Rocks and Rock Types, Rock cycle, Minerals

ROCKS AND MINERALS

Rock: Aggregation of one or more types of minerals, usually consolidated

Mineral:

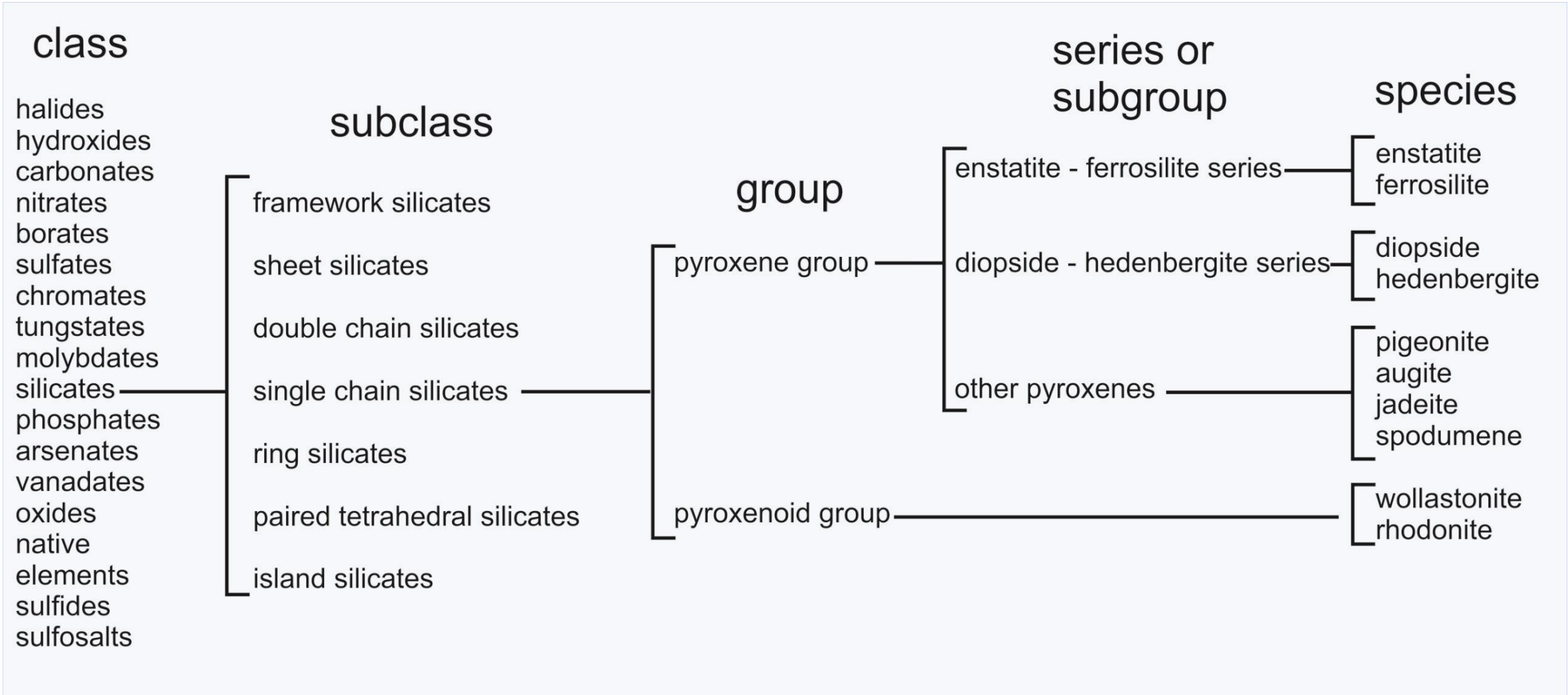
- A solid, naturally occurring element or compound of inorganic origin,
- having an ordered atomic structure and
- characteristic chemical composition, physical properties and crystal form

Source of figures: https://openpress.usask.ca/physicalgeology/chapter/5-4-silicate-minerals-2/
https://opentextbc.ca/geology/chapter/3-1-the-rock-cycle/
https://opengeology.org/Mineralogy/1-introduction/
https://www3.nd.edu/~asimonet/CE30540/SP2017/Lecture_21_new_Meta_Facies_2_SP2017_web_based.pdf

Minerals Classification

Mineral Classes		
class	**key elements or molecules**	**example mineral**
silicates	Si and O	quartz – SiO_2
halides	Cl, F, Br , I	halite – NaCl
hydroxides	(OH)	gibbsite – $Al(OH)_3$
carbonates	(CO_3)	calcite – $CaCO_3$
nitrates	(NO_3)	nitratite – $NaNO_3$
borates	(BO_3) or (BO_4)	sinhalite – $MgAlBO_4$
sulfates	(SO_4)	gypsum – $CaSO_4 \cdot 2H_2O$
chromates	(CrO_4)	crocoite – $PbCrO_4$
tungstates	(WO_4)	scheelite – $CaWO_4$
molybdates	(MoO_4)	wulfenite – $PbMoO_4$
phosphates	(PO_4)	apatite – $Ca_5(PO_4)_3(OH,F,Cl)$
arsenates	(AsO_4)	scorodite – $FeAsO_4 \cdot 4H_2O$
vanadate	(VO_4)	vanadinite – $Pb_5(VO_4)_3Cl$
oxides	O	corundum – Al_2O_3
native elements	single elements	copper – Cu
sulfides	S	pyrite – FeS_2
sulfosalts	As, Sb	niccolite – NiAs

Dana’s Mineral Classification


class
halides
hydroxides
carbonates
nitrates
borates
sulfates
chromates
tungstates
molybdates
silicates
phosphates
arsenates
vanadates
oxides
native
elements
sulfides
sulfosalts
subclass
framework silicates
sheet silicates
double chain silicates
single chain silicates
ring silicates
paired tetrahedral silicates
island silicates
group
pyroxene group
pyroxenoid group
series or subgroup
enstatite - ferrosilite series
diopside - hedenbergite series
other pyroxenes
species
enstatite
ferrosilite
diopside
hedenbergite
pigeonite
augite
jadeite
spodumene
wollastonite
rhodonite

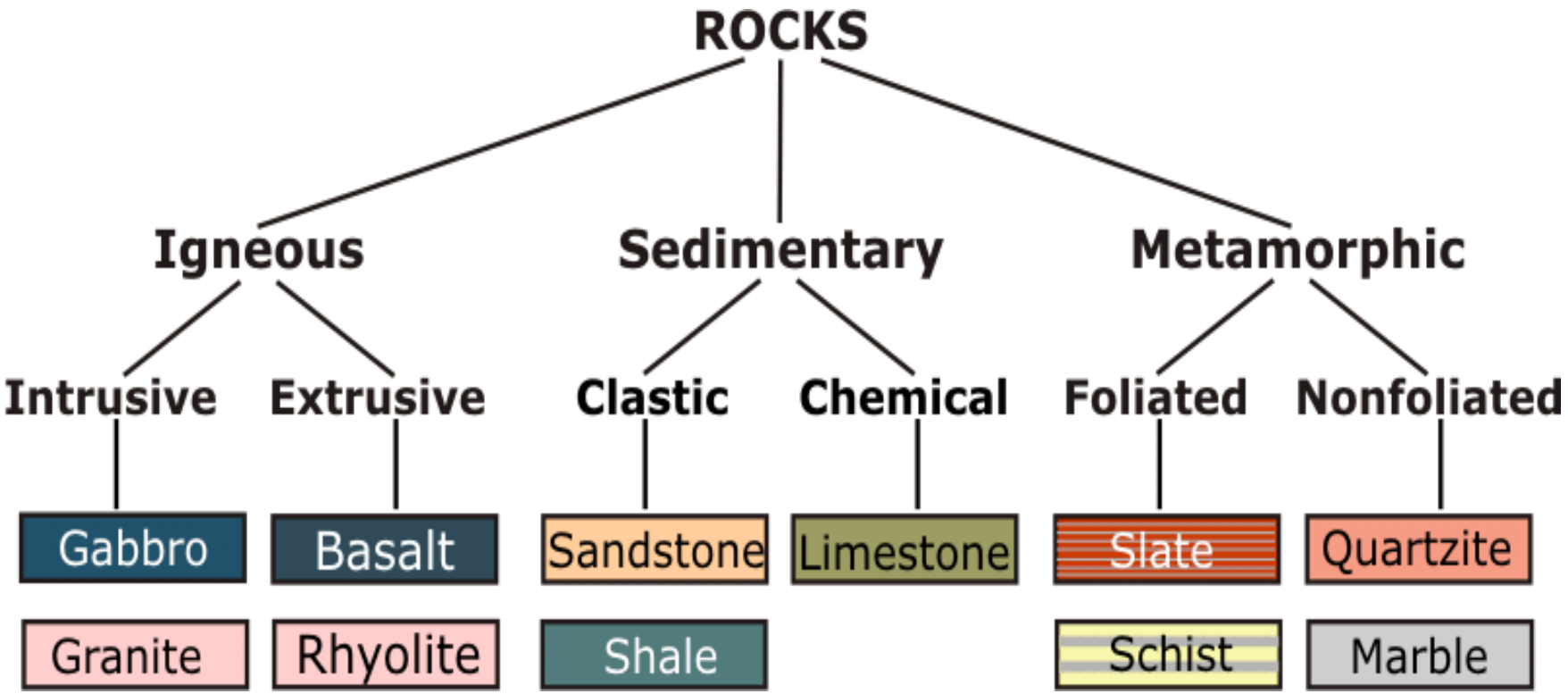
Where do rocks form?

- **Basin:** A low area in earth's crust, of tectonic origin, in which sediments accumulate

- Example- Vindhyan basin, Kutch basin

- Lakes and ponds may accumulate some sediments, are they basins?
- In order to be considered as basins they should form a thick sediment cover

Types of Rocks



Gabbro

Granite

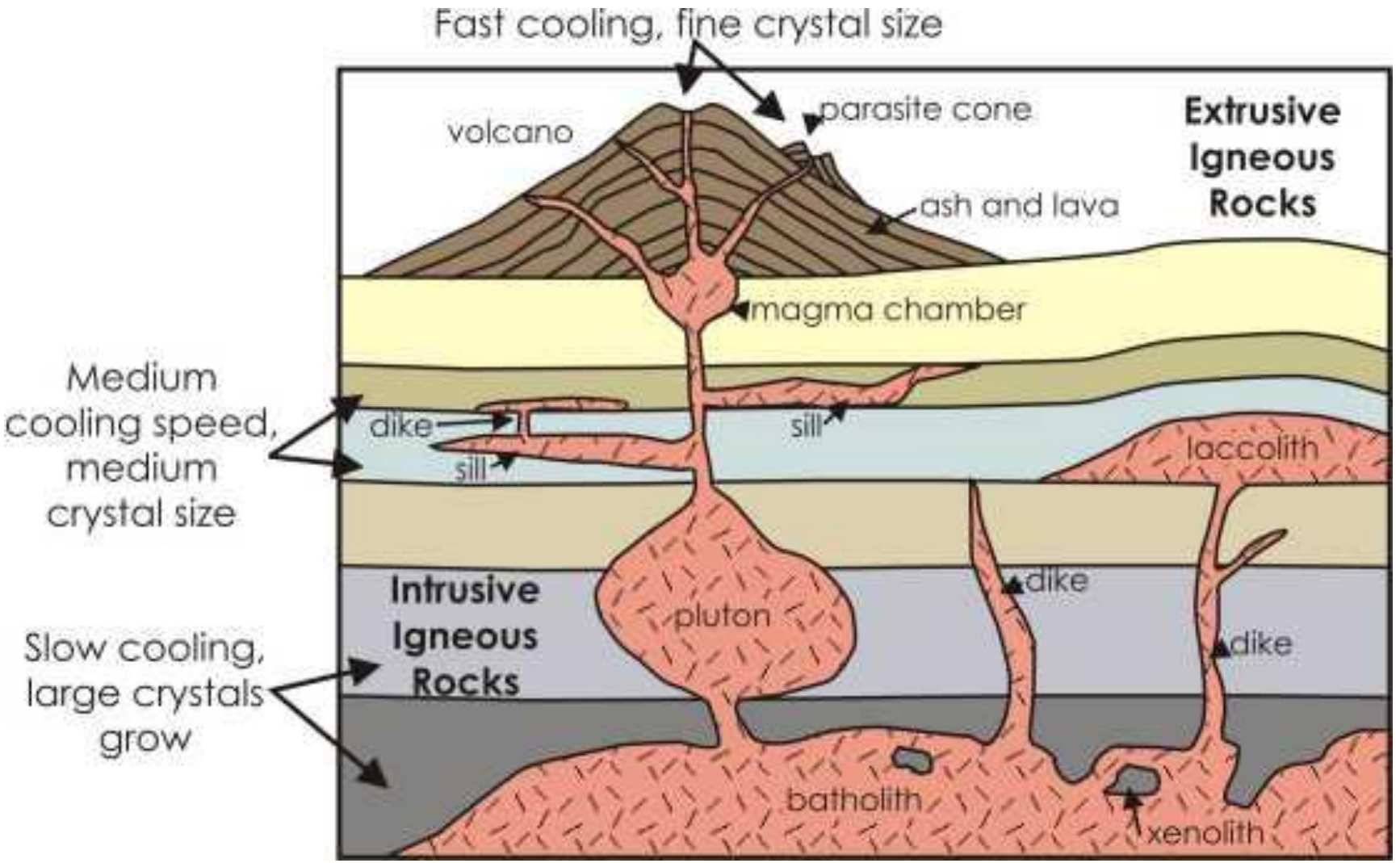
Basalt

Rhyolite

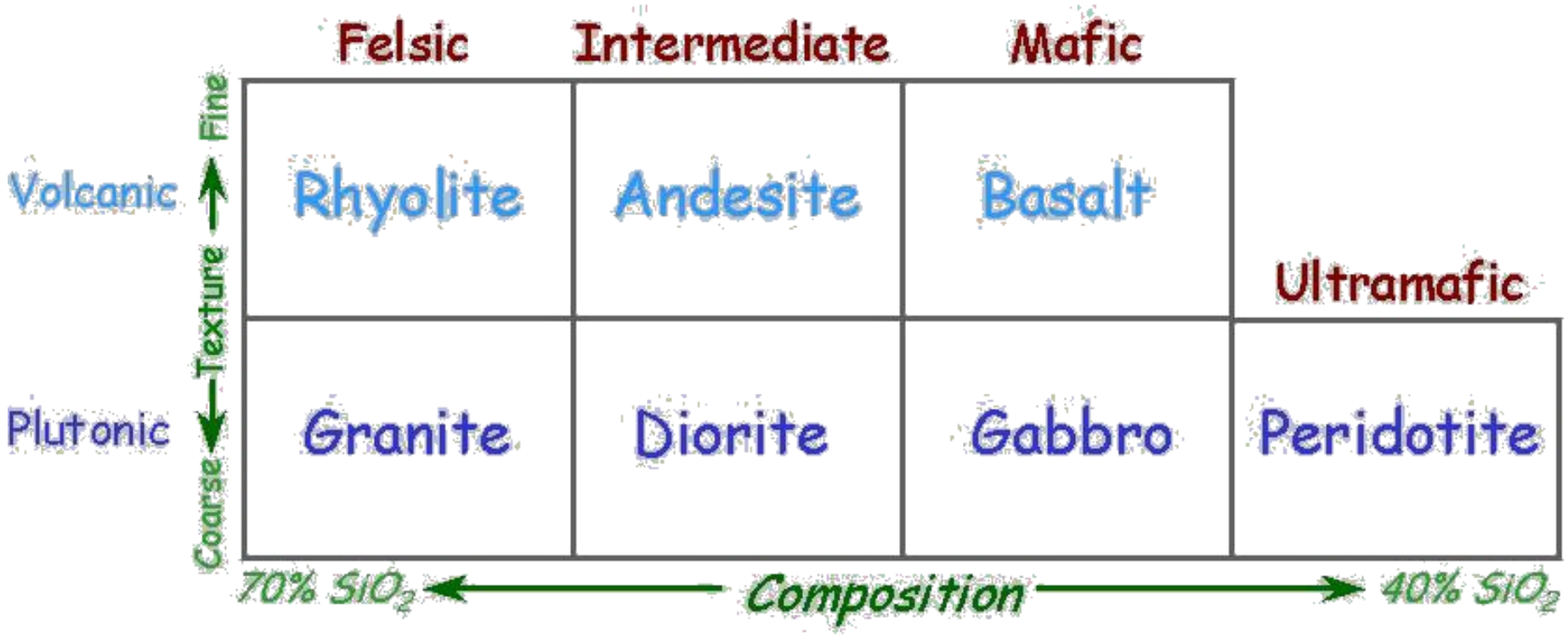
Gabbro and Basalt

Igneous Rocks and Structures

Plutonic = Intrusive
Volcanic = Extrusive



Igneous Rocks



Types of sedimentary rocks

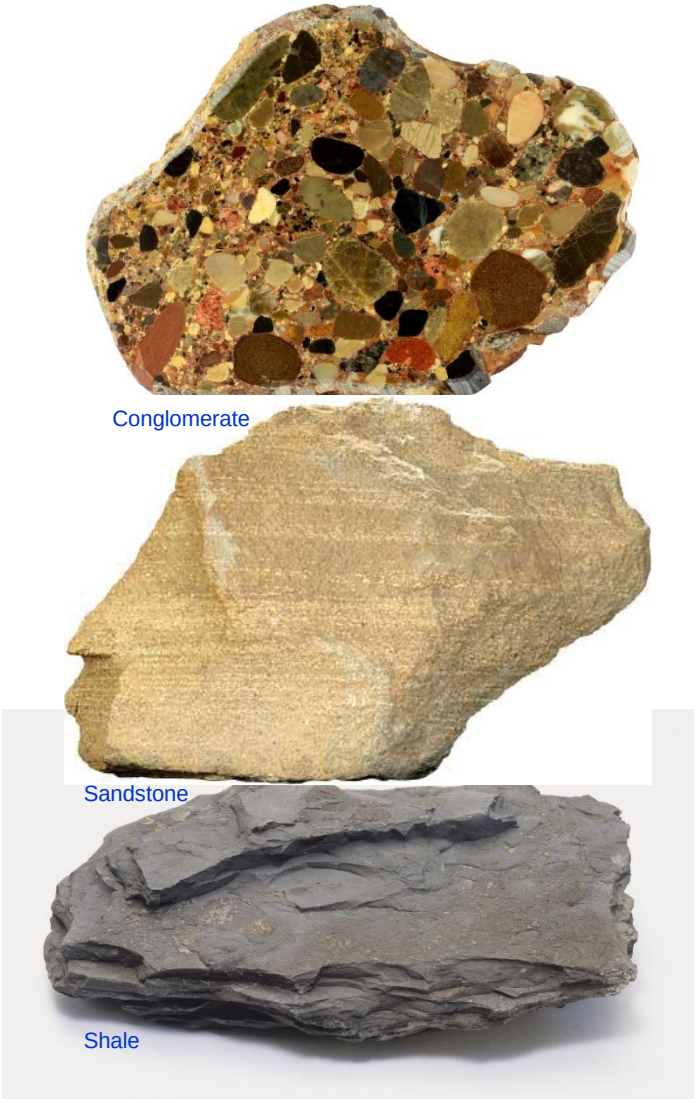
- **Clastic** – deposition of sediments through geological agents such as water, current, wind or ice, example conglomerate, sandstone, shale

- **Chemical** – dissolution and/or precipitation of minerals, example limestone, evaporite

- **Organic/Carbonaceous** – remains of organisms, example coal

Clastic sedimentary rocks

- Classified by sediment grain size
- **Conglomerate** – rounded gravel or pebble size grain
- **Sandstone** – sand size grains, cemented together
- **Shale** – clay size particles, flaky



Terrigenous clastic rocks

clay (<4 μm)
silt (4 μm to 63 μm)
sand (63 μm or 0.063 mm to 2.0 mm)
gravel/aggregates (>2.0 mm)

$$\phi = -\log_2 (\text{grain diameter in mm})$$

Negative representation on a graph

mm	phi	Name	
256	–8	Boulders	Gravel Conglomerate
128	–7		
64	–6	Cobbles	
32	–5		
16	–4		
8	–3	Pebbles	
4	–2	Granules	
2	–1	Very coarse sand	Sand Sandstone
1	0	Coarse sand	
0.5	1	Medium sand	
0.25	2	Fine sand	
0.125	3	Very fine sand	
0.063	4	Coarse silt	Mud Mudrock
0.031	5	Medium silt	
0.0156	6	Fine silt	
0.0078	7	Very fine silt	
0.0039	8	Clay	

Udden-Wentworth grain size scale

Chemical sedimentary rocks

Fossiliferous Limestone

Calcite, Dolomite

Evaporite

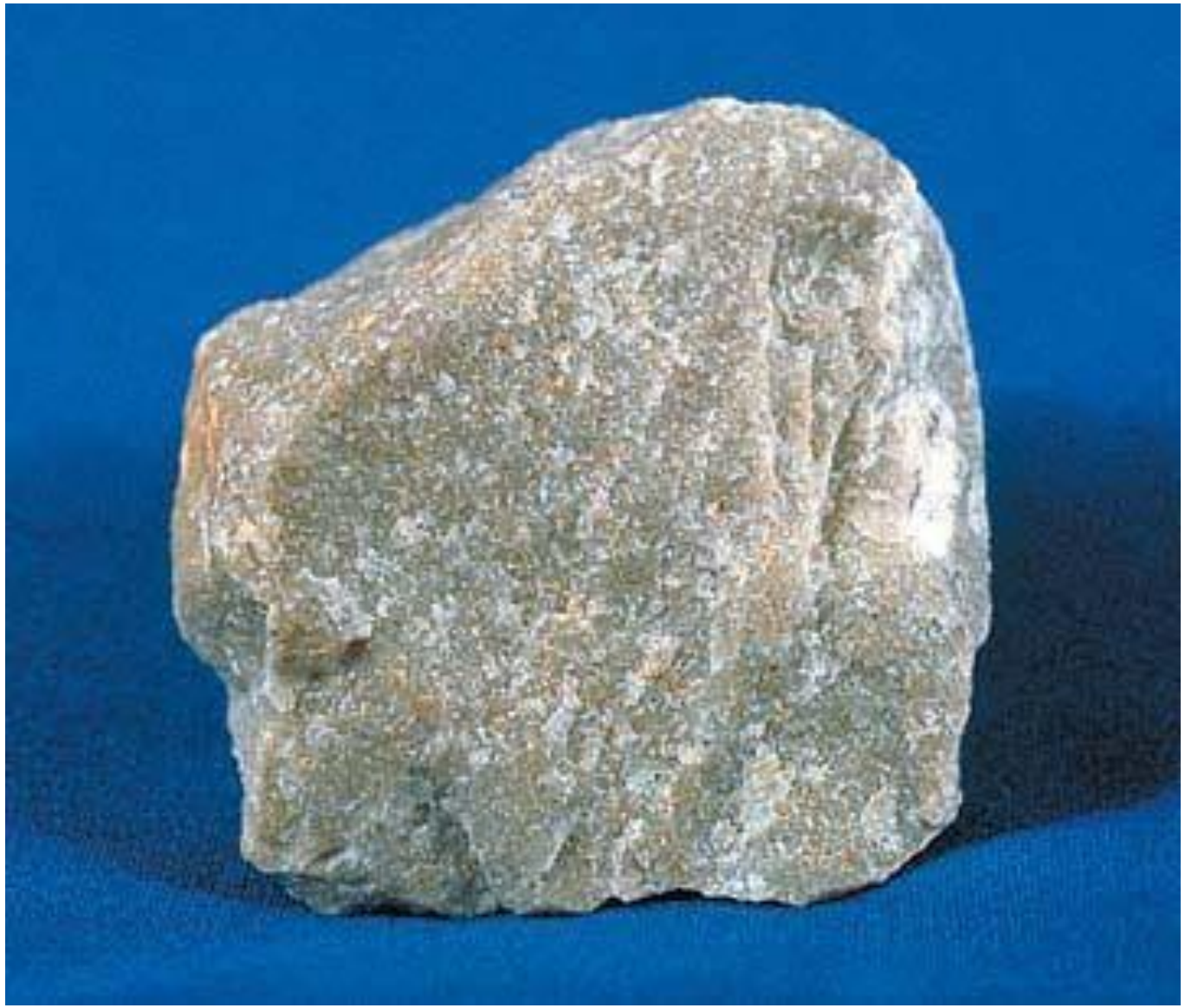
Gypsum

Slate

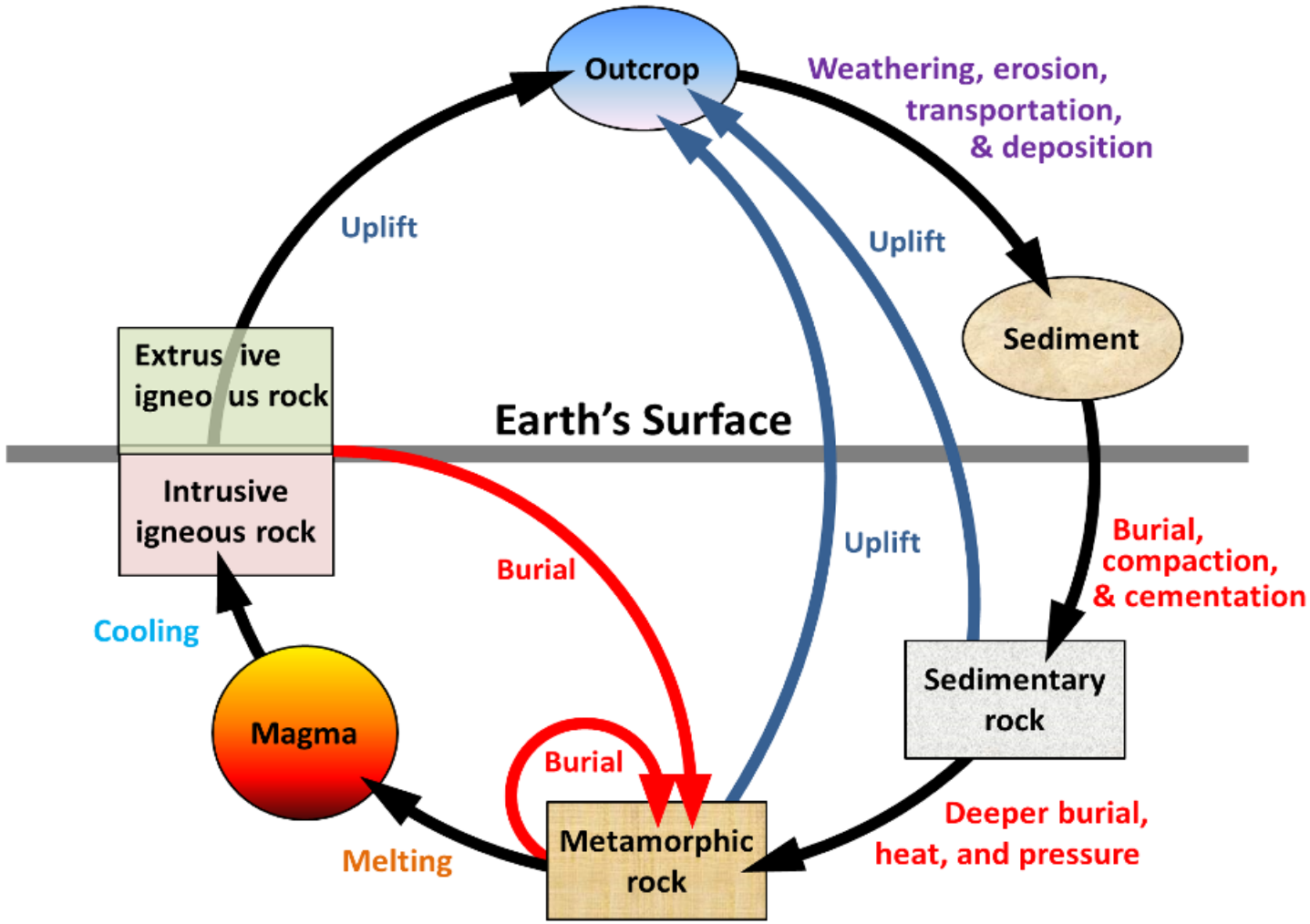
Schist

Alignment of platy minerals like mica flakes

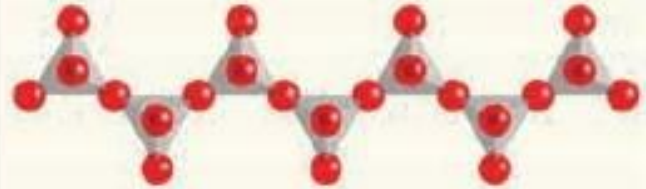
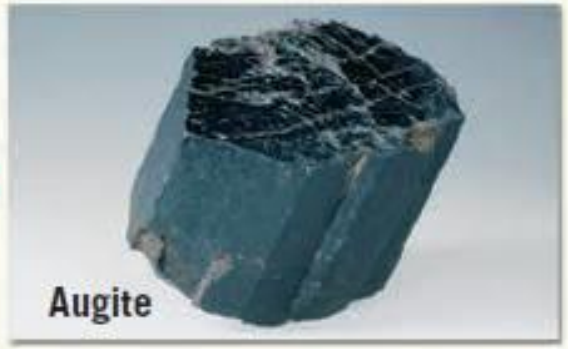
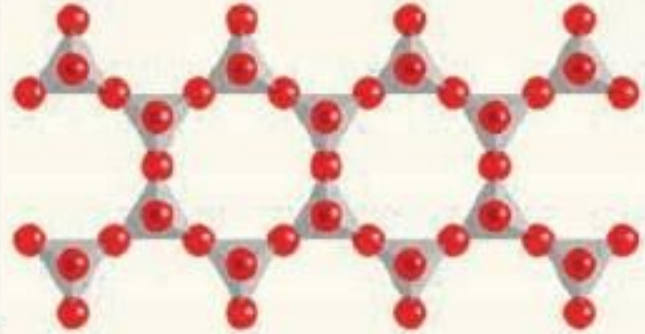
Quartzite

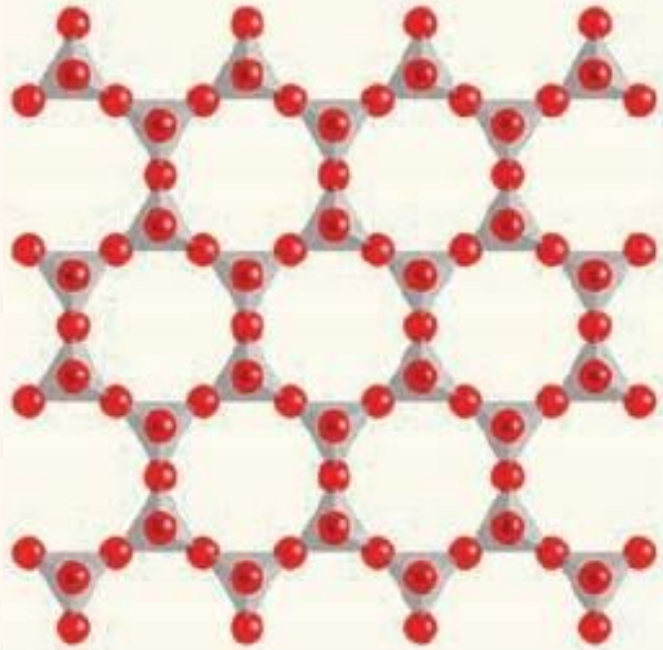
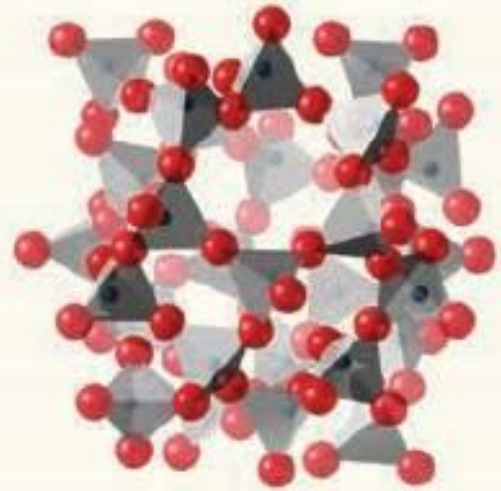


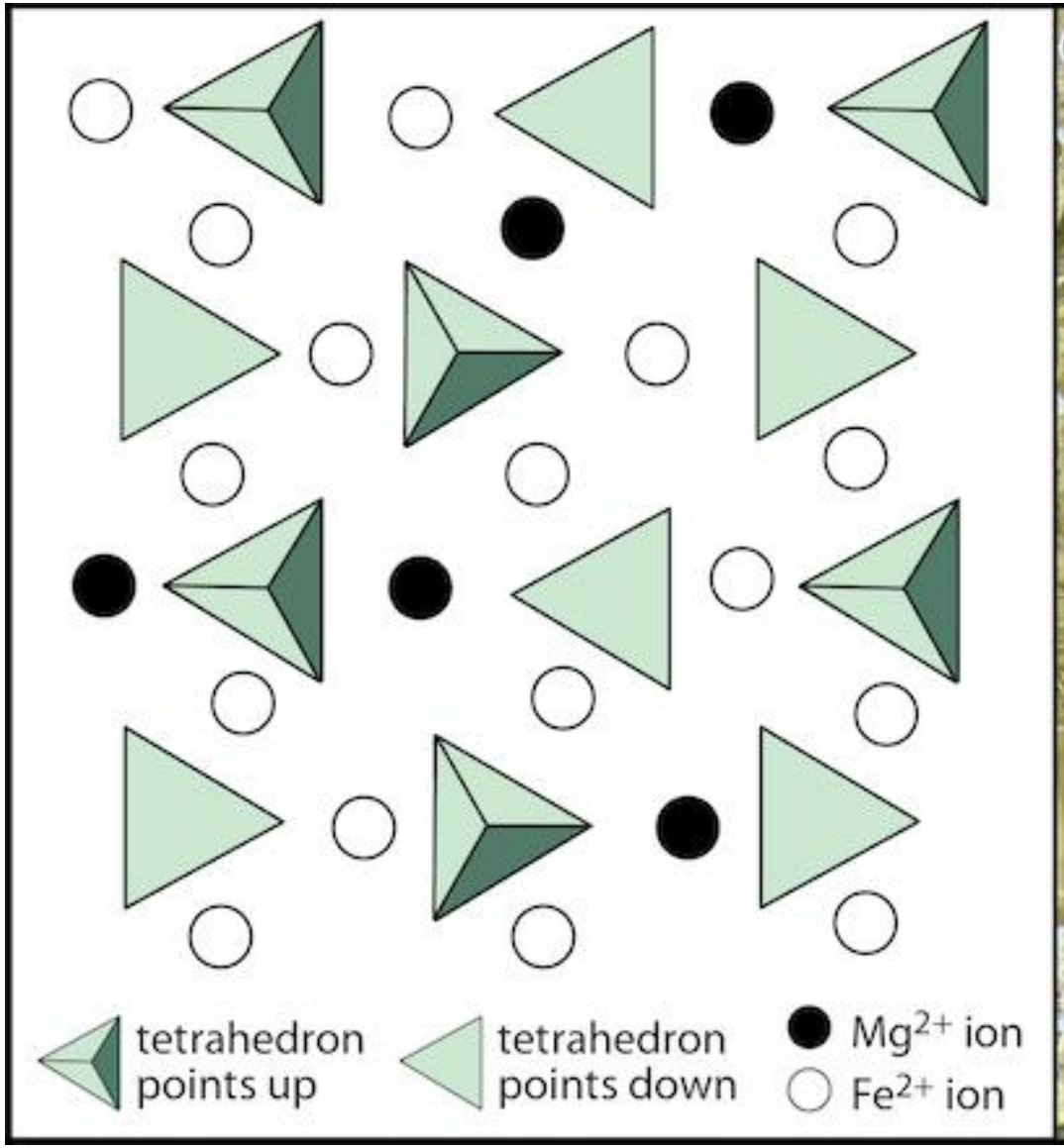
The Geologic Rock Cycle

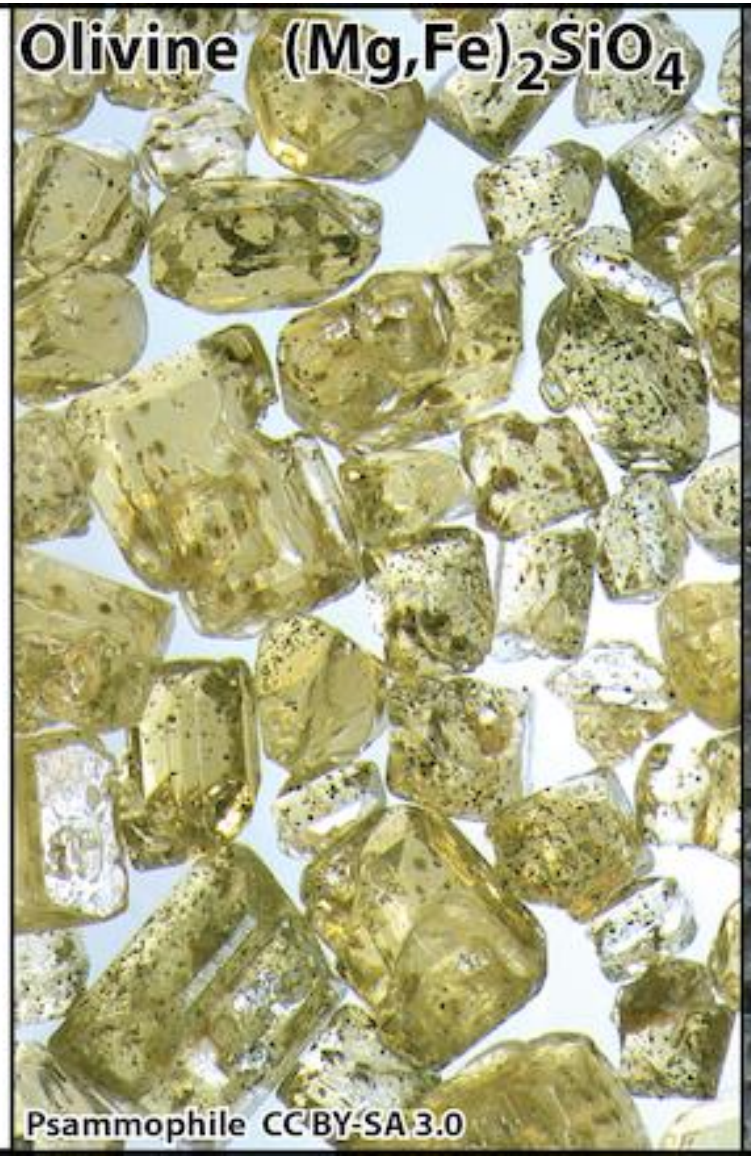


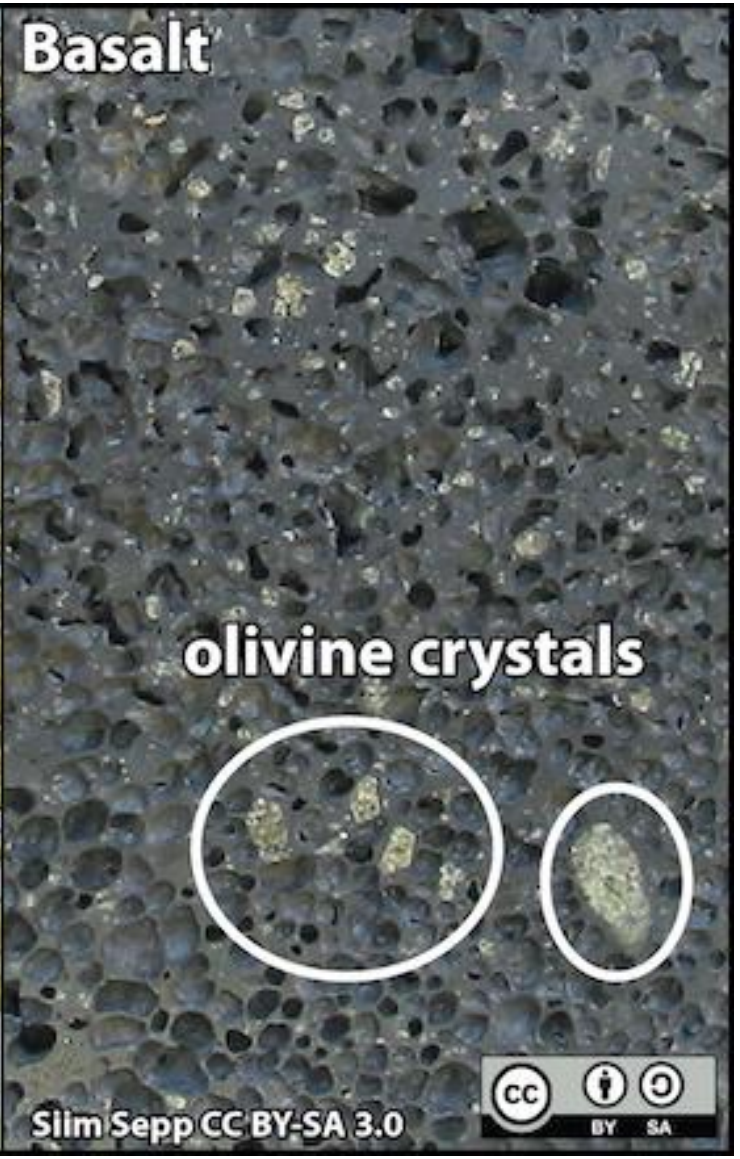
Common Silicate Minerals and Mineral Groups

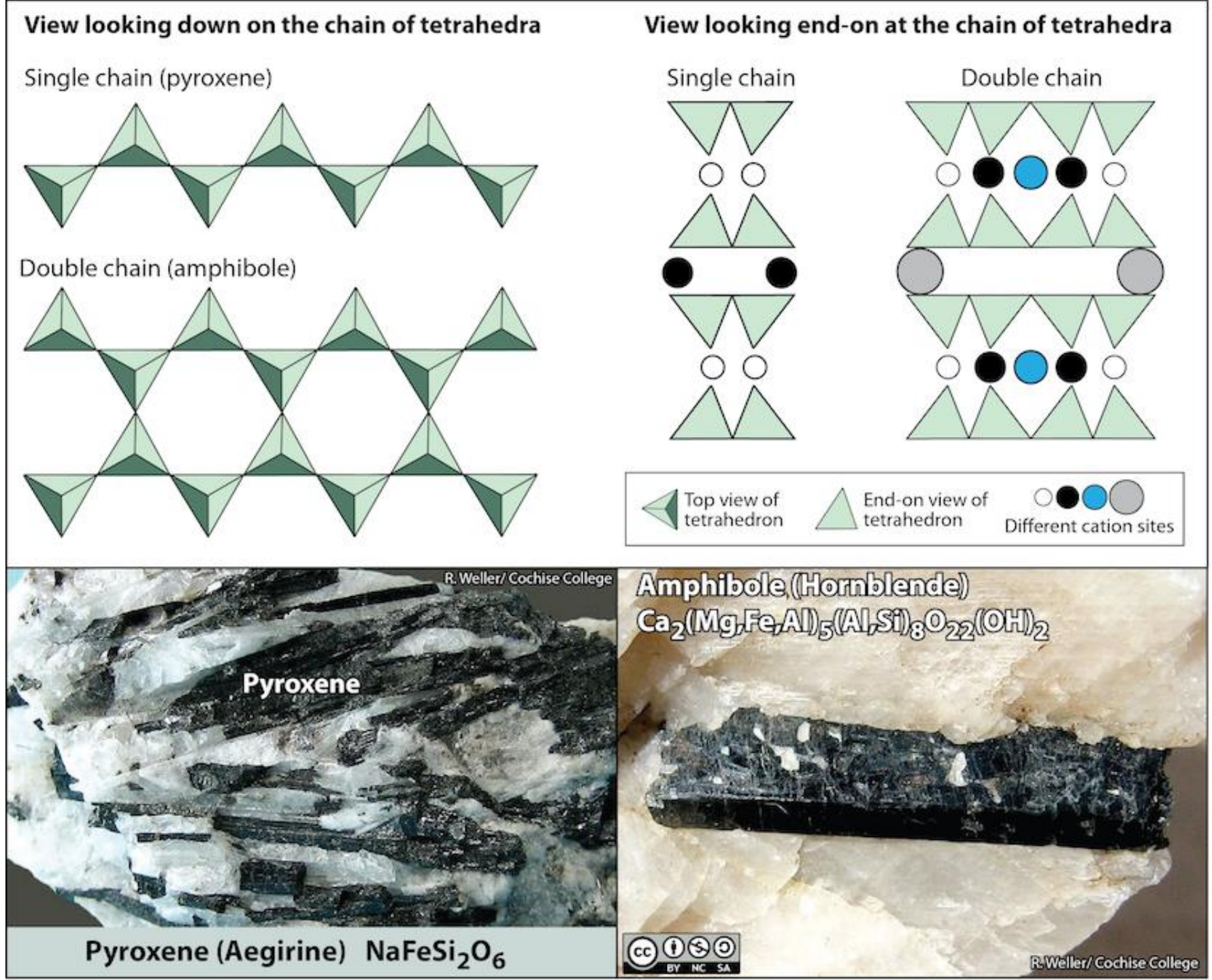
Mineral/Formula	Cleavage	Silicate Structure	Example
Olivine group $(Mg,Fe)_2SiO_4$	None	Single tetrahedra 	 Olivine
Pyroxene group (Augite) $(Mg,Fe,Ca,Na)AlSiO_3$	Two planes at 90°	Single chains 	 Augite
Amphibole group (Hornblende) $Ca_2(Fe,Mg)_5Si_8O_{22}(OH)_2$	Two planes at 60° and 120°	Double chains 	 Hornblende

Micas	**Biotite** $K(Mg,Fe)_3AlSi_3O_{10}(OH)_2$	One plane	Sheets 	Biotite 
	Muscovite $KAl_2(AlSi_3O_{10})(OH)_2$			 Muscovite
Feldspars	**Potassium feldspar (Orthoclase)** $KAlSi_3O_8$	Two planes at 90°	Three-dimensional networks 	 Potassium feldspar
	Plagioclase $(Ca,Na)AlSi_3O_8$			
	Quartz SiO_2	None		

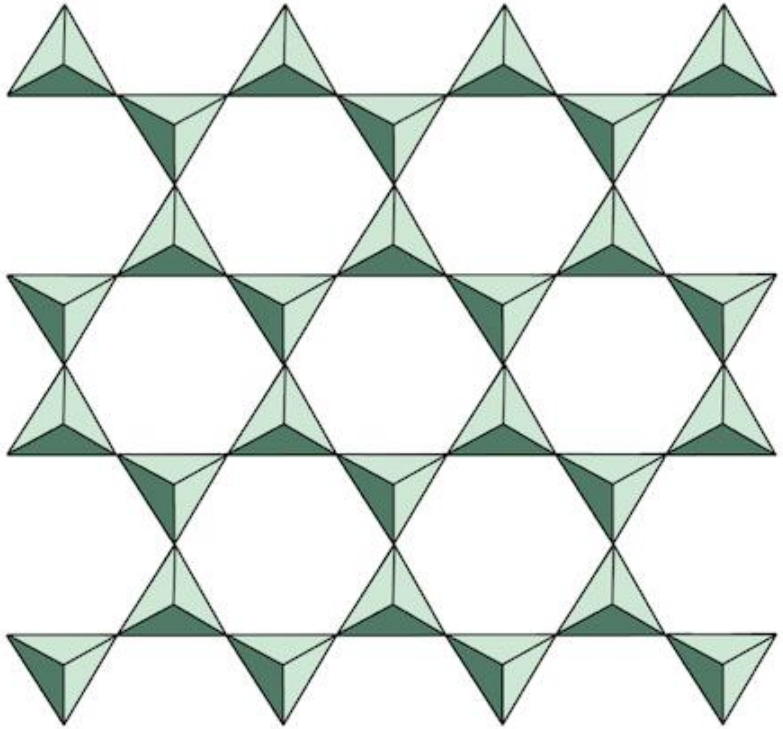

tetrahedron points up
tetrahedron points down
Mg^{2+} ion
Fe^{2+} ion


Olivine $(Mg,Fe)_2SiO_4$
Psammophile CC BY-SA 3.0

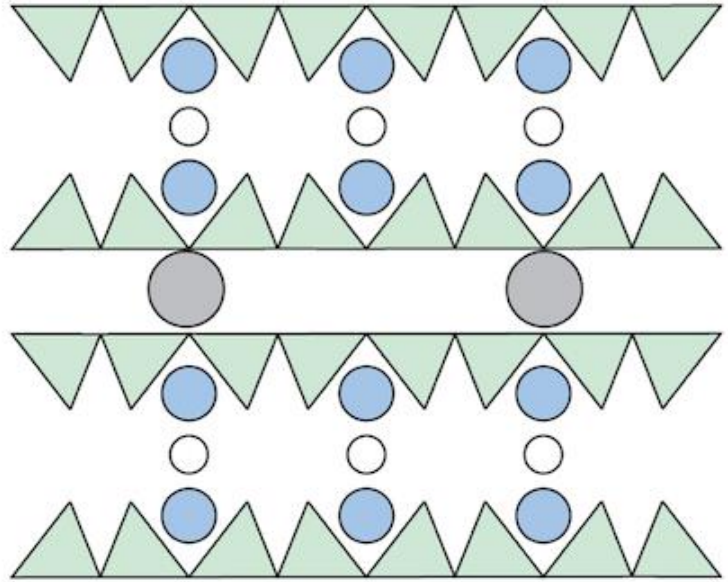

Basalt
olivine crystals
Slim Sepp CC BY-SA 3.0


View looking down on the chain of tetrahedra
Single chain (pyroxene)
Double chain (amphibole)
View looking end-on at the chain of tetrahedra
Single chain
Double chain
Top view of tetrahedron
End-on view of tetrahedron
Different cation sites
R. Weller/ Cochise College
Pyroxene
Pyroxene (Aegirine) NaFeSi2O6
Amphibole (Hornblende)
Ca2(Mg,Fe,Al)5(Al,Si)8O22(OH)2
R. Weller/ Cochise College

View looking down on the sheet of tetrahedra



View looking end-on at sheets of tetrahedra



Biotite group

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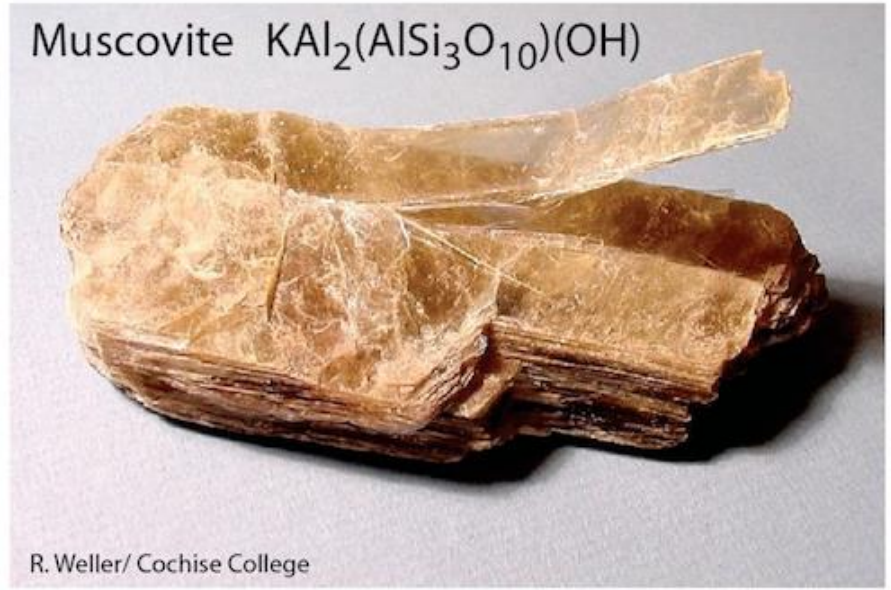
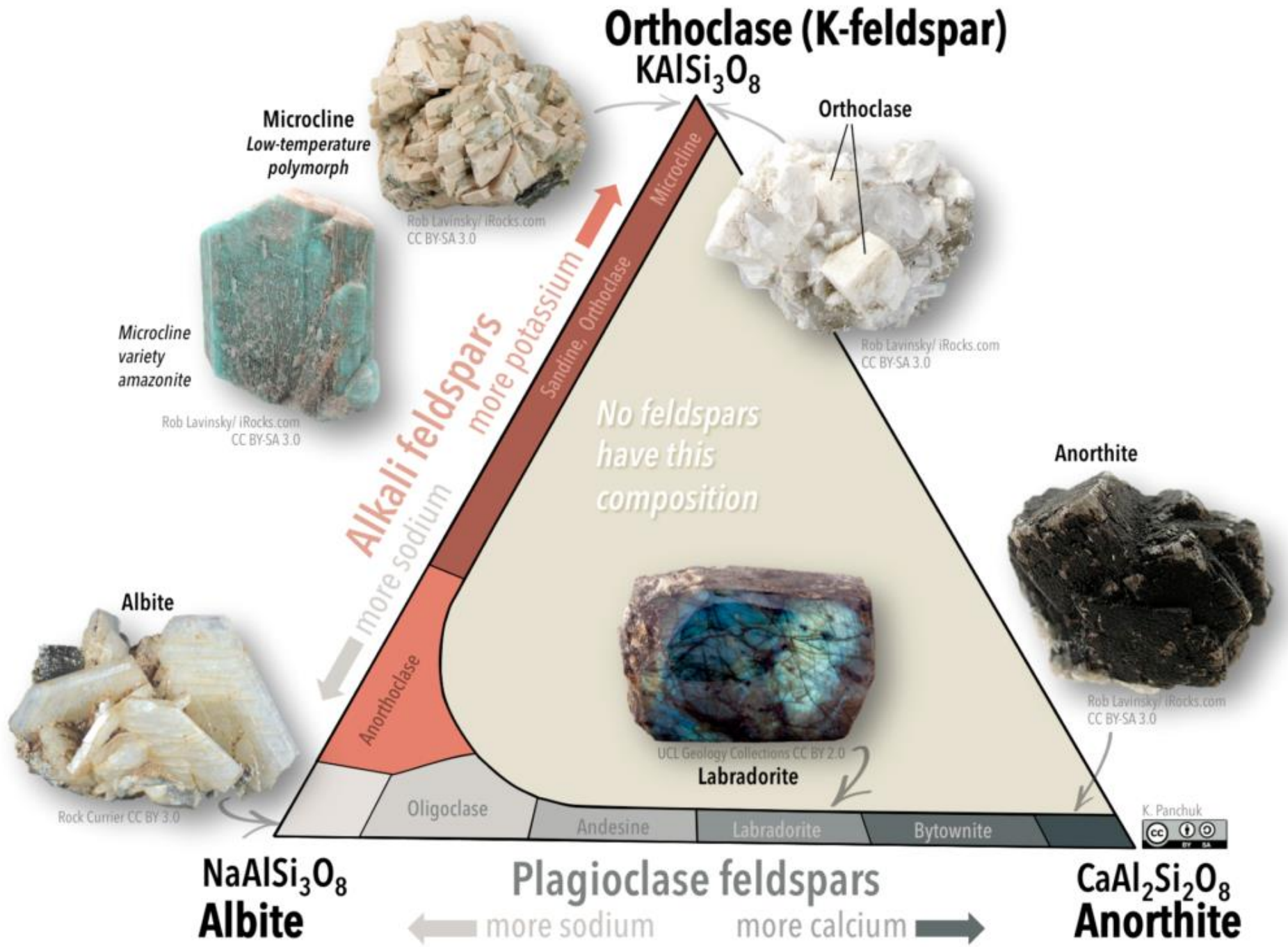
Cochise College

$K(Mg,Fe)_3(AlSi_3O_{10})(F,OH)_2$

Muscovite $KAl_2(AlSi_3O_{10})(OH)$



R. Weller/ Cochise College


Orthoclase (K-feldspar)
KAlSi3O8
Microcline
Low-temperature polymorph
Rob Lavinsky/ iRocks.com
CC BY-SA 3.0
Orthoclase
Rob Lavinsky/ iRocks.com
CC BY-SA 3.0
Microcline variety amazonite
Rob Lavinsky/ iRocks.com
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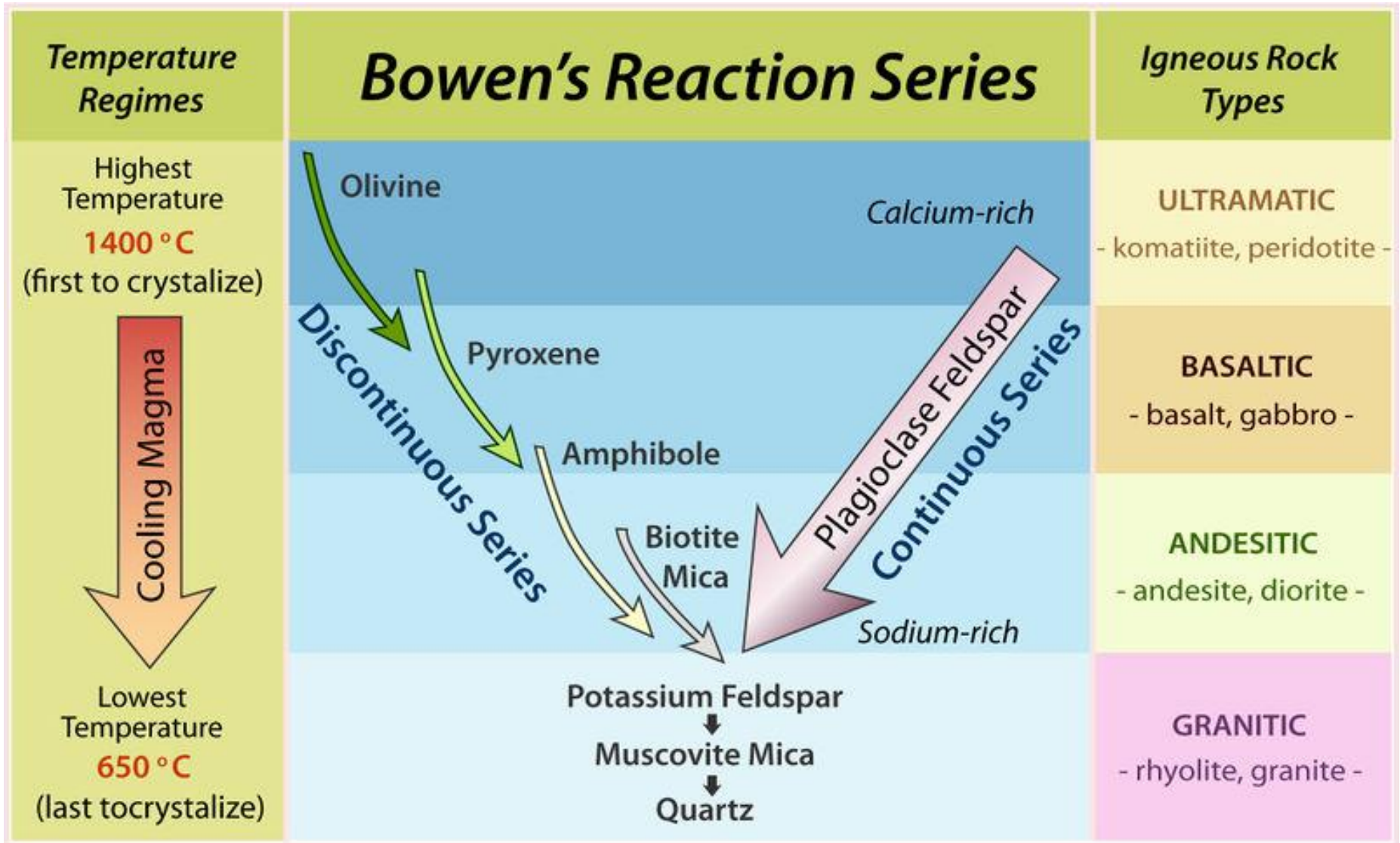
Alkali feldspars
more potassium
more sodium
Microcline
Sanidine, Orthoclase
No feldspars have this composition
Anorthite
Rob Lavinsky/ iRocks.com
CC BY-SA 3.0
Albite
Rock Currier CC BY 3.0
UCL Geology Collections CC BY 2.0
Labradorite
Anorthoclase
Oligoclase
Andesine
Labradorite
Bytownite
K. Panchuk
NaAlSi3O8
Albite
Plagioclase feldspars
more sodium
more calcium
CaAl2Si2O8
Anorthite


Quartz
SiO_2
R. Weller/ Cochise College
K. Panchuk
Granite
K-feldspar
Microcline
Albite
Amphibole
Quartz
R. Weller/ Cochise College

Igneous Rocks

BOWEN'S REACTION SERIES



Mineralogical composition of Sandstone

Major Mineral Composition	Accessory Mineral compositions: ≤1-2%	Miscellaneous Minerals	Other Component
• Quartz: ~ 65% • Feldspar: ~ 10-15% • Mica: Muscovite Biotite • Clay minerals	• Heavy minerals • Coarse mica grains	• Common igneous minerals like Olivine, pyroxene • Oxides of irons	• Lithic fragments • Biogenic particles • Authigenic minerals • Matrix

Metamorphic Rocks