Outline Talk of Lec.1

Updated November 2023

1-Introduction about Terrigenous clastic sediments.
2-Geology should be able to understanding what ?
3-Processes of rock cycle.
4-Types of sedimentary rocks.
5-Grain morphology.
6-Process which affect the shape of grains.
7-Grain fabric.
8-Grain contact in sedimentary rocks.
9-Sandstone maturity.
10- References.

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1-1Introduction:-

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***The Allochthonous sediments**, are defined or consist of Terrigenous and termed siliciclastic sediments are diverse group or rocks, ranging from fine-grained mud rocks through coarser grained sandstones to conglomerates and breccia's and pyroclastic detrital sediments.*
The pyroclastic sediments those derived from volcanic activity. The Allochthonous sediments may conveniently be classifed using the end-member triangle as shown in Fgure1, Table 1

The *Terrigenous* sediments are largely composed of clasts, derived from pre-existing igneous, metamorphic and sedimentary rocks. The clastic grains are released through mechanical and chemical weathering processes, and then transported to the depositional site. Mechanism involved transportation include wind, glacier, river, current, waves , tidal currents and turbidity currents.

The detrital grains may be rock fragments but the majority are individual crystal and chiefly Quartz and feldspar. In a broad sense the composition of clastic sediments is a reflection of the weathering processes largely determined by the climate and geology of the source area. However the sediment composition is also affected by distance of sediment transport and by the diagenetic process (Figure 2).

In general sense the composition of clastic sediments is a reflection of
1- Weathering processes, largely determined by climate and geology of source area.
2- Distance of transport sediments.
3- Diagenesis processes.
The general siliciclastic classification process is illustrated in the following chart below:

Table 1: Classification of sedimentary rocks

Group	Class
I. Autochthonous sediments	(a) *Chemical precipitates* — the evaporites: gypsum, rock salt, etc. (b) *Organic deposits* — coal, limestones, etc. (c) *Residual deposits* — laterites, bauxites, etc.
II. Allochthonous sediments	(d) *Terrigenous deposits* — clays, siliciclastic sands, and conglomerates (e) *Pyroclastic deposits* — ashes, tuffs, volcaniclastic sands, and agglomerates.

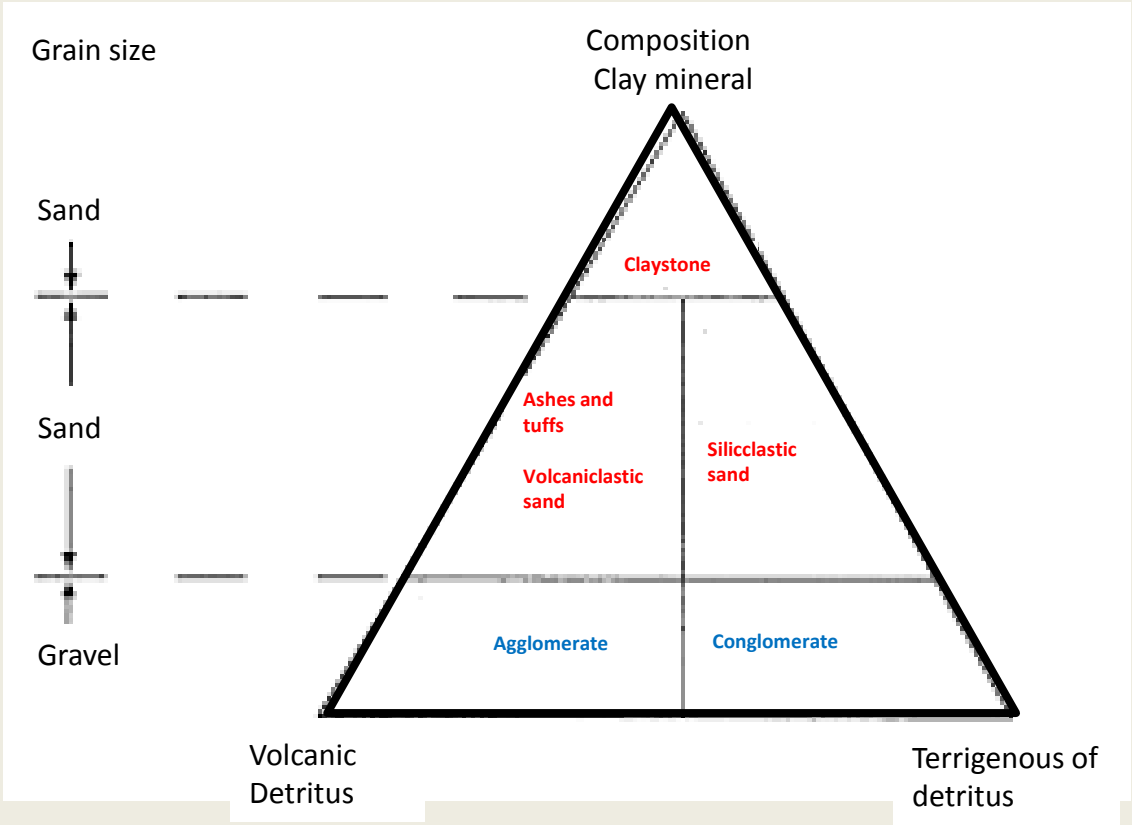


Figure 1: A classification of the allochtthonous sediments based on grain size and composition.

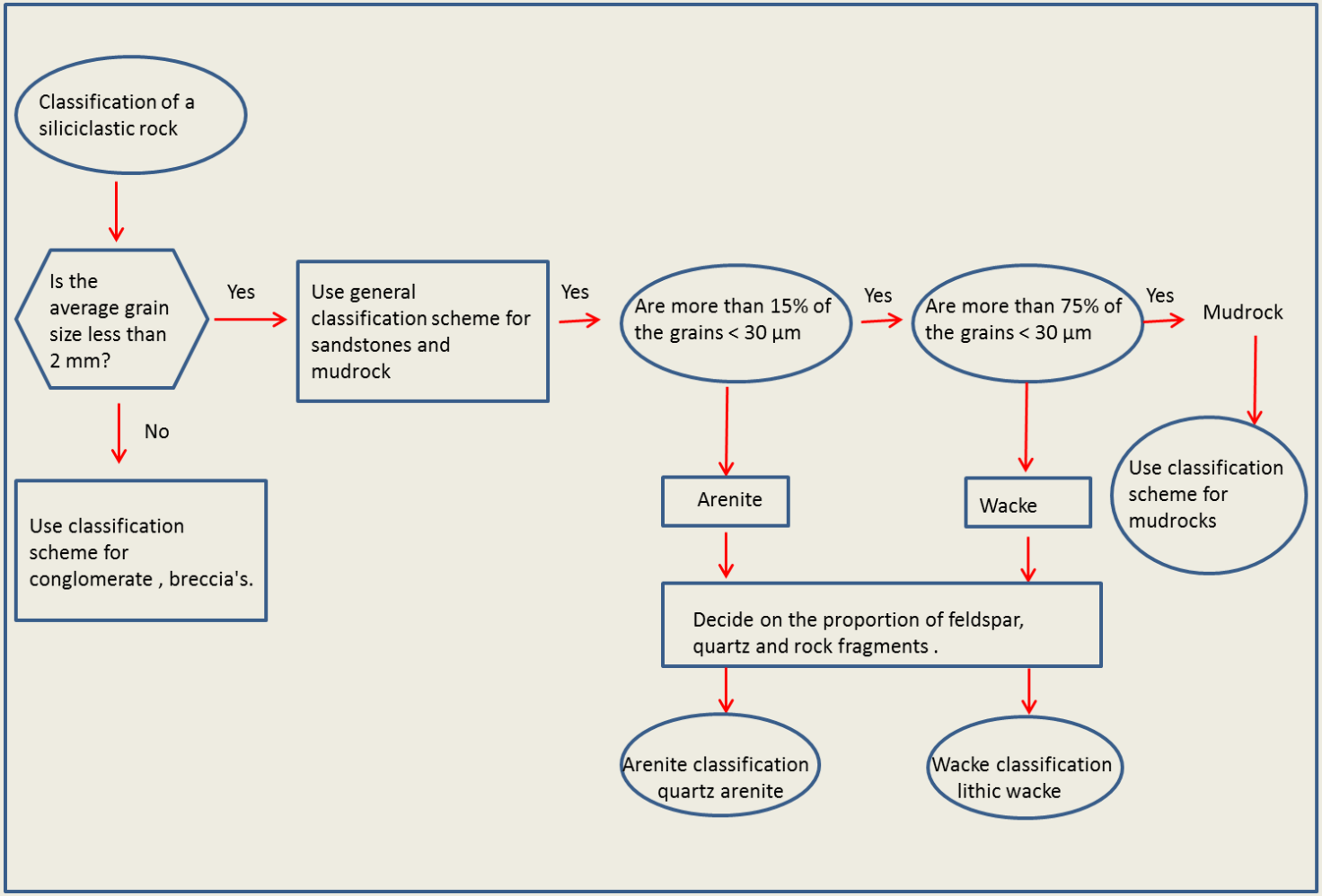


Figure 2: Flow chart showing general siliciclastic classification process .

1-2 Geology should be able to understanding that:

1- The depositional environment and related rock types and their special features.

2- The importance of sedimentary rocks is due to defects that they are good carriers for in petroleum , water and many other natural resources.

3- The formation of sedimentary rocks are closely related to depositional environment for chemical rocks (carbonate) and related to the positive area (provenance) and Depositional environment for non-chemical rocks (clastic).

4- Structures could give an indication on their style of sedimentation and environment.

5- Sedimentary rocks are the most important for studying heavy minerals provenance, sulphure, phosphore ,ect.

6- Sedimentary rocks are the base of geological record (time scale) and stratigraphy (Biostratigraphy & Lithostratigraphy).

7- Sedimentary rocks forming foundation of engineering project like tunnels, bridges ,high way , dams, building ,underground metro , air-port ,ect.

8- Sedimentary rocks are most important material for construction.

9- Sedimentary rocks are most important material for industry like cement ,plaster marble, maquillage, sugar factory, brick , paint industry .

1-3- Processes of the rock cycle

- **Erosion-** its abrasion and collapse of rock mass to a smaller particles . Fig. 3

- **Transportation-** movement of sedimentary particles from place to place inside any medium (water, wind, glacier) . Fig. 3
- **Deposition (sedimentation) –** its settlement of particle in any environment to be stable in it . Fig. 3
- **Burial-** remain of sediment under the compaction of other above layer during the geological period to be lithifide. . Fig. 3
- **Diagenesis-** any chemical or physical change after lithification (dolomitization , solution , cementation) . Fig. 3
- **Weathering-** climate influence on sediment exposure after uplifting to be the land. .Fig. 3

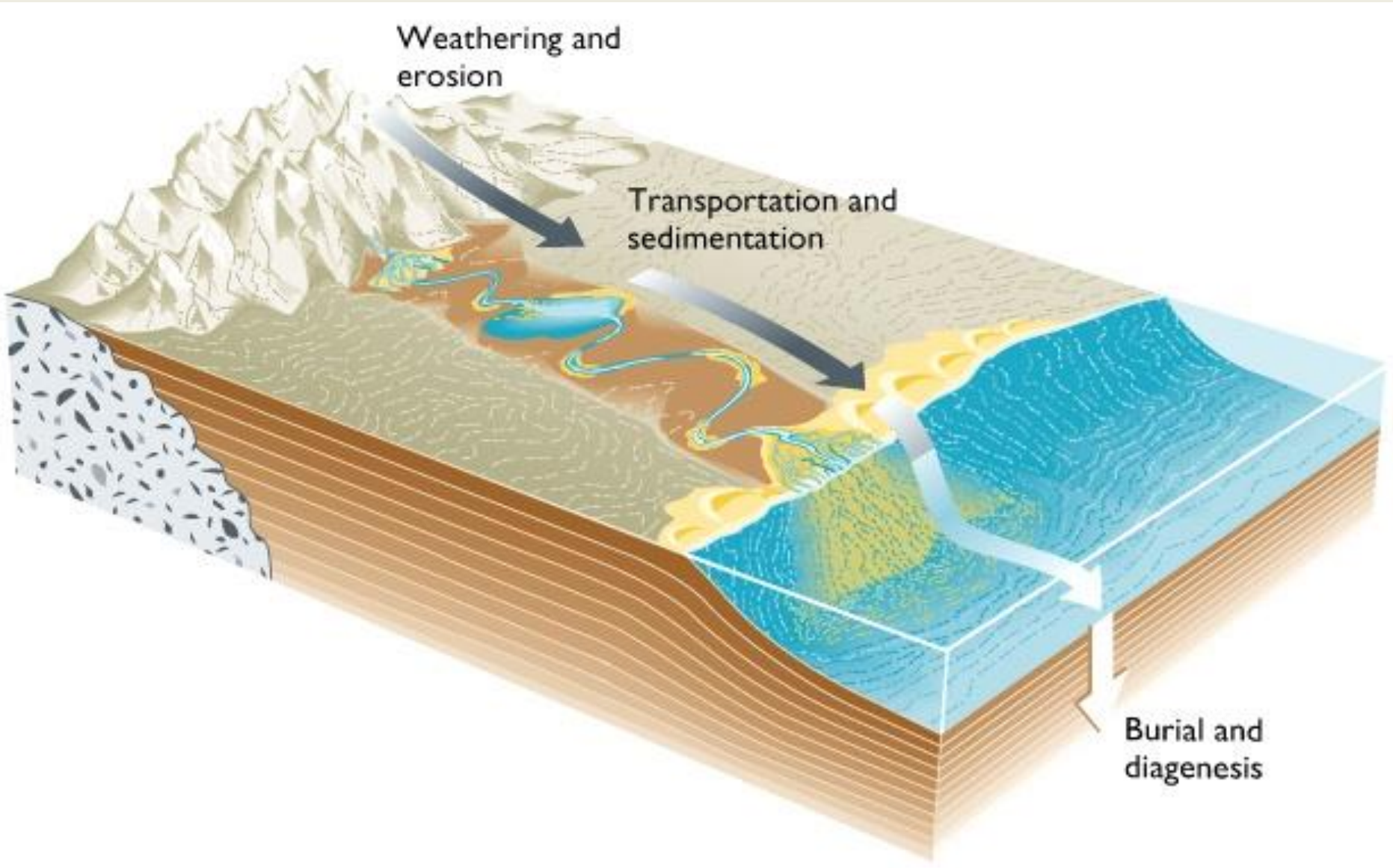


Figure 3: Sedimentary Stages in the Rock Cycle

2- Volume of Sedimentary rocks in crust and on the surface

- 5 % by volume of the upper crust (Figure 4).
- 75% by area of continental areas
- Often the only record of geologic events:

e.g. The Himalayas will someday be sandstone and limestone

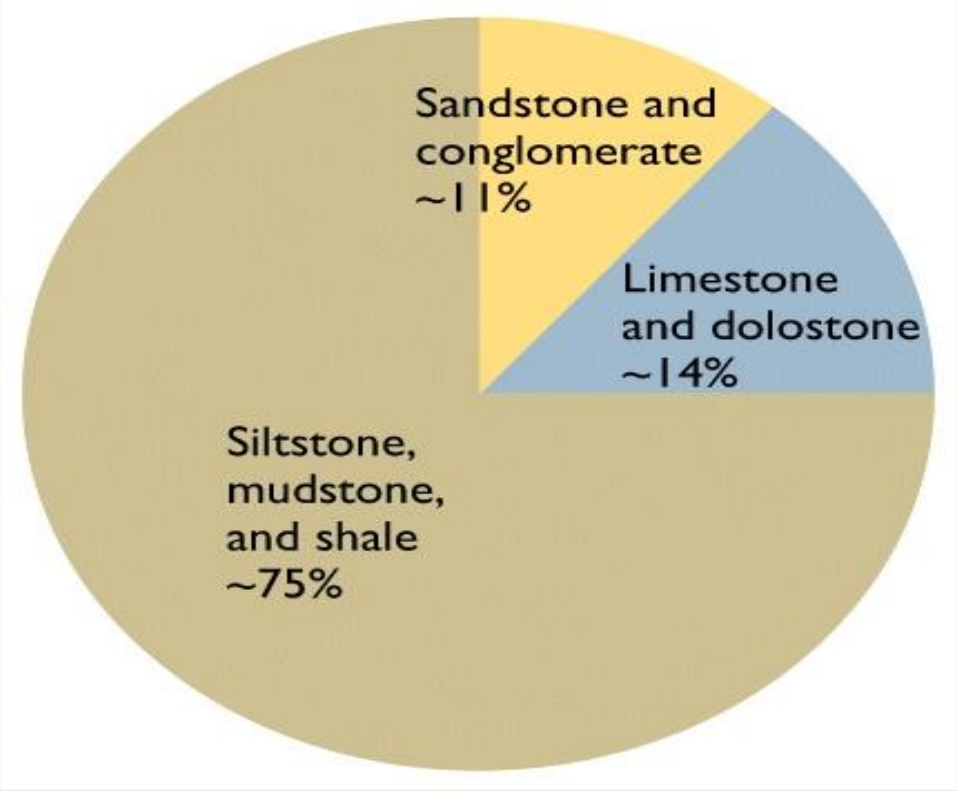


Fig.4 Relative Abundance of Sedimentary Rock Types

1- 4Types of Sedimentary rocks

- **(detrital or clastic) :-** Rock resulting from the consolidation of loose sediment that has been derived from previously existing rocks and accumulated in layers, Largely based on the size of the particles, which may be anything (Figure 5a)

Types of detrital rocks:

- Conglomerate
- Breccia
- Sandstone(quartzite, arkose, greywacke)
- Shale
- Mudstone
- Siltstone

- *What is a main differences between*
- *mudstone & claystone ????*

(Fig.5a) clastic rock (sandstone**)**

- **(chemical) :-** Rock formed by the precipitation of minerals from solution by either organic or inorganic processes.

Types of biochemical rocks (Carbonates):

- Limestone
- Dolomite
- Silicate rock
- Coal

Types of chemical rocks

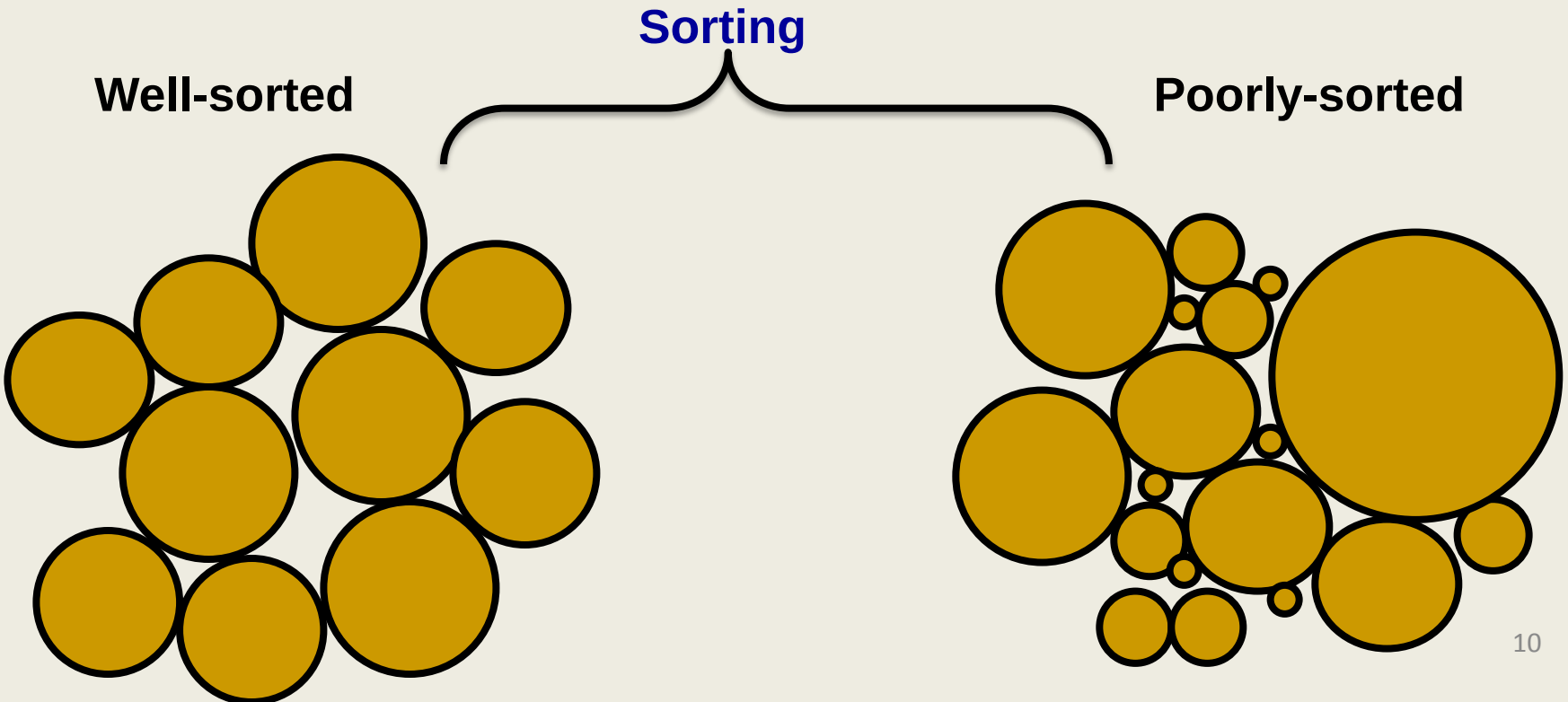
Ironstones and Evaporites

(Fig. b) chemical rock (Halite)

4- Transport affects the sediment in several ways

1. ***Sorting*:** measure of the variation in the range of grain sizes in a clastic rock or sediment

- Well-sorted sediments:- indicate that they have been subjected to prolonged water or wind action. Fig. 6
- Poorly-sorted sediments:- are either not far-removed from their source or deposited by glaciers. Fig. 6



2. ***Roundness*:** measure of how rounded the corners are (figure7).
3. ***Sphericity*:** measure of how much it is like a sphere (Figure 7).

Sorting, roundness, and sphericity all increase with amount of transport.

5- From sediment to sedimentary rock (lithification)

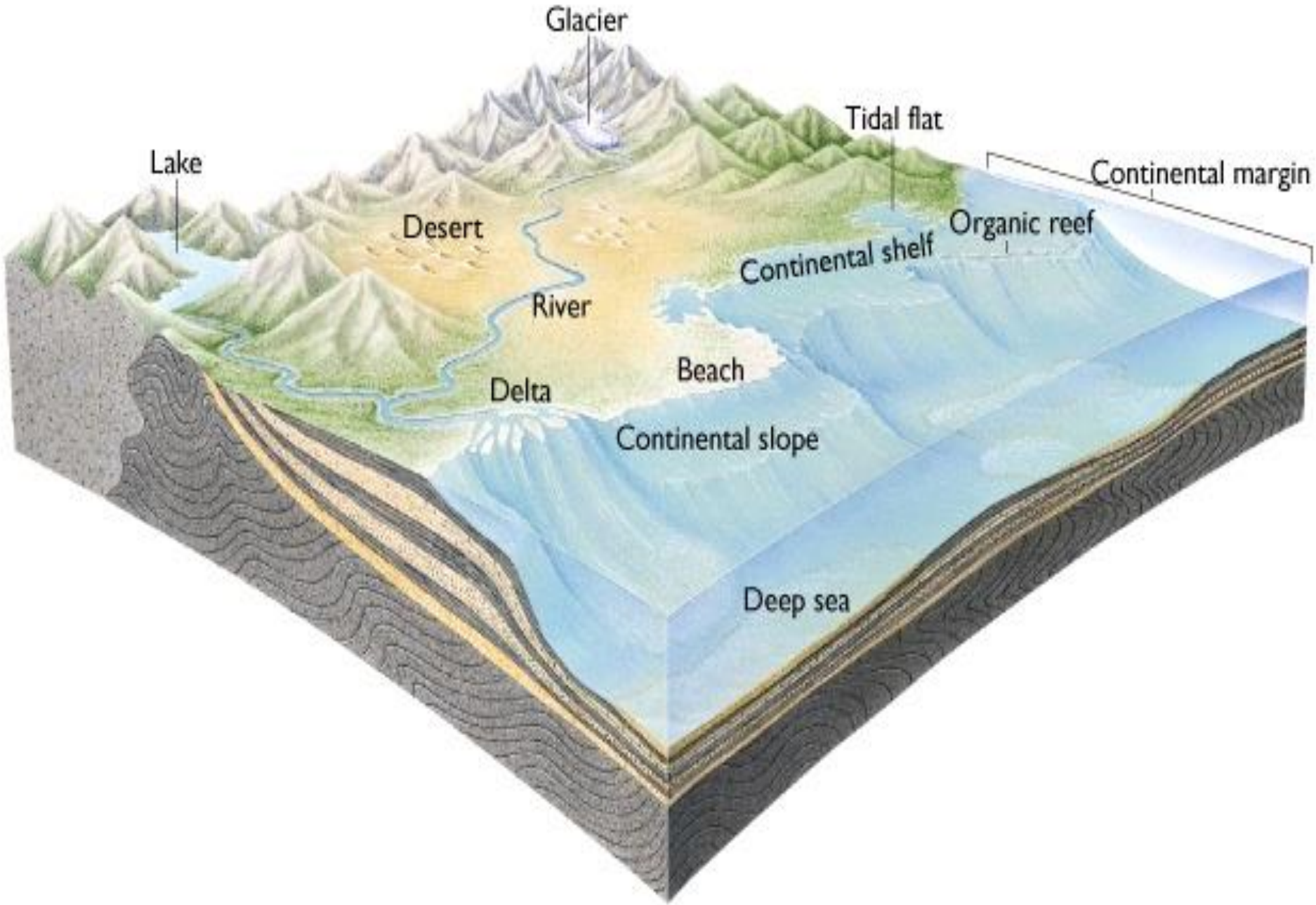
Lithification is the process in which sediments compact under pressure, expel connate fluids, and gradually become solid rock.

- ***Compaction*:** reduces pore space. Clays and muds are up to 60% water 10% water after compaction (Figure 8a).

- ***Cementation*:** chemical precipitation of mineral material between grains (SiO_2, $CaCO_3$, Fe_2O_3) binds sediment into hard rock (Figure 9b).

- ***Recrystallization*:** *P* and *T* increase with burial 30°C/km or 1°C/33 m (Figure 9c).

6- Common Sedimentary Environments



1-5 Grain Morphology:-

Three aspects of grain morphology are the *shape, sphericity and roundness*. The shape or form of grain is measured by various ratios of the long, intermediate and short axes and descriptive terms for the *four classes based on theses rations are oblate(tabular) , equant (cubic), bladed and prolate (rod shaped*).

*Sphericity i*s a measure of how closely the grain shape approaches that of a sphere.

Roundness is concerned with the curvature of the corners of a grain and six classes from 1-very angular 2-angular 3-subnagluar 4-subrounded 5 -rounded to 6-well rounded are usually measured. *Here for environmental interpretations the roundness is more significant than sphericity or form*.

The morphology of grains is dependent on many factors :-

1-Initially the mineralogy.

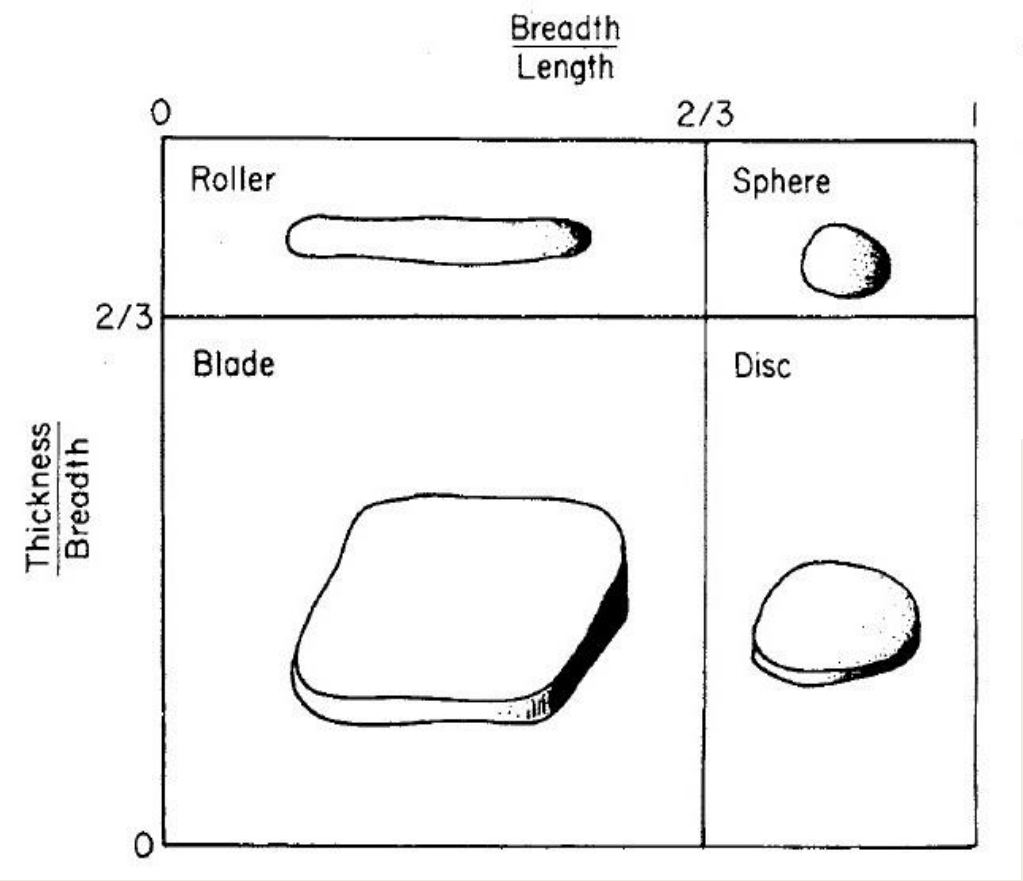
2-Nature of the source rock and degree of weathering (Physical & chemical).

3-Degree of abrasion during transportation.

4-Corrosion or solution during diagenesis.

In general way the roundness increases with the duration of transportation or reworking.

For example Beach and Desert sands is more and better rounded than river sands or glacial out wash sands.



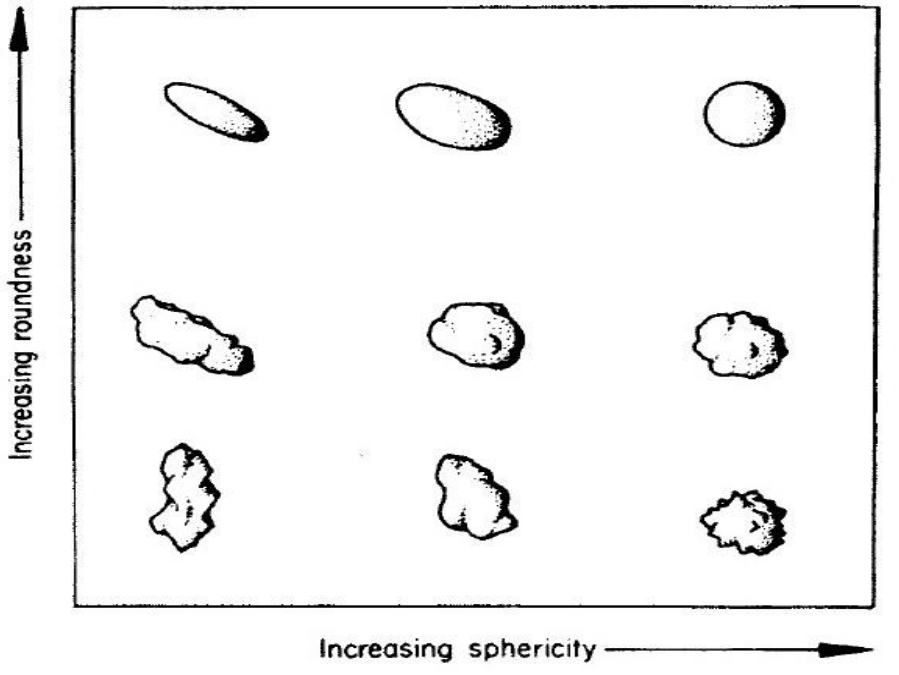


Figure 10: according to a scheme devised by Zingg (1935). Measurements of the ratios betweenlength, breadth, and thickness are used to define four classes: spherical (equant), oblate(disk or tabular), blade, and prolate (roler).

1-6 Process which affects shape of grains

- During the depositional history from the source area towards the deep sea, many processes affect the grains, these are:-

1. Distance of transportation from the source area
2. Kind of the rocks at source area
3. Nature of depositional environment
4. Subsequence events affect the grains
5. Re-deposition or reworking of grain
6. Hardness of the rock
7. Mineral composition of the rock or grains
8. Texture of the grain (fine, Corse or medium)
9. Sedimentary structure and deformation structure
10. Nature of the floor from which the transportation of the grain takes place
11. Intensity of the process of different medium of transportation (water, wind, glacial and gravity)
12. Mechanical resistance of particle

Surface texture :- the minor or micro relief feature of the grain surface, which are independent on size and shape

-kinds of surface texture are :-

*** V-shape pits:-** maybe produced by chemical etching and grain impact

*** Abration patterns:-** which are characteristic of glacial eolian .(striation)

*** Shiny surface (Desert varnish):-** such as cloud covers the grain surface, because of fine abraion or desert oil

Factors affecting surface texture are:-

1. internal structure of grains
2. impact with other grains
3. chemical solution
4. re-deposition
5. medium of transportation (wind, water, glacial and gravity).

Packing:- its arrangement of the solid particle in sediment or sedimentary rock ,and reduction in bulk volume or thickness of the pore space within the body of fine grained sediment ,due to increasing weight of the overlying loads ,that is continuously deposited, or the pressure resulting from earths movement within the crust .

1-7 Grain Fabric:-

The term grain fabric in a sedimentary rock refers to their *orientation and packing, and the nature of the boundaries between them*. In many sandstones and conglomerate and pebbles are aligned with their long axes in the same direction. The Packing of sediment grains is an important consideration since it affects porosity & permeability. Therefore *packing is largely dependent on the grain size, shape and sorting*.
Modern beach sands are composed of well sorted and rounded grains, have porosities from 25-65%. Poorly sorted sediments have a closer packing and thus a lower porosity through the greater range of grain size and filling of pore space between grains large grains by finer grains.

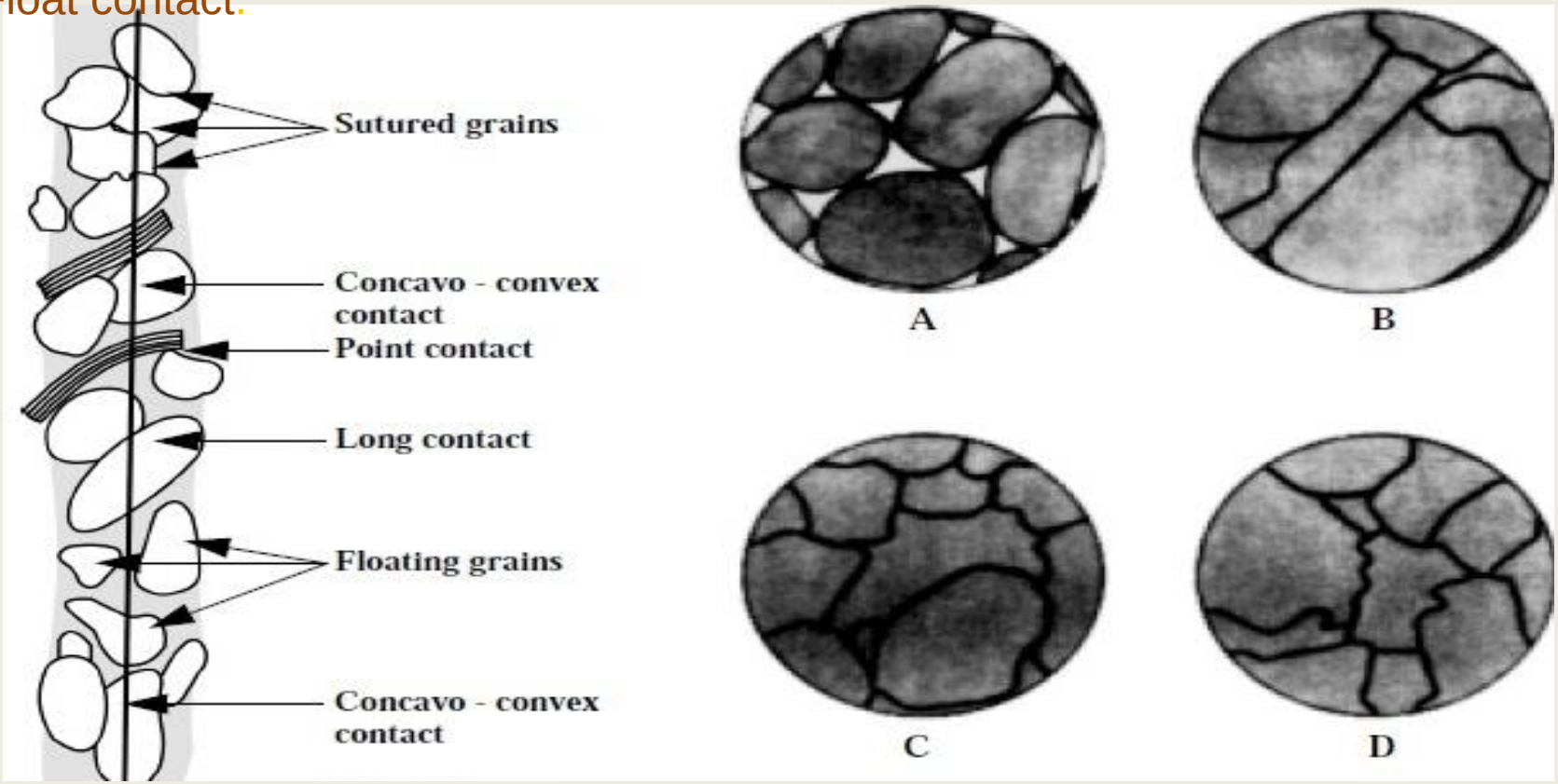
Sorting: is a measure of standard deviation i.e. spread of grain size distribution. Sorting is determined by several factors *1-sediment source , 2-grain size itself , 3-depositional mechanisms.*

Textural maturity:-

Texturally **Immature sandstones** are those *with much matrix contains, a poor sorting and angular grains;* **Mature** *are those where little or not matrix , moderate to good sorting and subrounded to rounded grains* , **Supermature sandstones** *are those with not matrix , very good sorting and well rounded*. Primary porosity and permeability increase with increasing textural maturity .

1-8 Grain contact in sedimentary rocks:-

- **sutured grains:-** its sutured line between the grains , because of solution of the outer part of grain (Figure 11).
- **concavo-convex contact:-** formed because one grain (convex surface) has resistance more than the other (concave surface).
- **point contact:-** two grains meet or contact each other at a point.
- **long contact:-** two grains meet or contact each other along a line .
- Float contact.



(Figure 11) grain contact terminology a)point contact b)long contact c)concavo-convex d)sutured

1-9 Sandstone Maturity:-

The term maturity is applied to sandstones in two different ways. *Compositional maturity refers to the relative abundance of stable and unstable framework grains in a sandstones*. A sandstone composed mainly of quartz is considered compositionally mature, where as a sandstone that contains abundant unstable minerals (e.g. feldspar or rock fragments) is immature compositional. *Textural maturity is determined by the relative abundance of matrix and the degree of rounding and sorting of framework grains (Boggs, 2006) .*Textural maturity can range from *immature high content of feldspar and rock fragments(much clay, poorly sorted and poorly rounded) enrichment of Al_2O_3 and host of trace elements are anticipated in a very fine grained fraction, where as enrichment of SiO_2 and K_2O and host of heavy minerals associated elements will be expected in medium to coarse grained* (Fig.12*). Mature* sandstones have grains that subangular to subrounded. Virtually no feldspar or rock fragments (except possibly chert) occur in mature or supermature sandstone. *Supermature* (little clay, sand framework is well sorted, and well rounded) with high percentage of SiO_2 (Figure 12).

There are three problems in its application in maturity of sandstones , however **1st** *the roundness of quartz sand is controlled in part by depositional environment*. **2nd** problem occur when there is mixing of sediment from different environment. **3rd** *problem is that clay matrix can be produced after burial in sandstones that contain chemically unstable grains*. (Folk, 1974,Pettijohn et al.,1987, Boggs, 2006) concluded that the most important part of sorting is the removal of clay thus high textural maturity.

$$\text{Mineralogical maturity} = \frac{\text{Quartz} + \text{Chert}}{\text{Feldspar + rock fragments}}$$

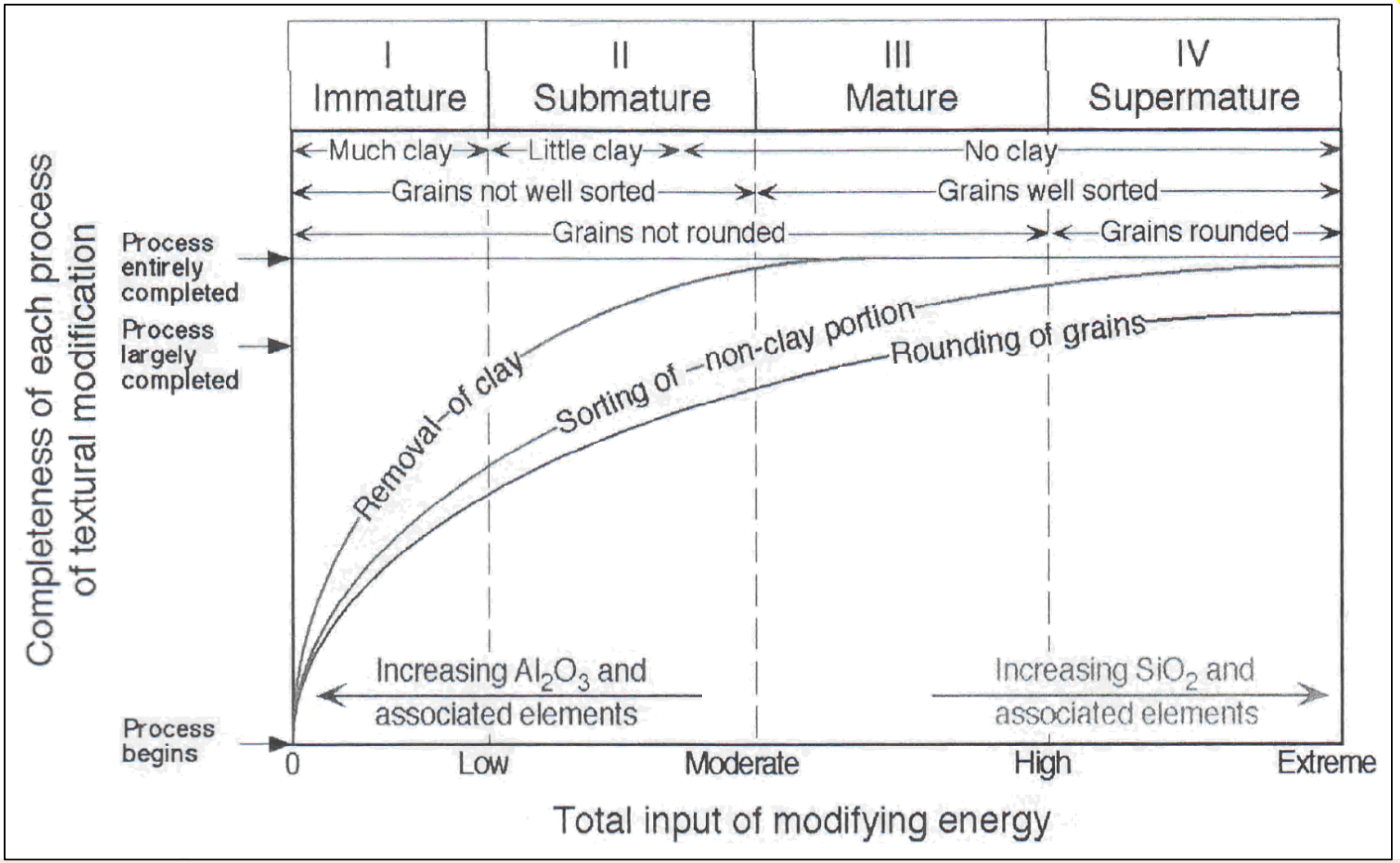


Figure 12: Textural maturity classification of a sands as a function of input of kinetic energy (From Folk,1951)

According to Folk, mature sandstones particularly common in fluvial channels. Mature to supermature sandstones are also common in beaches an eolian dunes, because of the high energies and abrasive potential of these environments. See (Fig. 13).

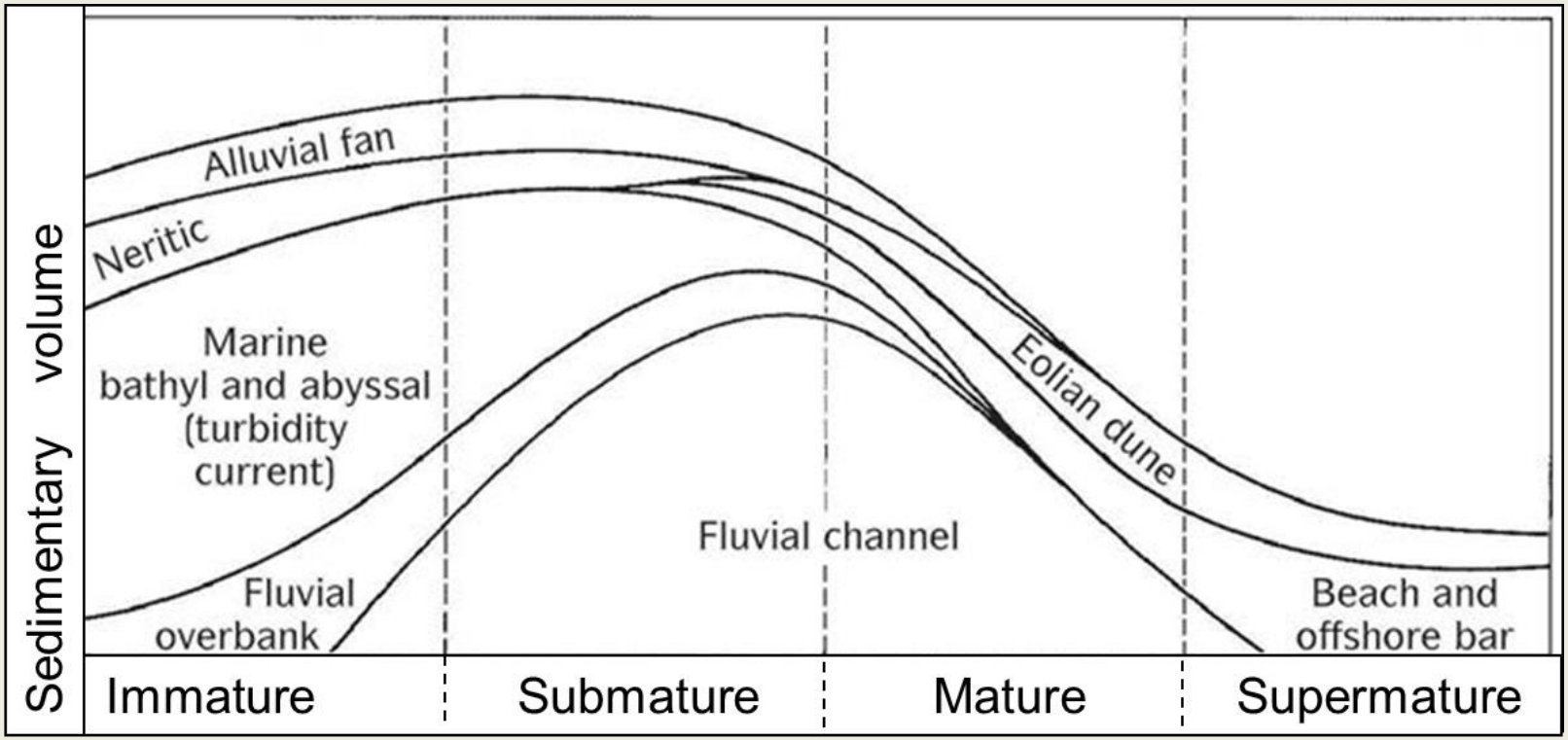


Figure 13: A particular sedimentary environment often has sands of characteristics maturity. Fluvial overbank, marine turbidity and neritic sands tend to be immature. Fluvial channel tend to be submature to mature. Eolian and beach sands tend to be mature to supermature sands. (After Folk, 1951).

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