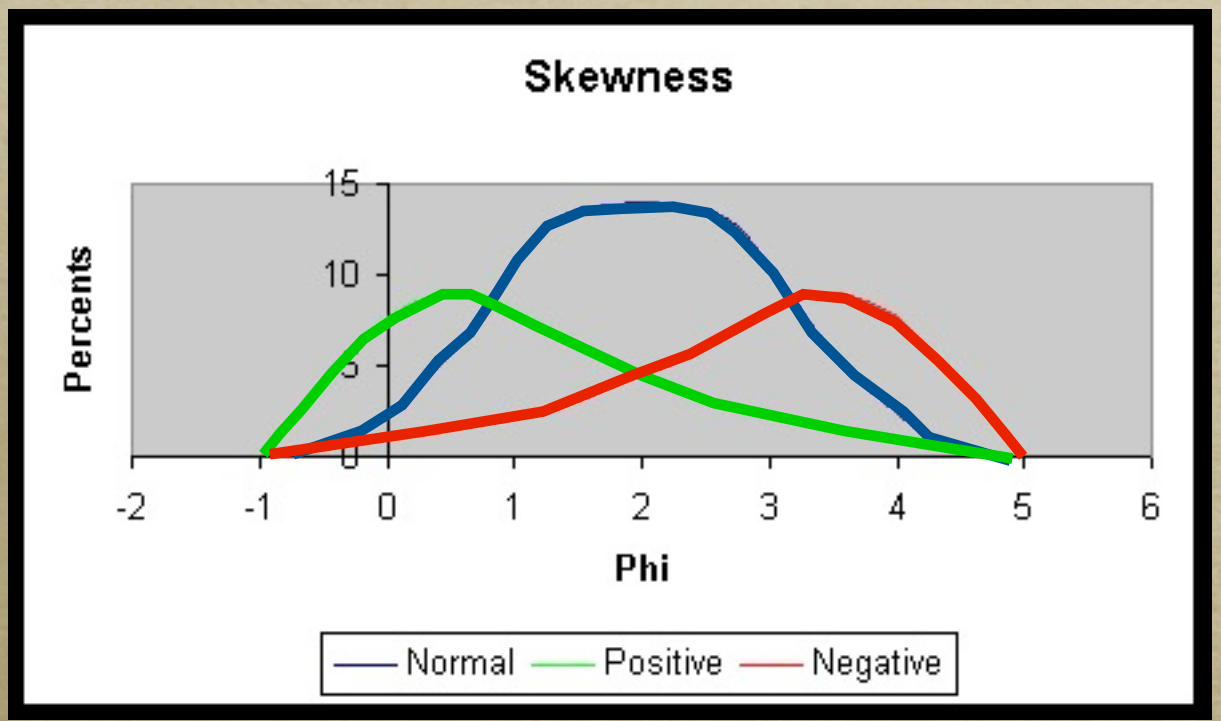
Base of curve occupies small range of grain sizes



Poorly Sorted

Base of curve occupies wide range of grain sizes

Skewness



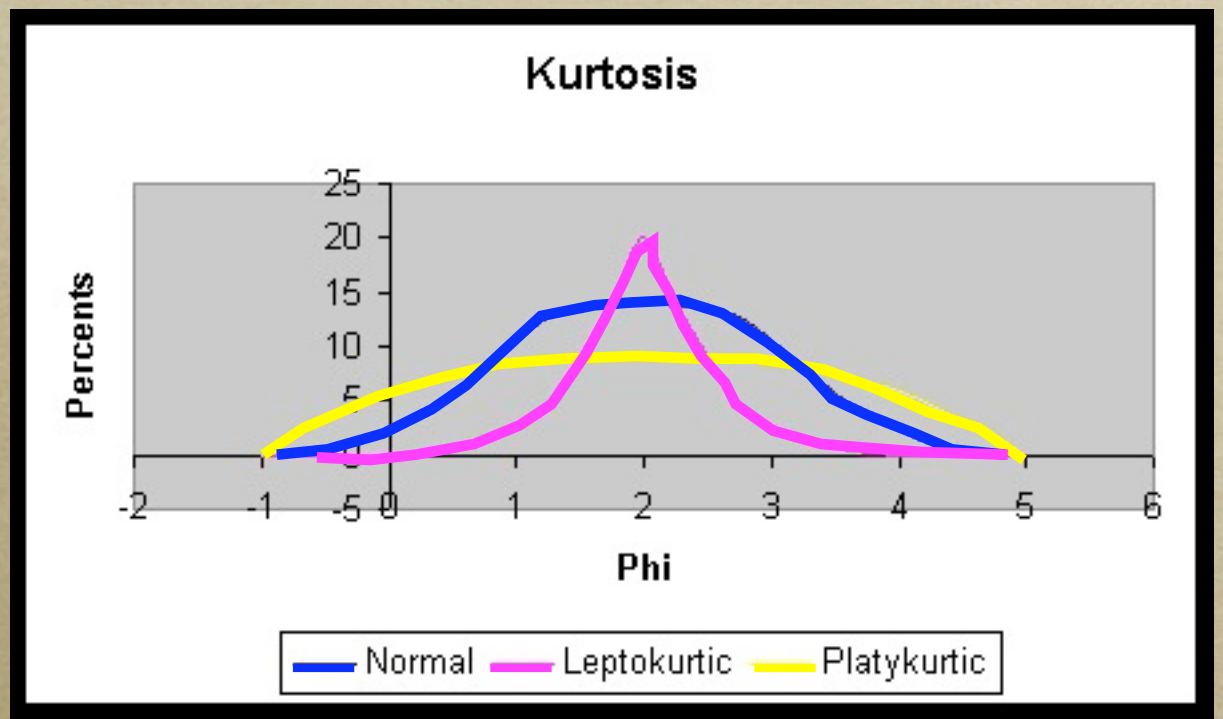
Positive skew: fine grained tail (larger Φ)

Negative skew: coarse grained tail (smaller, or negative Φ)

- *degree of asymmetry*
- *compared to a normal distribution, a Positive skewed sample has an excess of fine particle*

http://gpc.edu/~janderso/historic/labman/sievean.htm

Kurtosis



- *"peakedness" of frequency curves*
- *degree of sorting of central population vs edges*

http://gpc.edu/~janderso/historic/labman/sievean.htm

Method of Moments

- *Grain Size paramters*
  - *Mean*
  - *Standard Deviation*
  - *Skewness*
  - *Kurtosis*
- *Can be obtained mathematically*

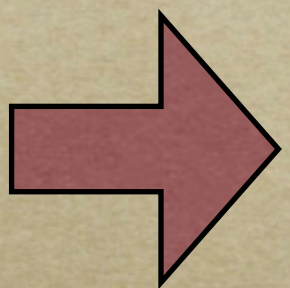
4) Importance

- *Descriptive of the rock itself*
- *Economically important*
  - *sorting, shape etc.. are linked to porosity & permeability*
- *Depositional Environment*
  - *hopefully this tells us something about where the sediment came from*

Particle Shape

Depends on…

- *Parent rock*
- *Weathering*
- *Transport*
- *Burial*

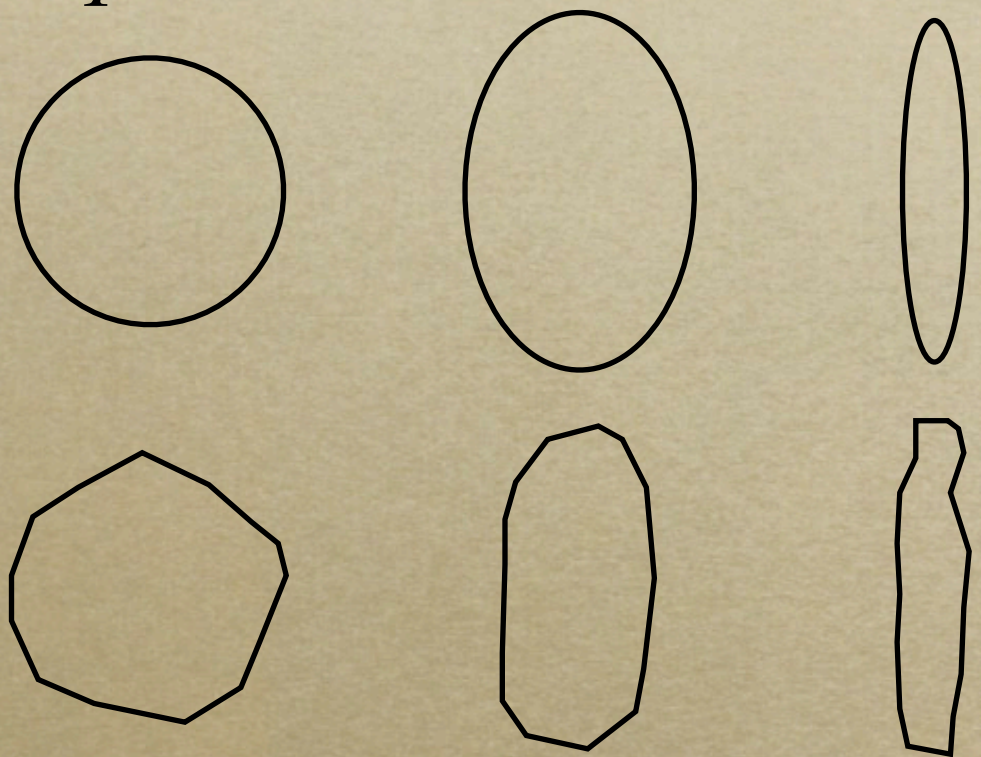


Described by…

- *Form*
- *Roundness*
- *Texture*

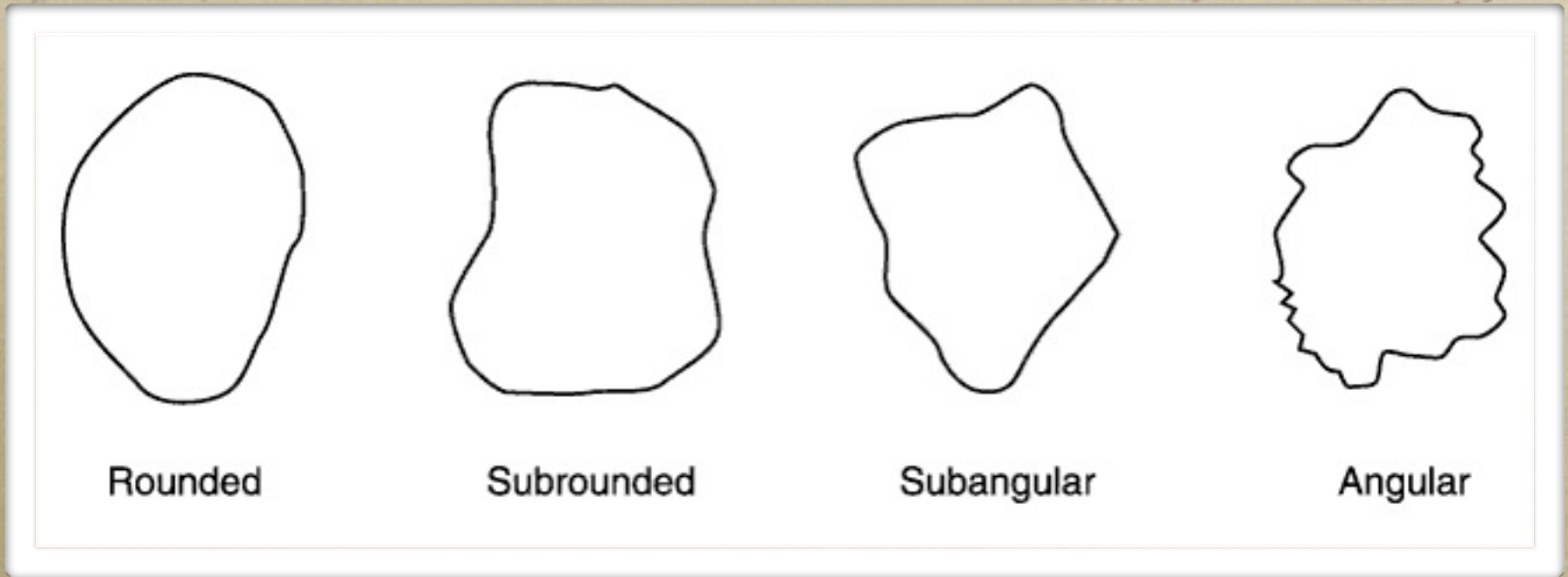
Form

Equant *Platy*



- *Sphericity*
- *Depends a lot on composition*

Roundness



Depends on abrasion history, clast size & composition

Larger clasts round faster than small ones

Softer clasts round faster than hard ones

http://maps.unomaha.edu/maher/ESSlectures/ESSlabs/lab6sediments.html

What environments do the most rounding of grains...

for sand sized quartz

http://members.aol.com/Mmcbs3/mississippi-grandrapids1.jpg

<

http://jan.ucc.nau.edu/~rcb7/Wavetrainsore.jpg

<

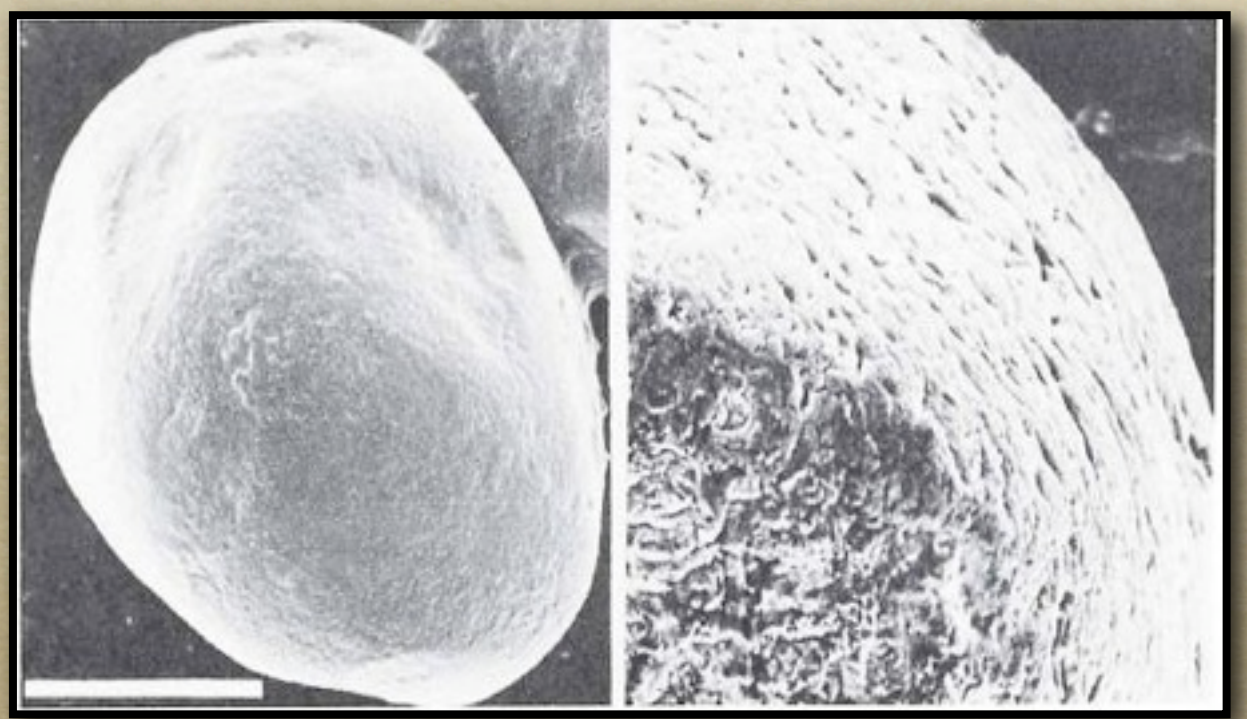
http://www.seedmagazine.com/news/uploads/singingdune.jpg

for pebbles

http://www.cc.gatech.edu/cpl/projects/graphcuttextures/data/interaction/LittleRiver.jpg

Surface texture

- *mechanical*
- *chemical*
- *tectonic*

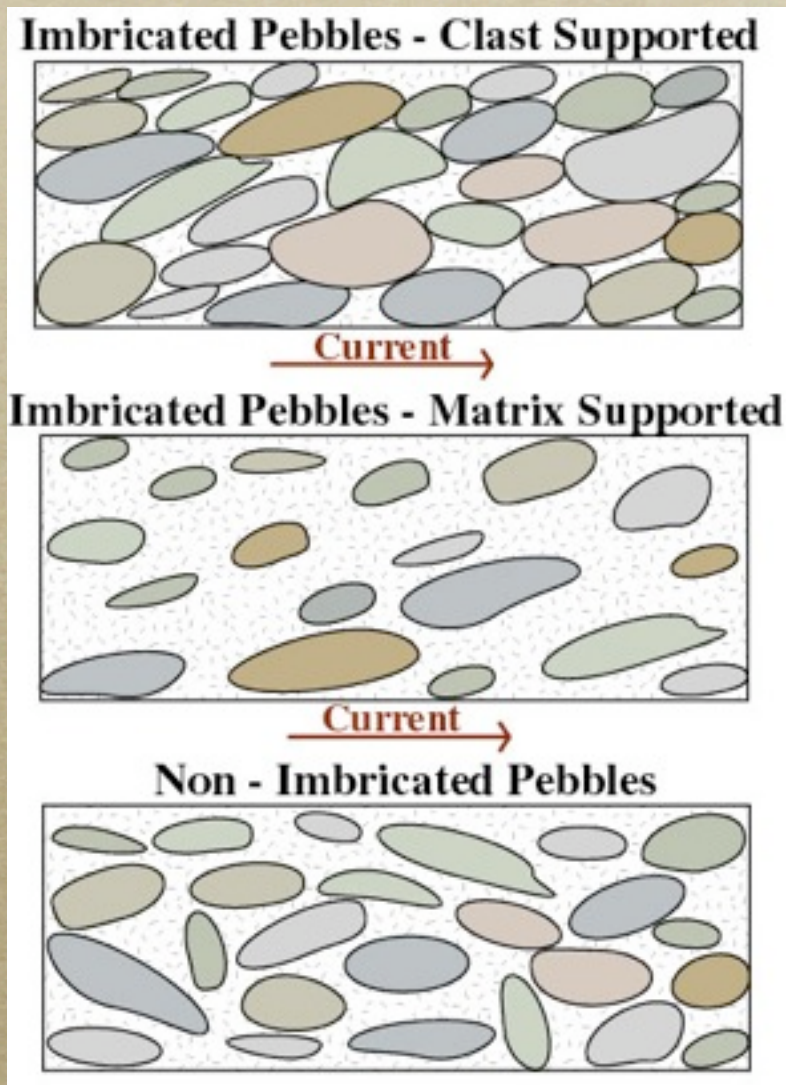


SEM image of a rounded sand grain showing extreme "frosting" indicating wind transport

http://www.nvcc.edu/home/cbentley/shenandoah/sauk.jpg

Fabric

- *Grain Orientation*
- *Grain Packing*
  - *affects bulk density*
  - *porosity*
  - *permeability*



http://www.umt.edu/geosciences/faculty/hendrix/g100/imbrication.jpg

Is this useful?

- *Individual calculations or features may not be diagnostic of an environment*
- *but combining a variety of these grain analyses along with observations of sedimentary structures can help narrow down the possibilities*