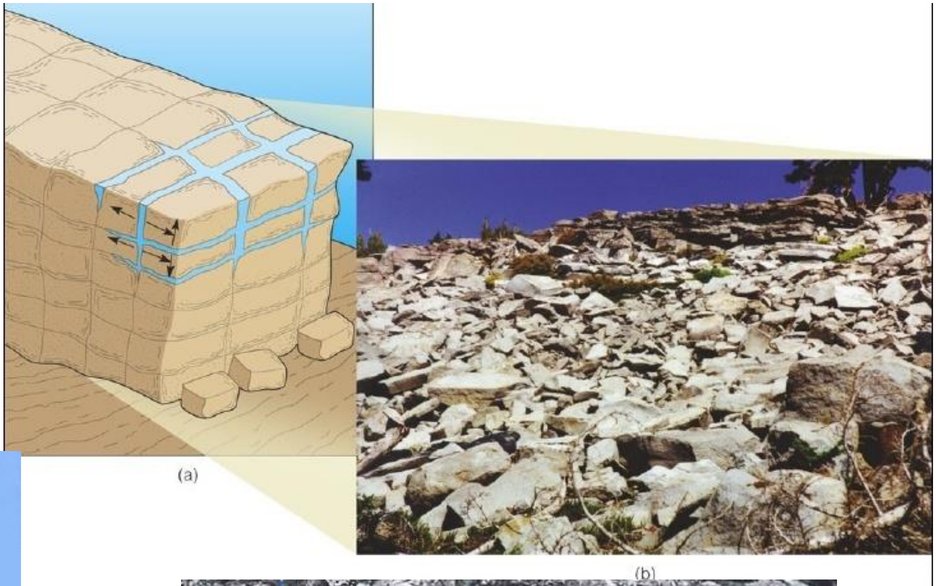
Sedimentary Rocks

The Prologue

Weathering → **Mechanical (particularly important in very cold or dry climate)**

↓

Chemical



The Chemistry of Weathering

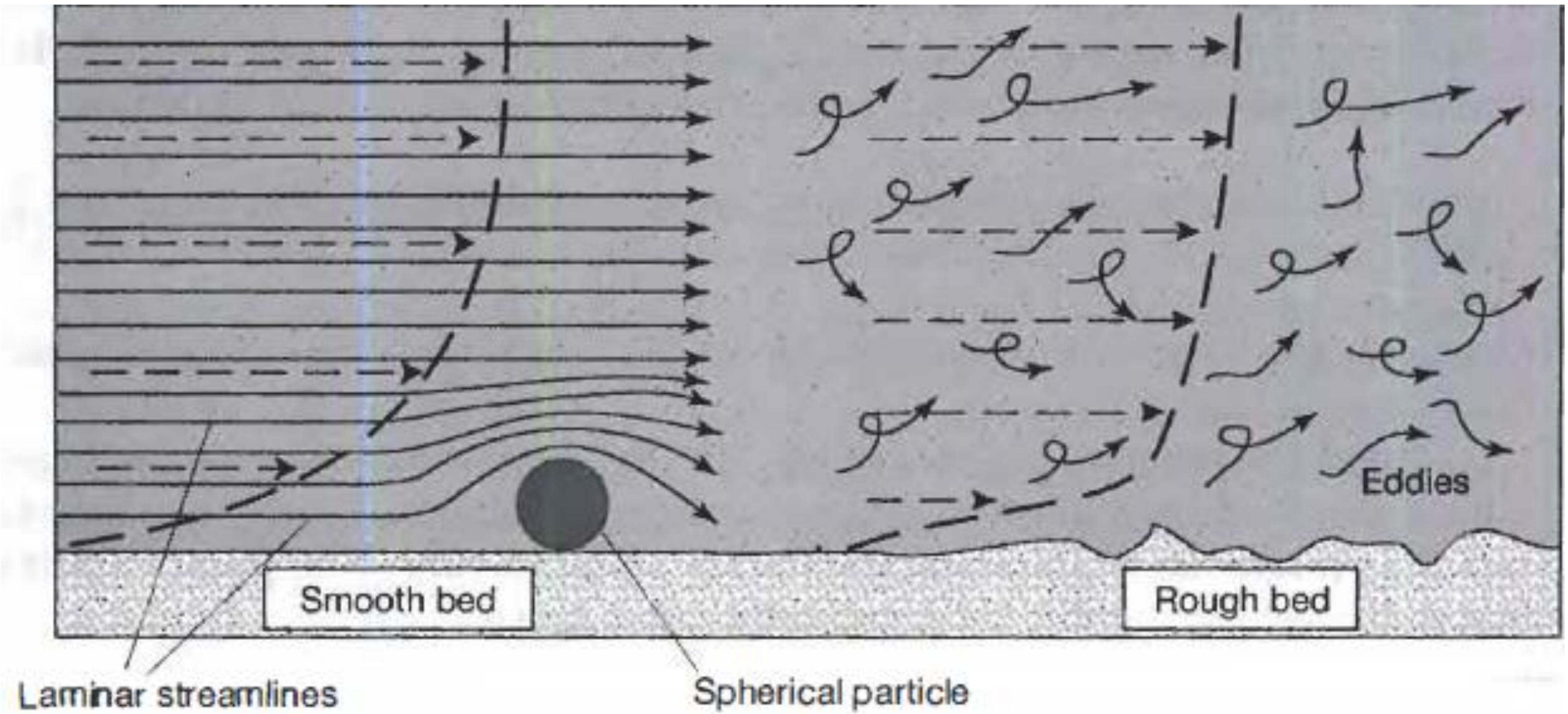
Most important processes	Examples	Principal kinds of rock materials affected
Simple (congruent) Solution—Dissolution of soluble minerals in H_2O (direct solution) or in $H_2O + CO_2$ (carbonation) to yield cations and anions in solution	$SiO_2 + 2H_2O \rightarrow H_4SiO_4$ (direct solution) (quartz) (silicic acid) aq	Highly soluble minerals (e.g., gypsum, halite), quartz
	$CaCO_3 + H_2O + CO_2 \leftrightarrow Ca^{2+} + 2HCO_3^-$ (Carbonation) (calcite) aq aq	Carbonate rocks
Hydrolysis (incongruent dissolution)—Reaction between H^+ and OH^- ions of water and the ions of silicate minerals, yielding soluble cations, silicic acid, and clay minerals (if Al present)	$2KAlSi_3O_8 + 2H^+ + 9H_2O \rightarrow H_4Al_2Si_2O_9 + 4H_4SiO_4 + 2K^+$ (orthoclase) aq (kaolinite) (silicic acid) aq	Silicate minerals
	$2NaAlSi_3O_8 + 2H^+ + 9H_2O \rightarrow H_4Al_2Si_2O_9 + 4H_4SiO_4 + 2Na^+$ (albite) aq (kaolinite) (silicic acid) aq	
Oxidation—Loss of an electron from an element (commonly Fe or Mn) in a mineral, resulting in the formation of oxides or hydroxides (if water present)	$2FeS_2 + 15/2O_2 + 4H_2O \rightarrow Fe_2O_3 + 4SO_4^{2-} + 8H^+$ (pyrite) (hematite) aq aq	Iron- and manganese-bearing silicate minerals, iron sulfides
	$MnSiO_3 + 1/2O_2 + 2H_2O \rightarrow MnO_2 + H_4SiO_4$ (rhodonite) (pyrolusite) (silicic acid)	
Other Processes		
Hydration and Dehydration—Gain (hydration) or loss (dehydration) of water molecules from a mineral, resulting in formation of a new mineral	$Fe_2O_3 + H_2O \leftrightarrow 2FeOOH$ (hydration) (hematite) (goethite)	Ferric oxides
	$CaSO_4 \cdot 2H_2O \leftrightarrow CaSO_4 + 2H_2O$ (dehydration) (gypsum) (anhydrite)	Evaporites
Ion Exchange—Exchange of ions, principally cations, between solutions and minerals	K-clay + Mg^{2+} $\leftrightarrow$ Mg-clay + K^+ Ca-zeolite + Na^+ $\leftrightarrow$ Na-zeolite + Ca^{2+}	Clay minerals and zeolites
Chelation—Bonding of metal ions to organic molecules having ring structures	Metal ions (cations) + chelating agent (e.g., secreted by lichens) $\rightarrow$ H^+ ions + chelate (metal ions/organic molecules in solution)	Silicate minerals

Submarine Weathering Processes and Products

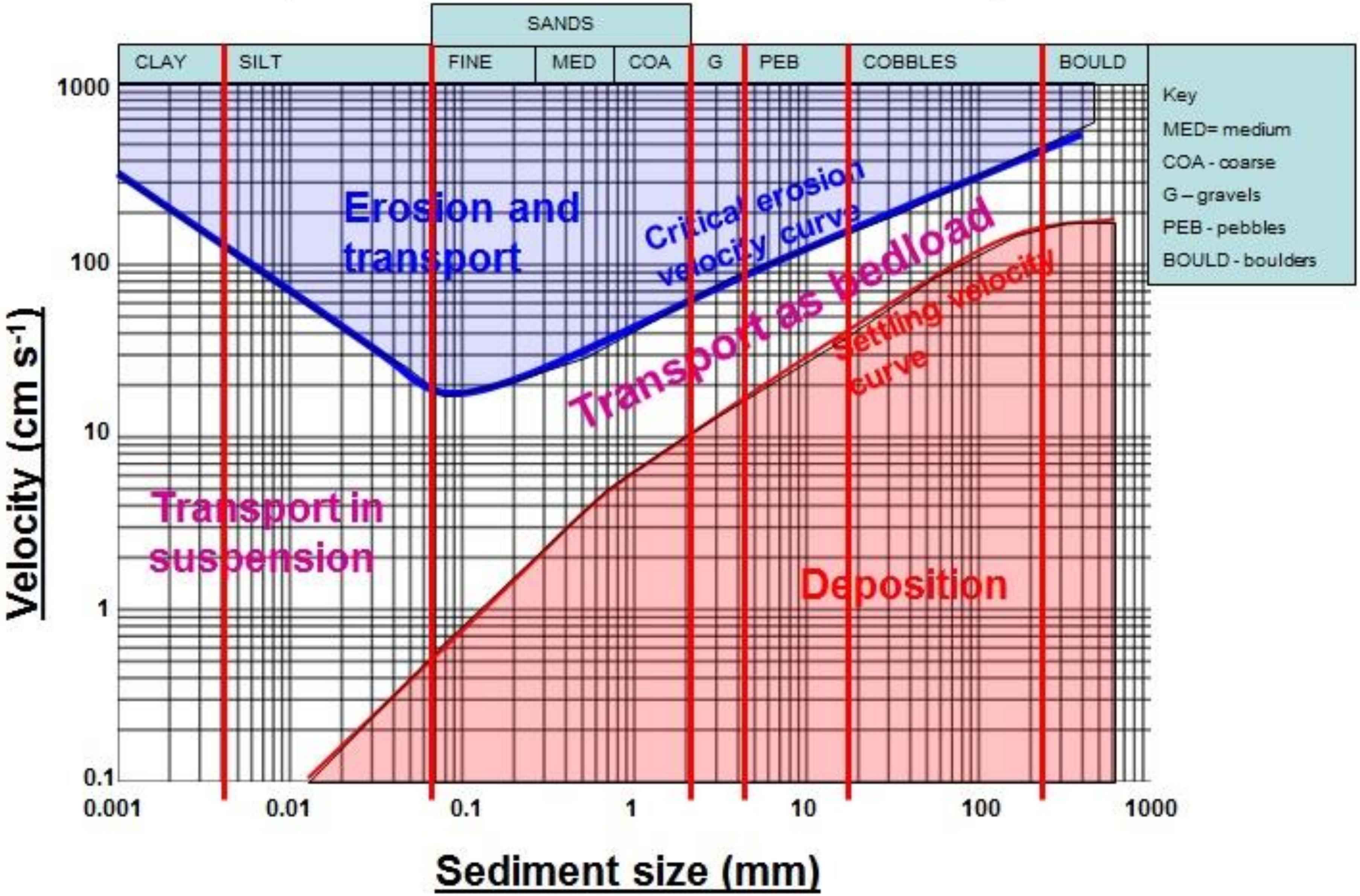
Alteration of ocean rocks occurs both at low temperature (<20°C) as well as at high temperature (~350°C)

As a result of submarine weathering, chemical elements are exchanged between rock and seawater and large mass of seawater becomes fixed in the oceanic crust in the form of altered hydrous minerals

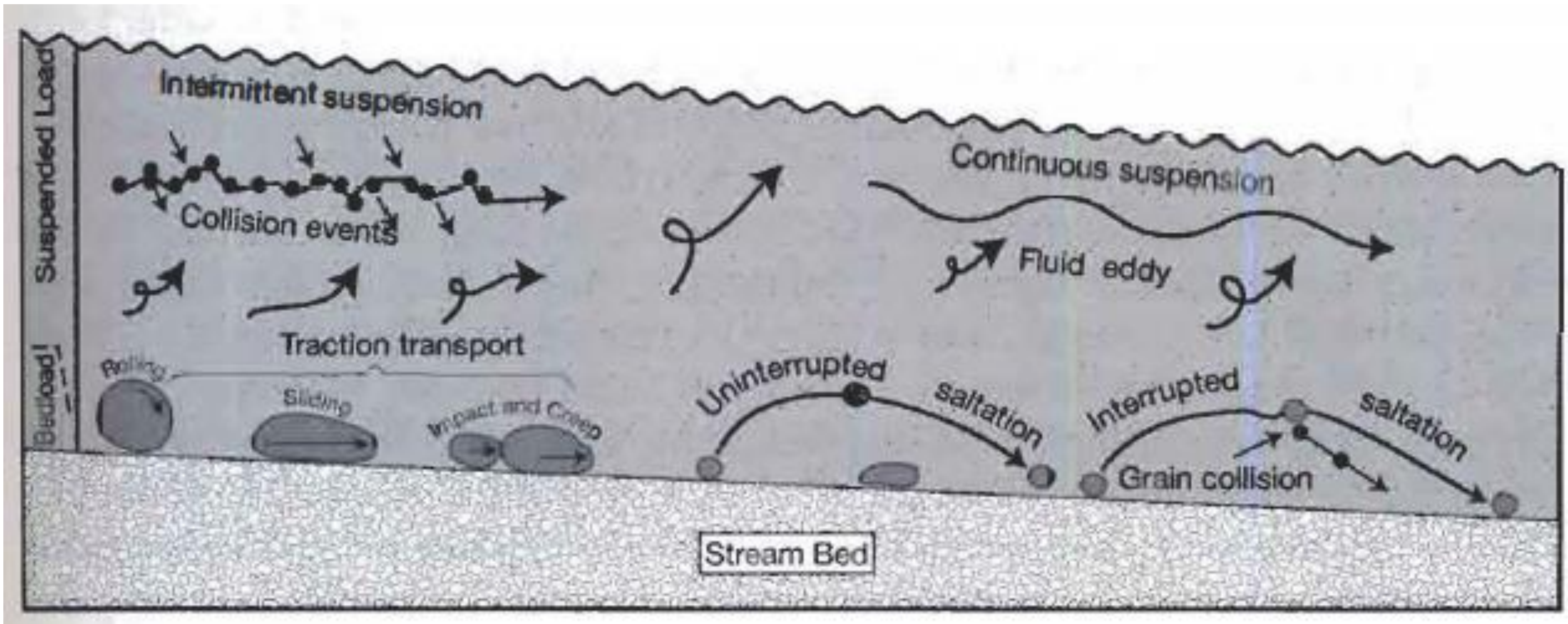
Fluid Flow- Laminar vs. Turbulent



The Hjulström curve

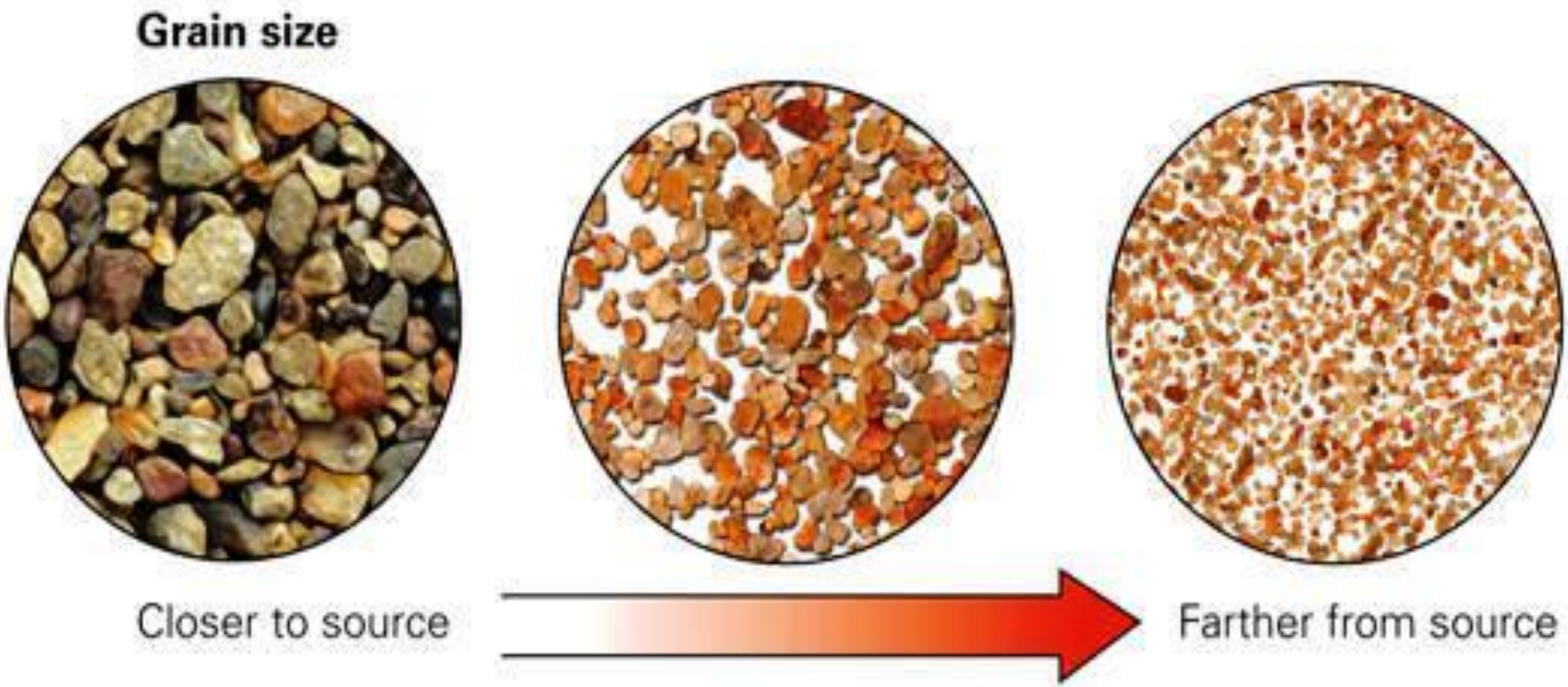


Sediment Transport Path

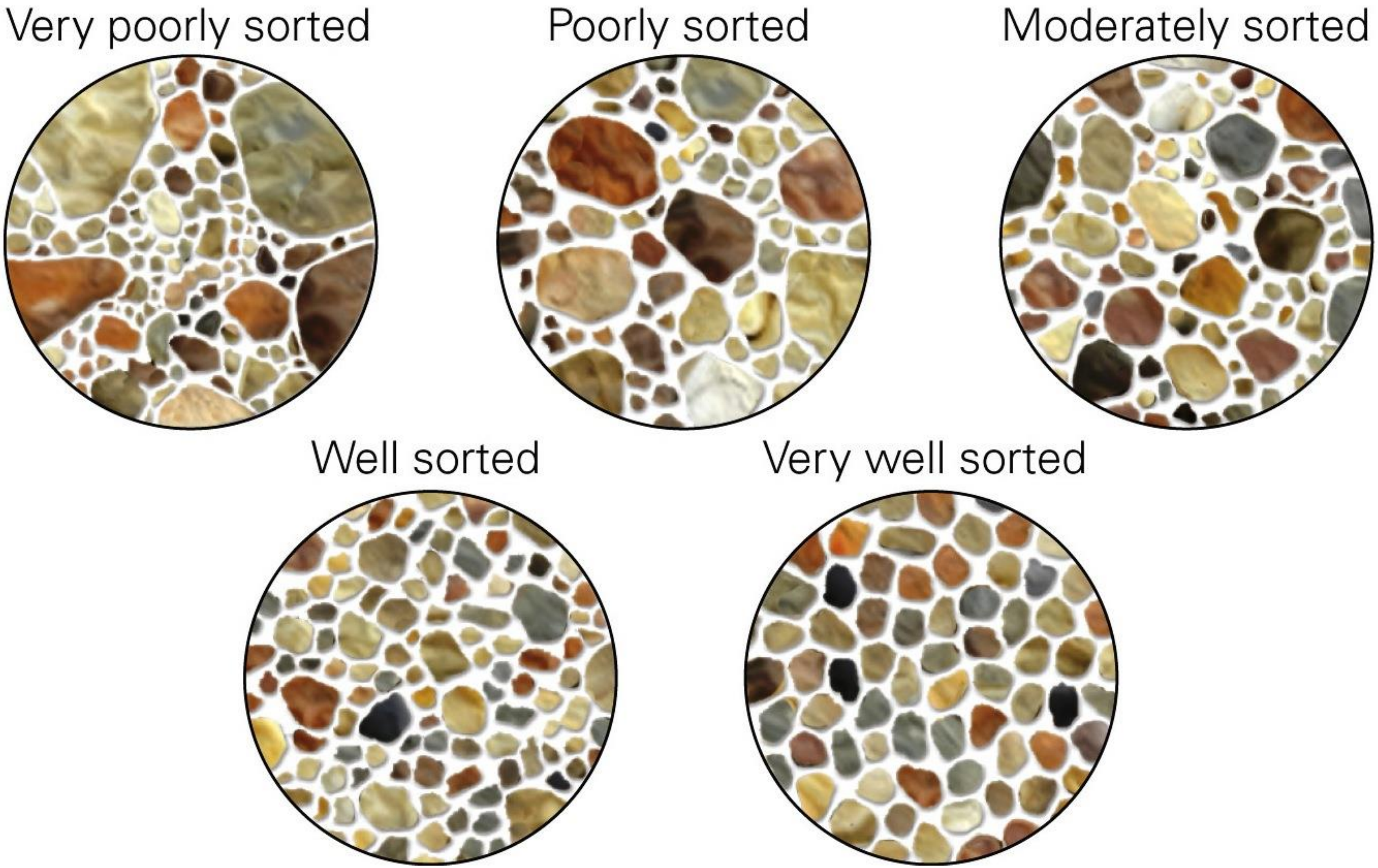


Texture-Grain Size

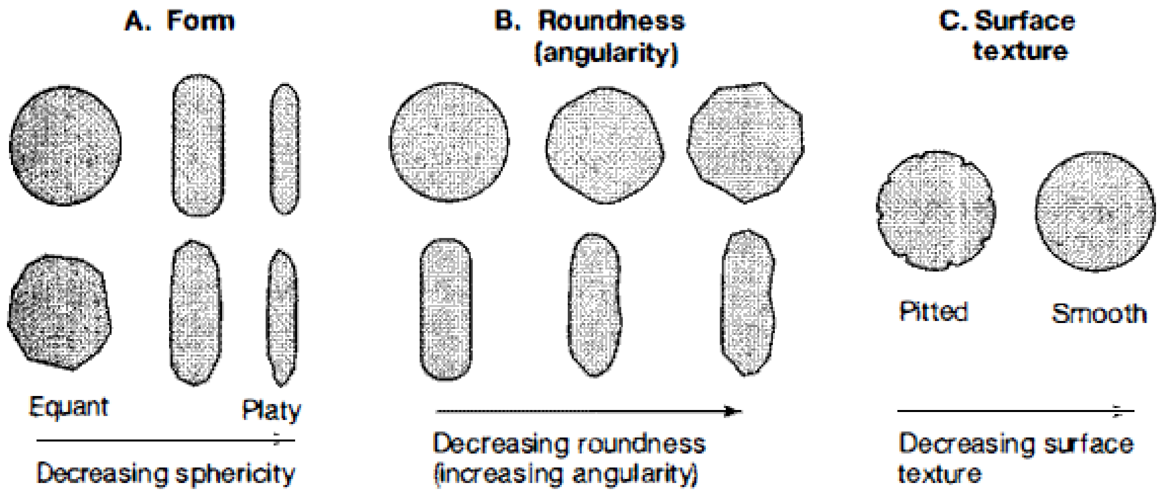
	U.S. standard sieve mesh	Millimeters		Phi (ϕ) units	Wentworth size class
GRAVEL		4096		−12	Boulder
		1024		−10	
		256	256	−8	
		64	64	−6	Cobble
		16		−4	Pebble
	5	4	4	−2	
	6	3.36		−1.75	Granule
	7	2.83		−1.5	
	8	2.38		−1.25	
	10	2.00	2	−1.0	
SAND	12	1.68		−0.75	Very coarse sand
	14	1.41		−0.5	
	16	1.19		−0.25	
	18	1.00	1	0.0	
	20	0.84		0.25	Coarse sand
	25	0.71		0.5	
	30	0.59		0.75	
	35	0.50	½	1.0	
	40	0.42		1.25	Medium sand
	45	0.35		1.5	
	50	0.30		1.75	
	60	0.25	¼	2.0	
	70	0.210		2.25	Fine sand
	80	0.177		2.5	
	100	0.149		2.75	
	120	0.125	⅛	3.0	
	140	0.105		3.25	Very fine sand
	170	0.088		3.5	
	200	0.074		3.75	
	230	0.0625	1/16	4.0	
MUD – SILT	270	0.053		4.25	Coarse silt
	325	0.044		4.5	
		0.037		4.75	
		0.031	1/32	5.0	
		0.0156	1/64	6.0	Medium silt
		0.0078	1/128	7.0	Fine silt
		0.0039	1/256	8.0	Very fine silt
MUD – CLAY		0.0020		9.0	Clay
		0.00098		10.0	
		0.00049		11.0	
		0.00024		12.0	
		0.00012		13.0	
		0.00006		14.0	

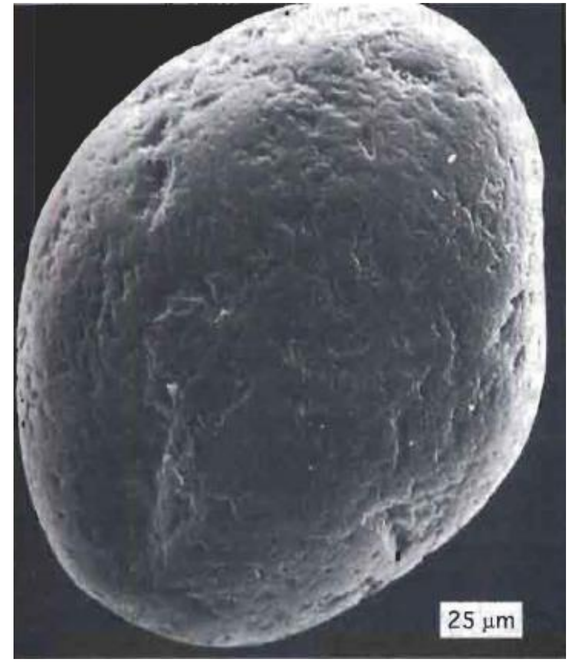

Grain size
Closer to source
Farther from source

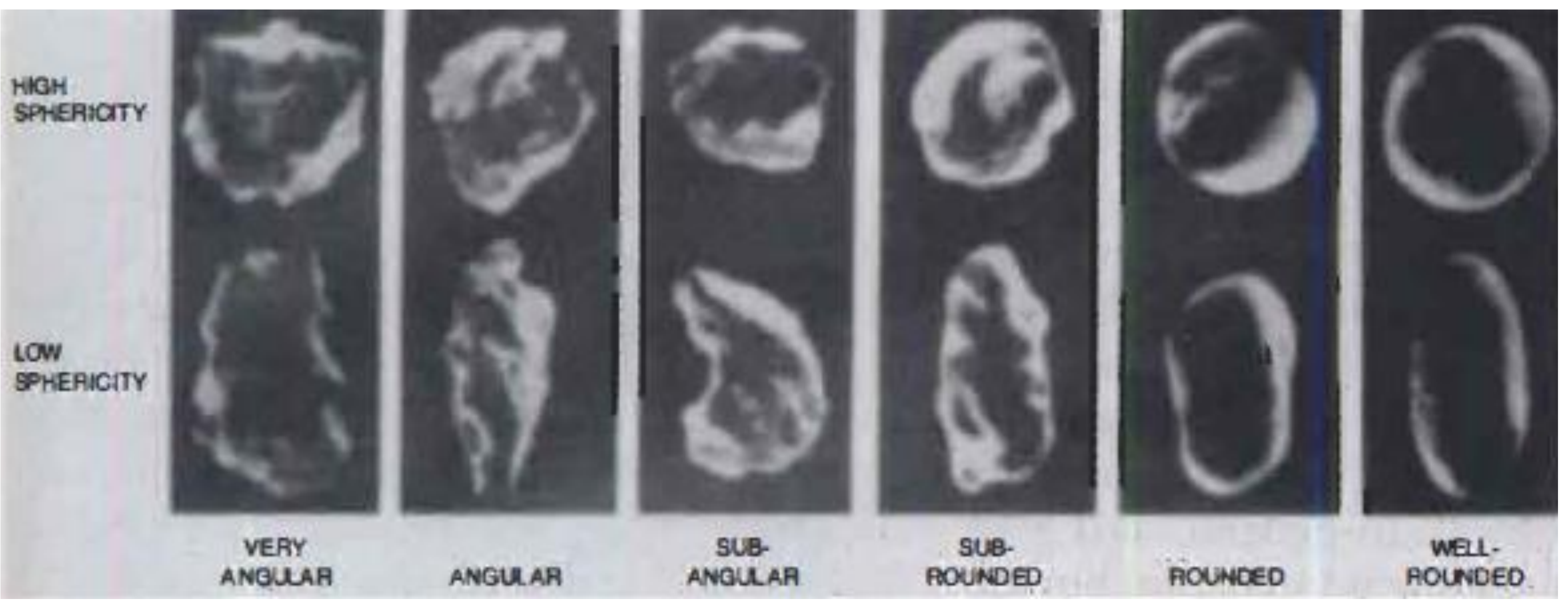
Texture- Grain Sorting



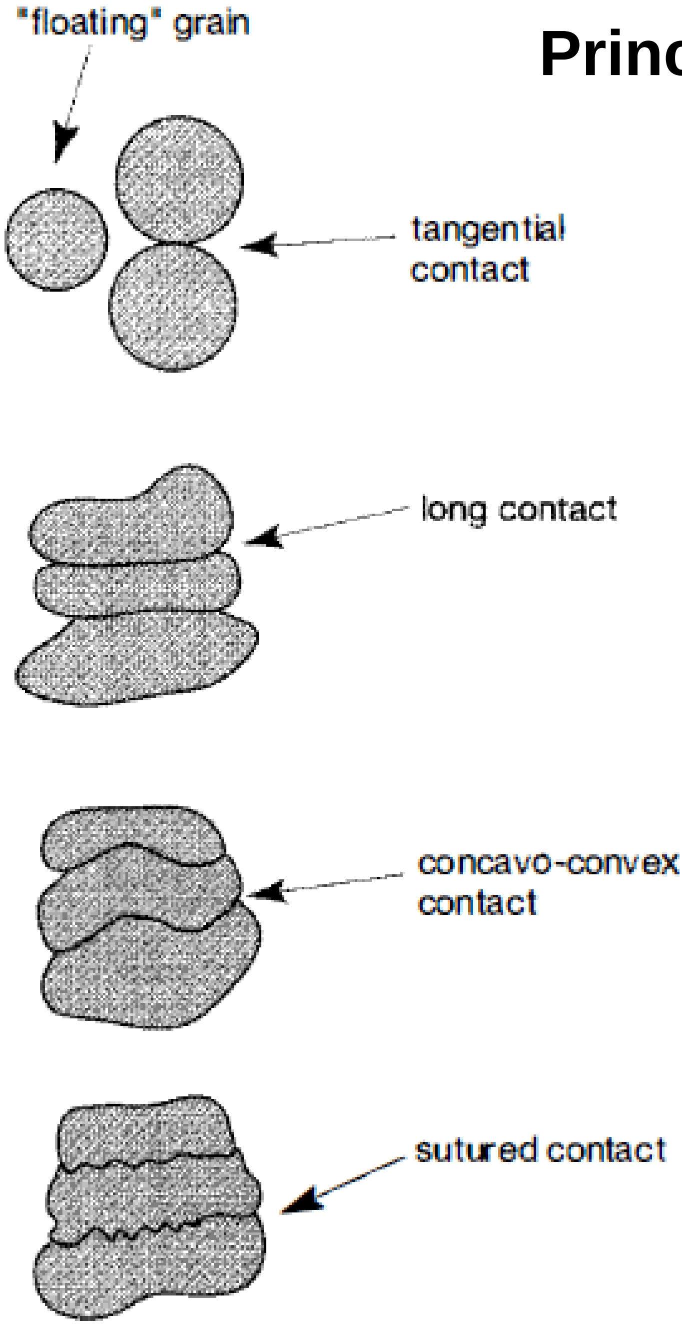
Texture- Roundness and Sphericity







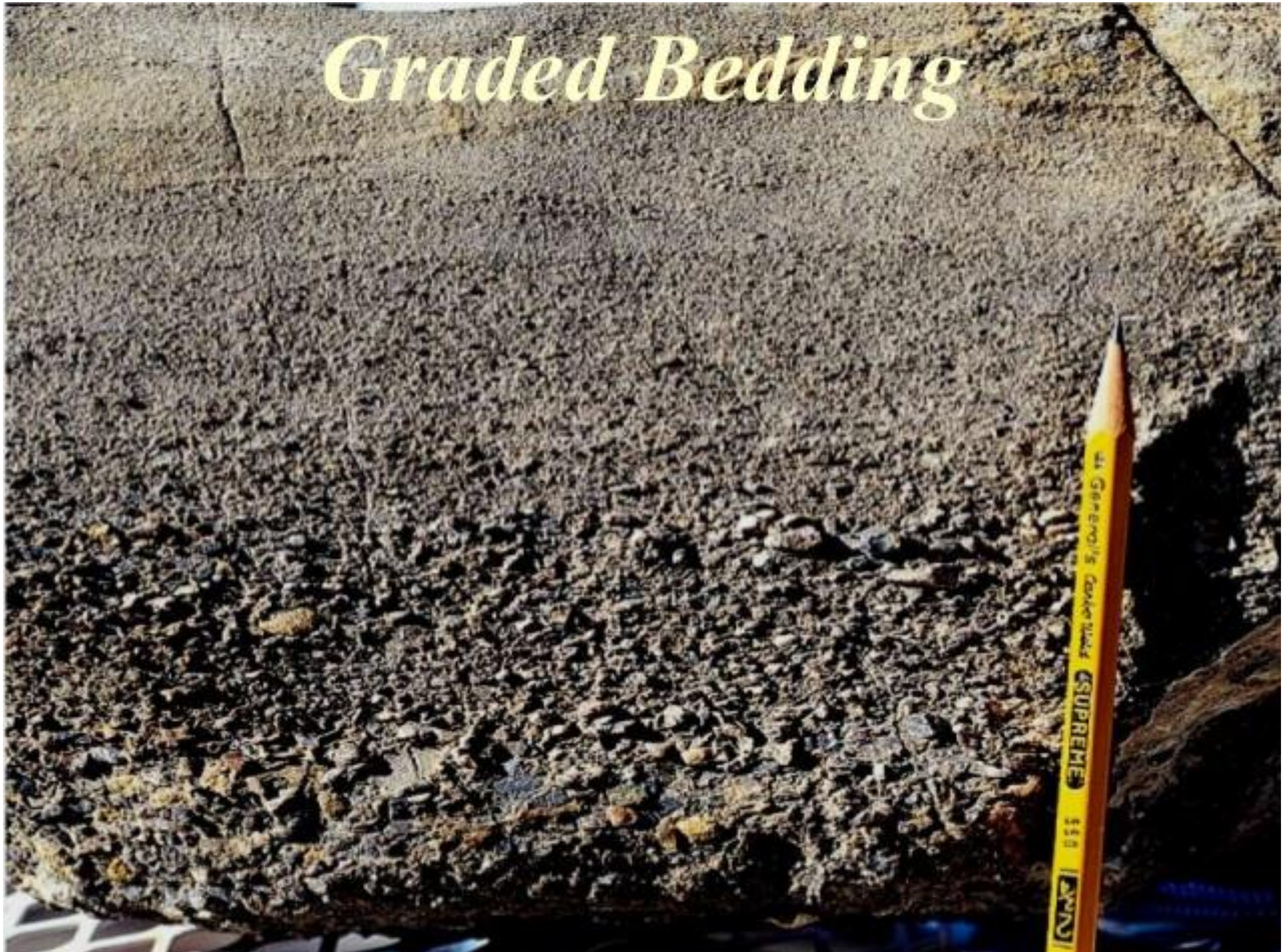
Principal kinds of Grain Contacts



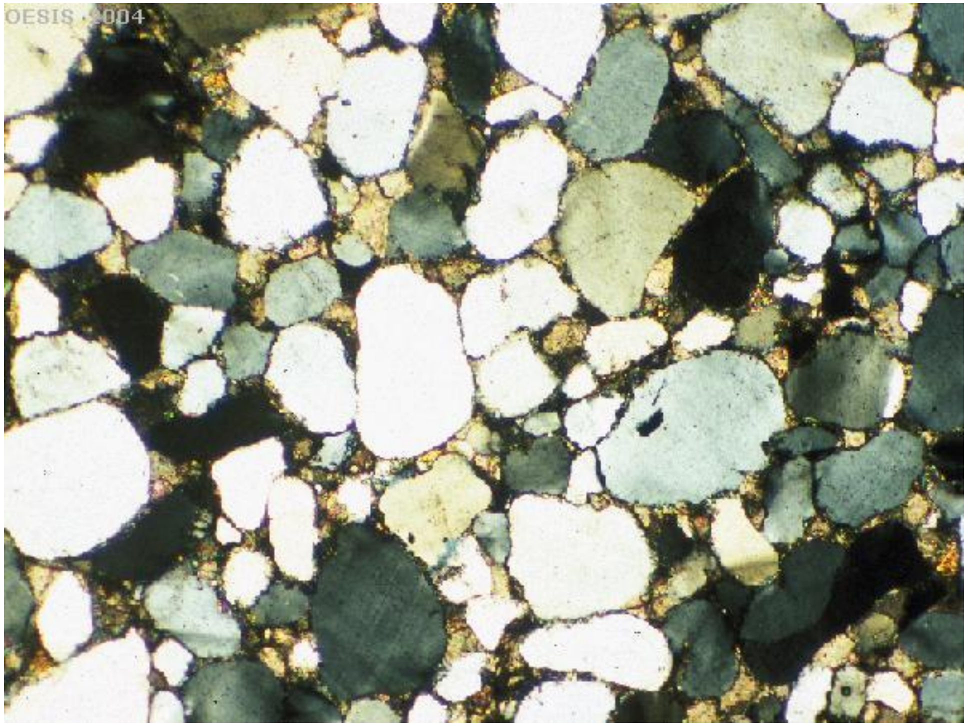
Sedimentary Structures- Bedding

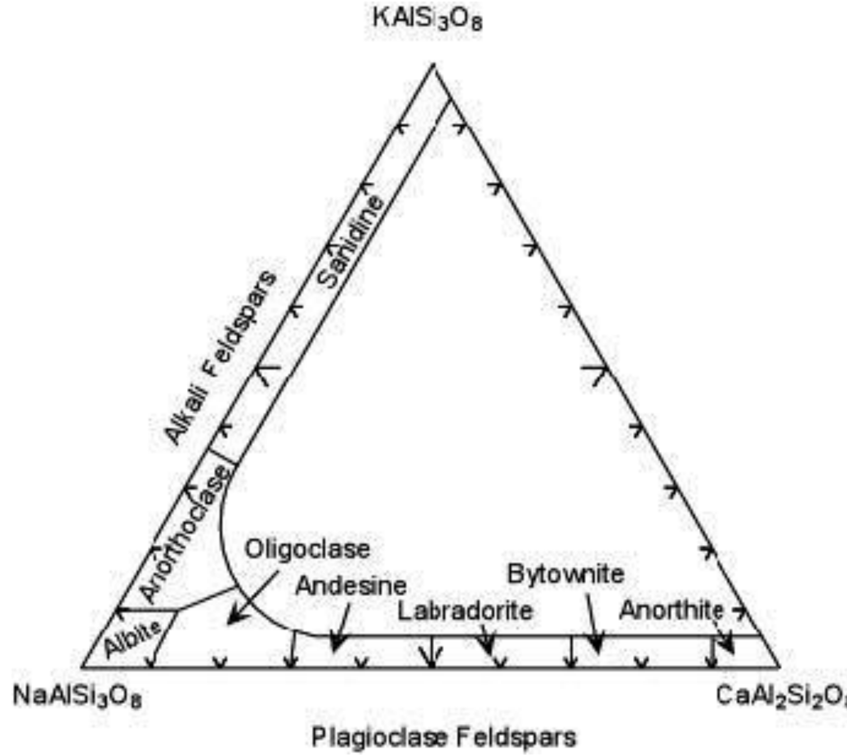
Laminated Bedding

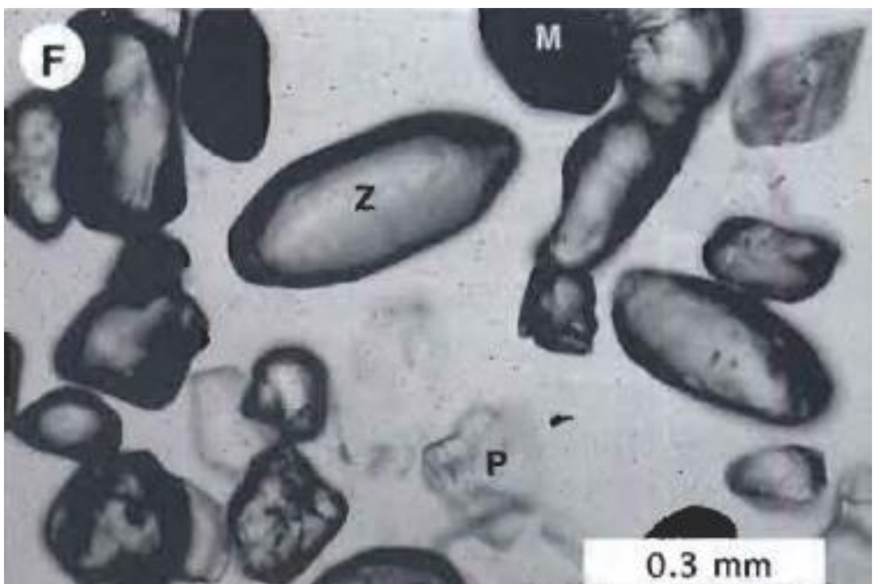
Graded Bedding

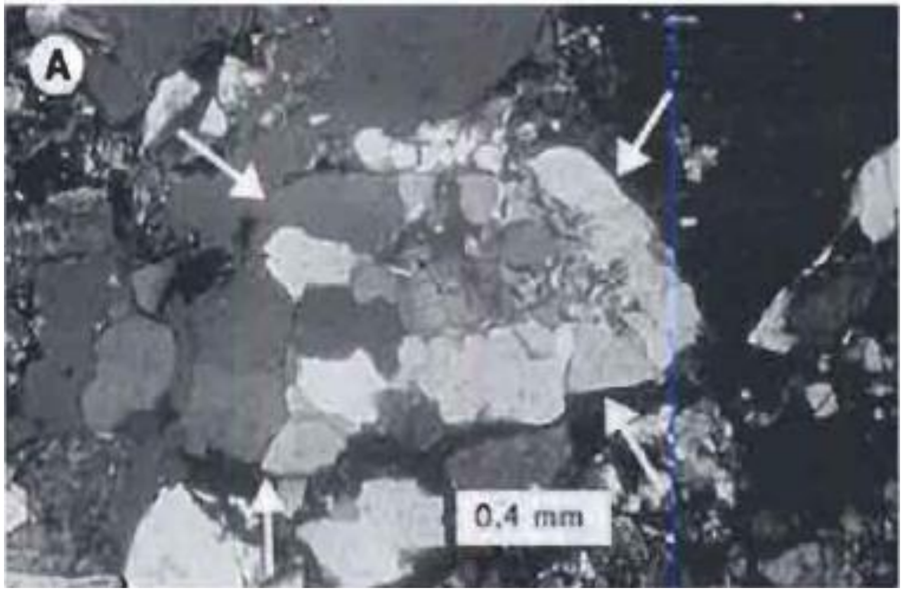


Massive Bedding


OESIS 2004

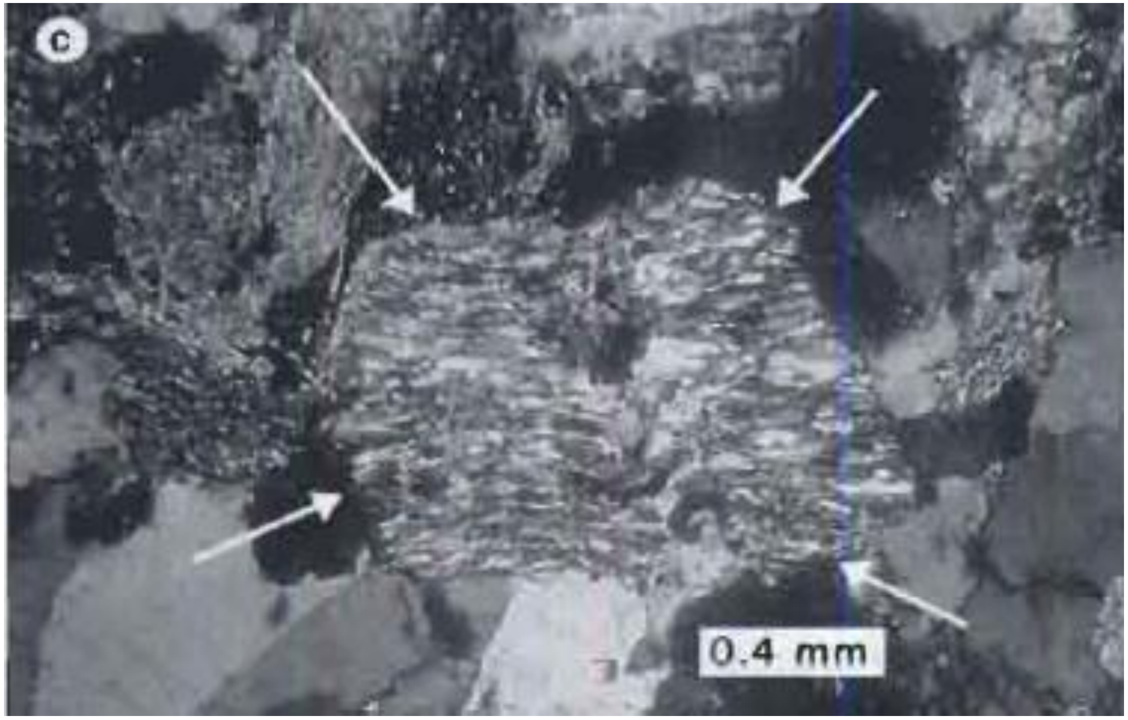

KAlSi3O8
Alkali Feldspars
Sanidine
Anorthoclase
Albite
Oligoclase
Andesine
Labradorite
Bytownite
Anorthite
NaAlSi3O8
CaAl2Si2O8
Plagioclase Feldspars


F
M
Z
P
0.3 mm



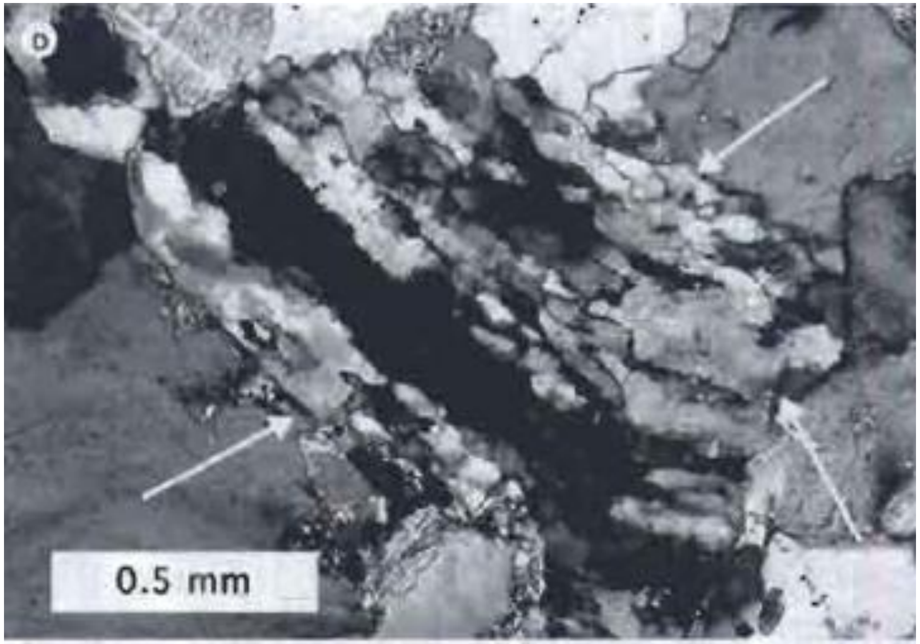
Plutonic

Volcanic

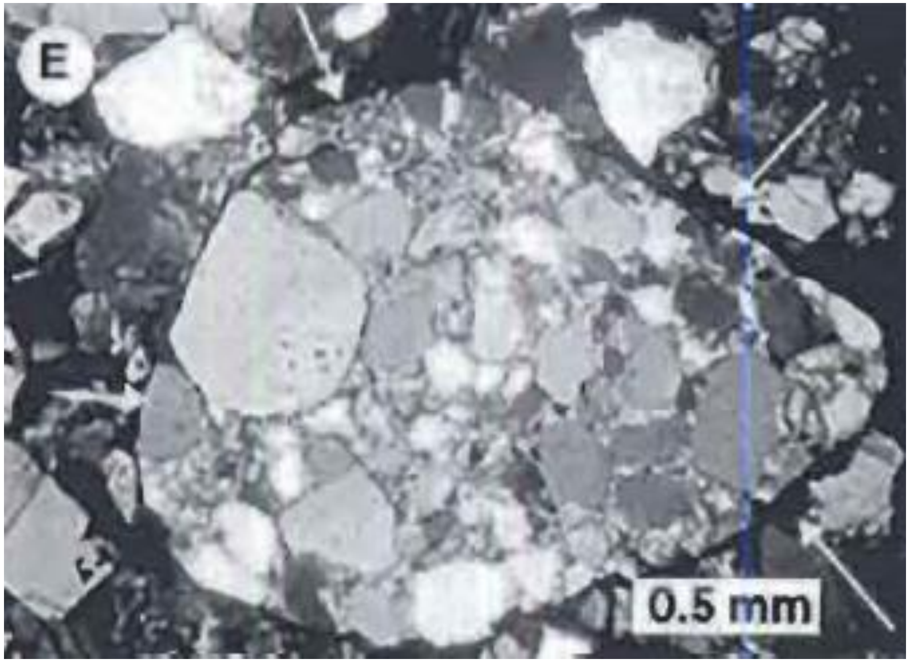


Lithic Fragments

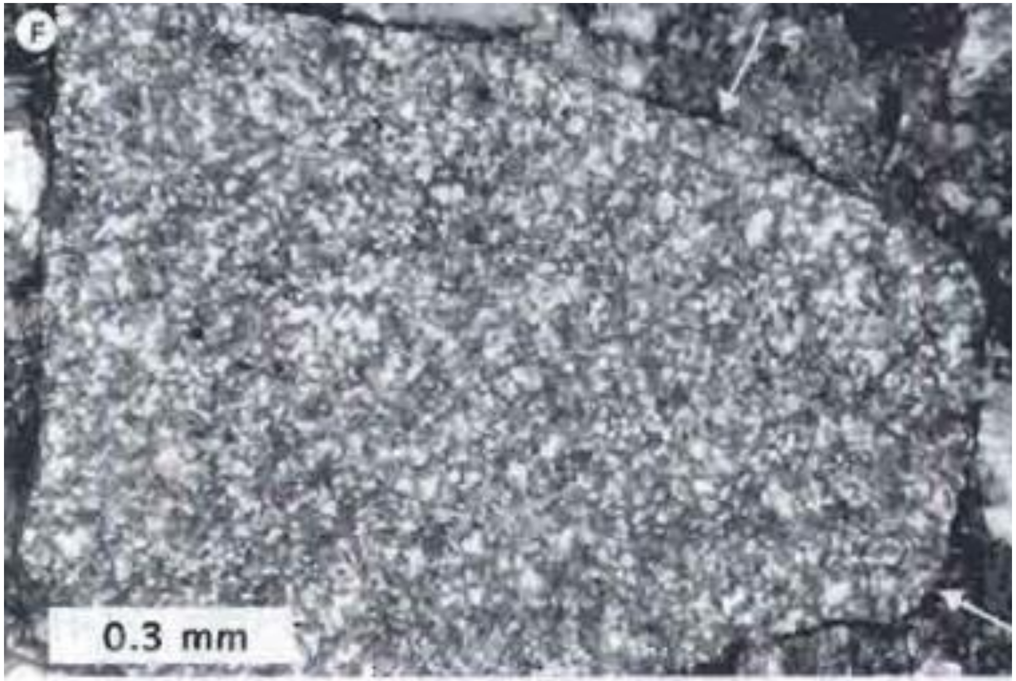
Metamorphic schist



Metamorphic Quartzite



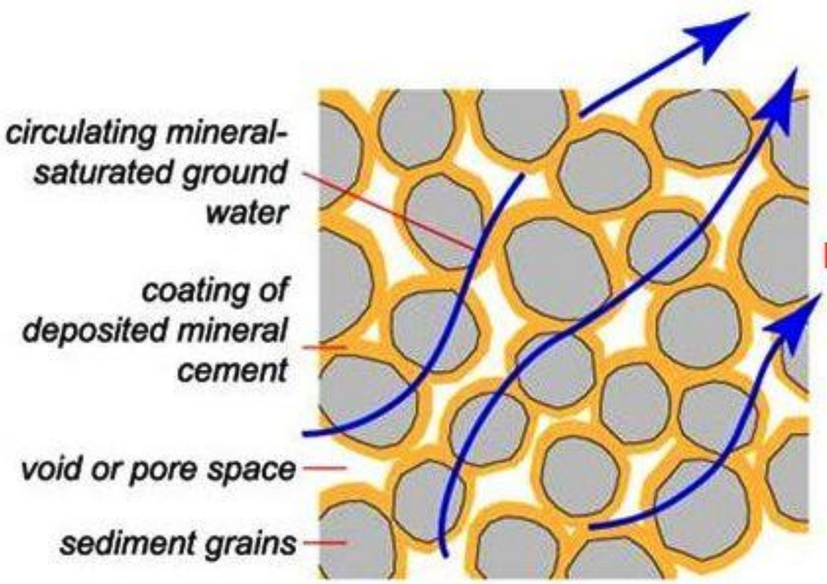
Sandstone



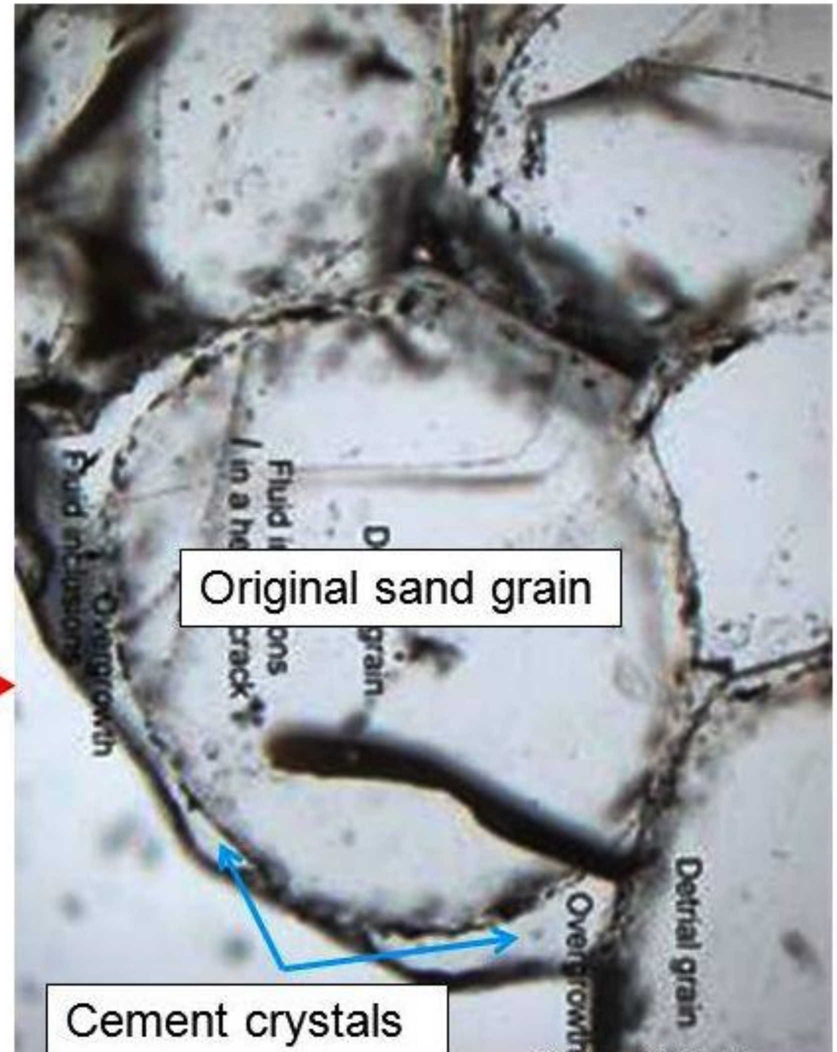
Lithic Fragments

Chert

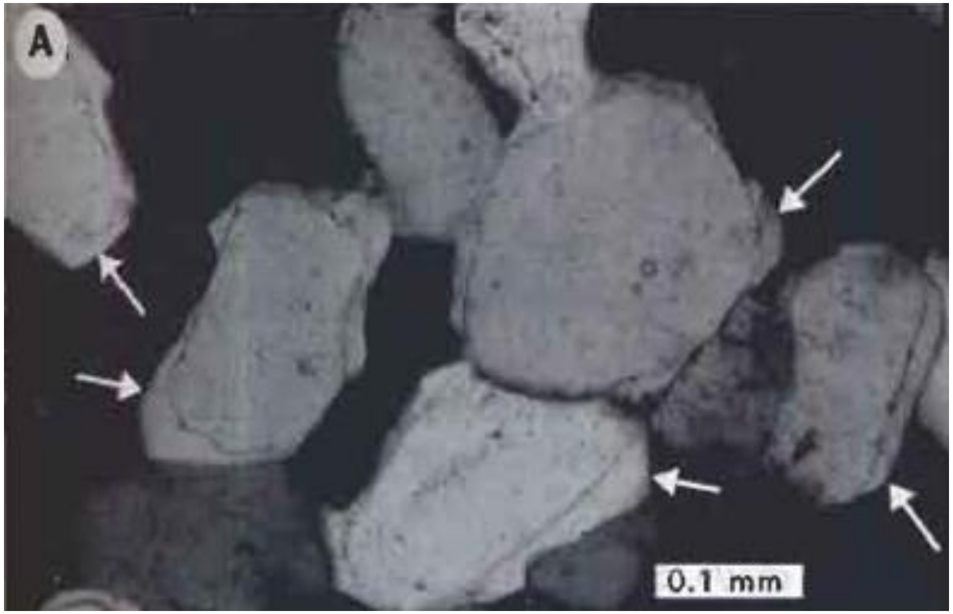
- New crystals form between grains
- Precipitation out of groundwater
- Fills in remaining porosity

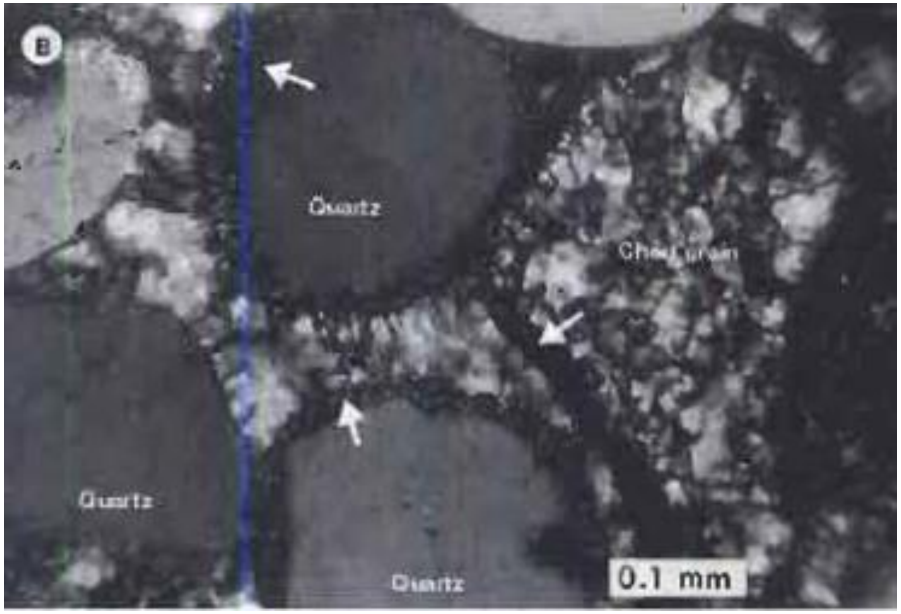


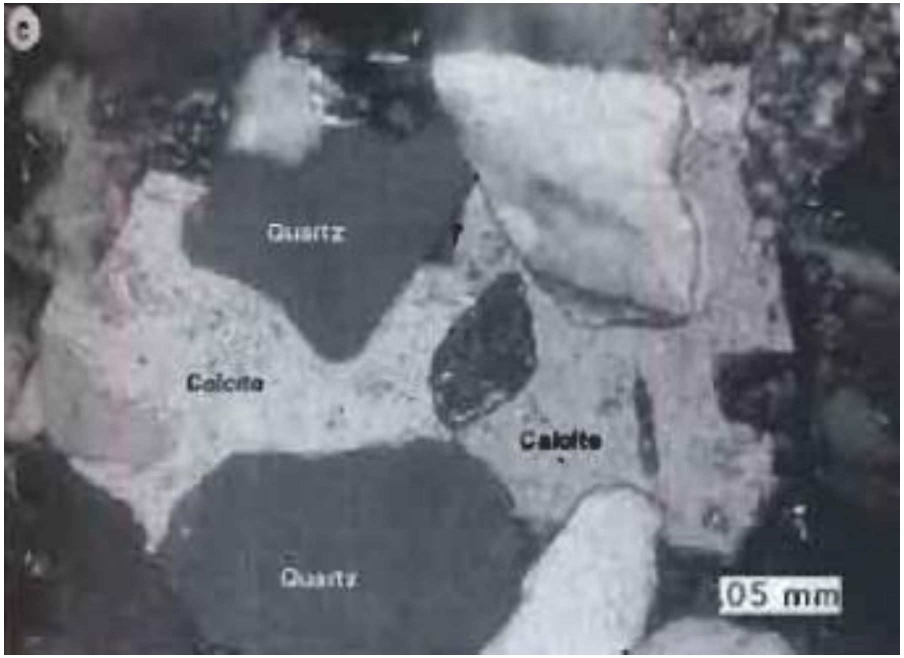
From: northstonematerials.com



From: unibe.ch

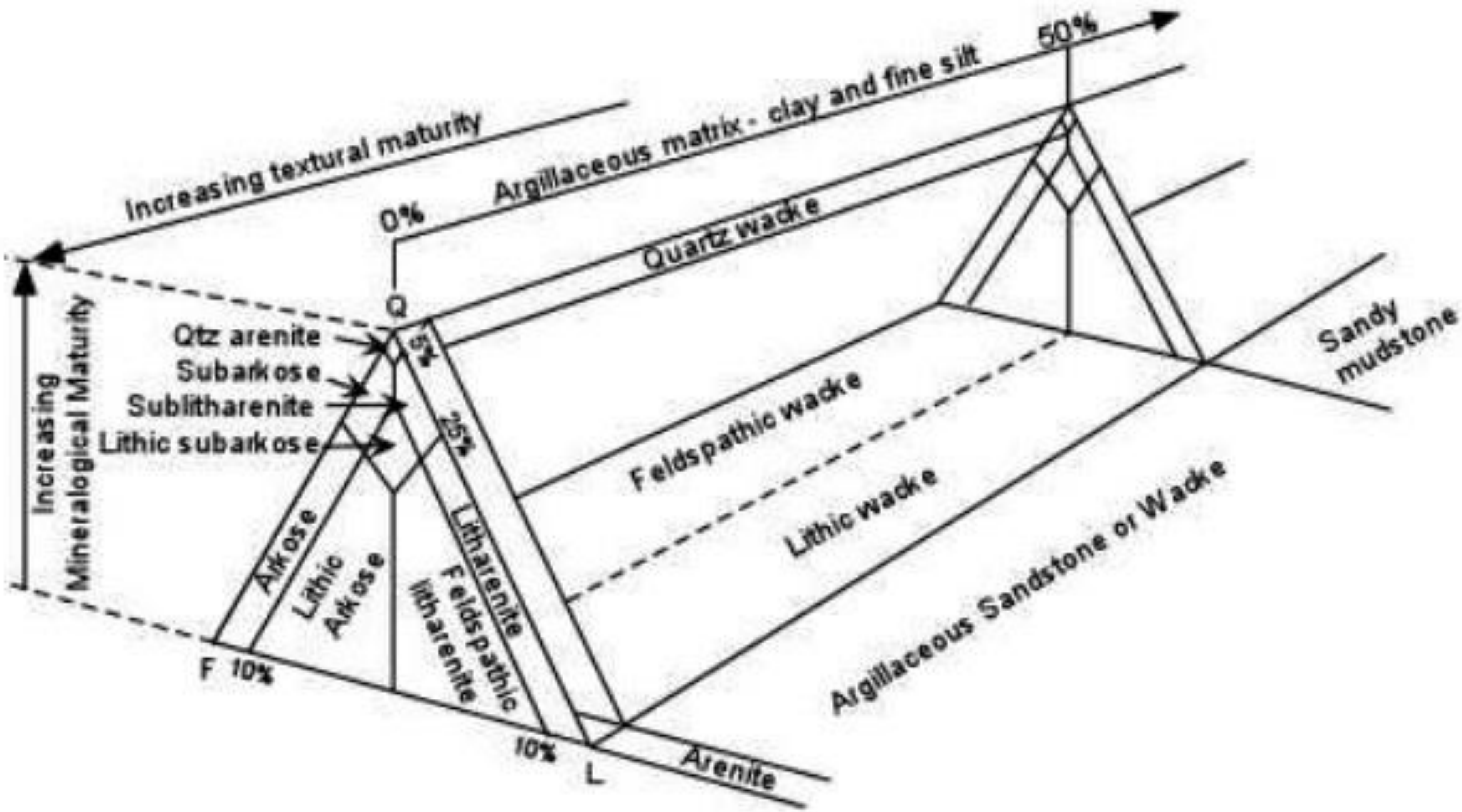

A
0.1 mm


B
Quartz
Quartz
Quartz
0.1 mm

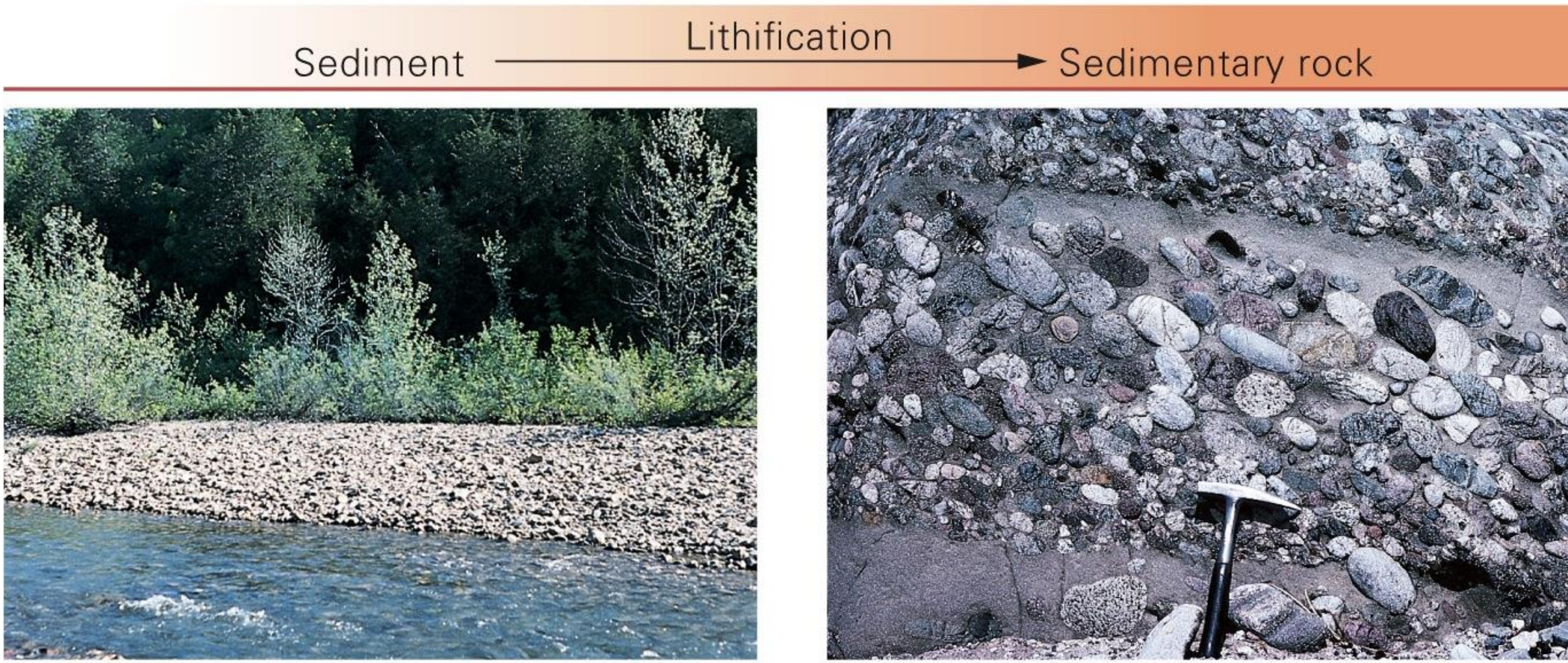

C
Quartz
Calcite
Calcite
Quartz
05 mm

Cement

Dott Classification



Conglomerate

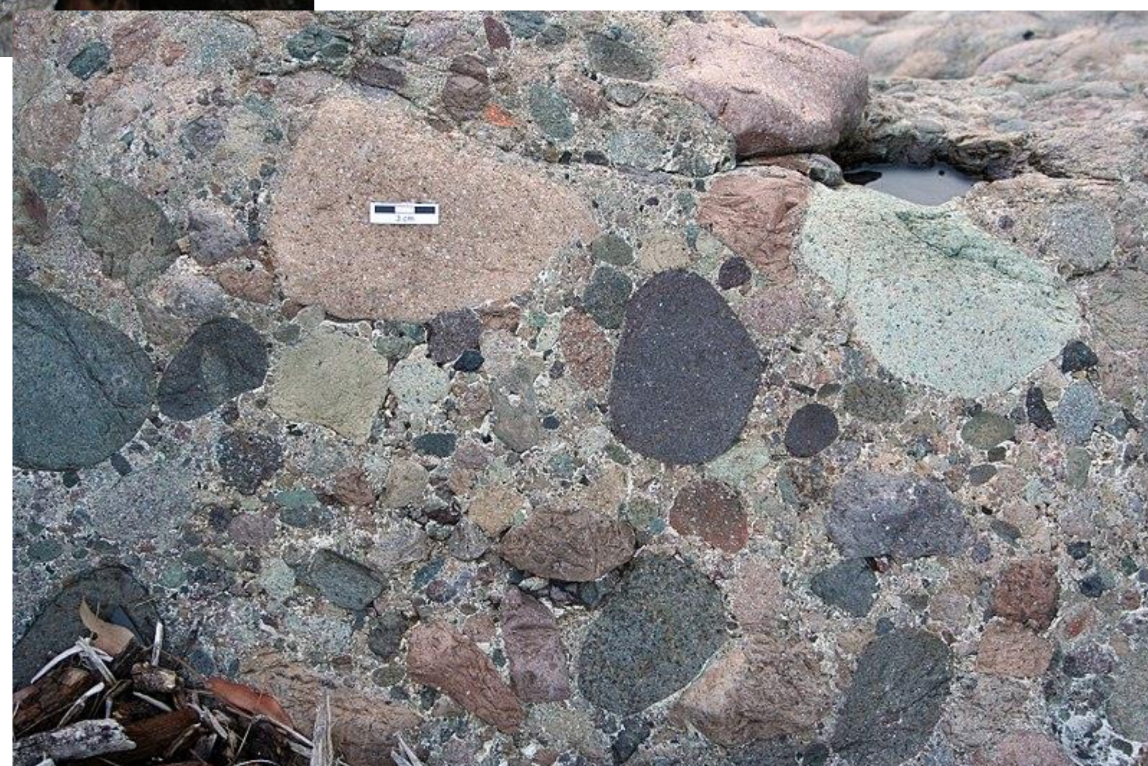


Clast-Supported Conglomerate

Breccia

Matrix-Supported Conglomerate

Oligomictic Conglomerate



Polymictic Conglomerate