Soils: The mothers of forests
Forests: The mothers of soils

Soil formation

Parent Material → The Rock that is weathering to form soil.

Weathering → Is the biochemical process that involves destruction and synthesis.

→ Rocks are broken down into smaller and smaller fragments based on their constituent materials (Mineral)

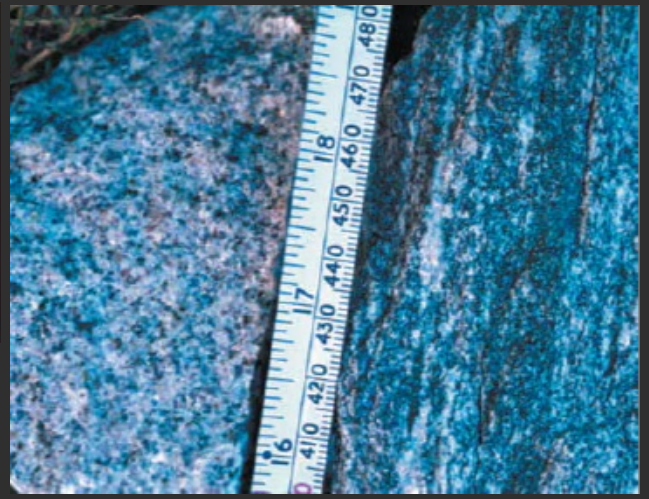
Chemical decomposition

→ Minerals are altered or decomposed through chemical reactions and solvents are synthesized

Physical Disintegration

→ Rocks breaking into smaller pieces through mechanical action (water, wind, expansion, rocks/ biology)

Rock texture	Light-colored mineral (e.g., feldspars, muscovite) Quartz		Dark-colored minerals (e.g., hornblende, augite, biotite)	
Coarse	Granite	Diorite	Gabbro	Peridotite Hornblendite
Intermediate	Rhyolite	Andesit	Basalt	
Fine	Felsite/Obsidian		Basalt glass	



Rock texture determines

1) Item quickly material weathers

2) Influence soil particle size

	Type of Rock	
Dominant Mineral	**Sedimentary**	**Metamorphic**
Calcite ($CaCO_3$)	Limestone	Marble
Dolomite ($CaCO_3 \cdot MgCO_3$)	Dolomite	Marble
Quartz (SiO_2)	Sandstone	Quartzite
Clays	Shale	Slate
Variable, silicates	Conglomerate[a]	Gneiss[b]
Variable, silicates		Schist[b]

[a]Small stones of various mineralogical makeup are cemented into conglomerate.

[b]The minerals present are determined by the original rock, which has been changed by metamorphism. Primary minerals present in the igneous rocks commonly dominate these rocks, although some secondary minerals are also present.

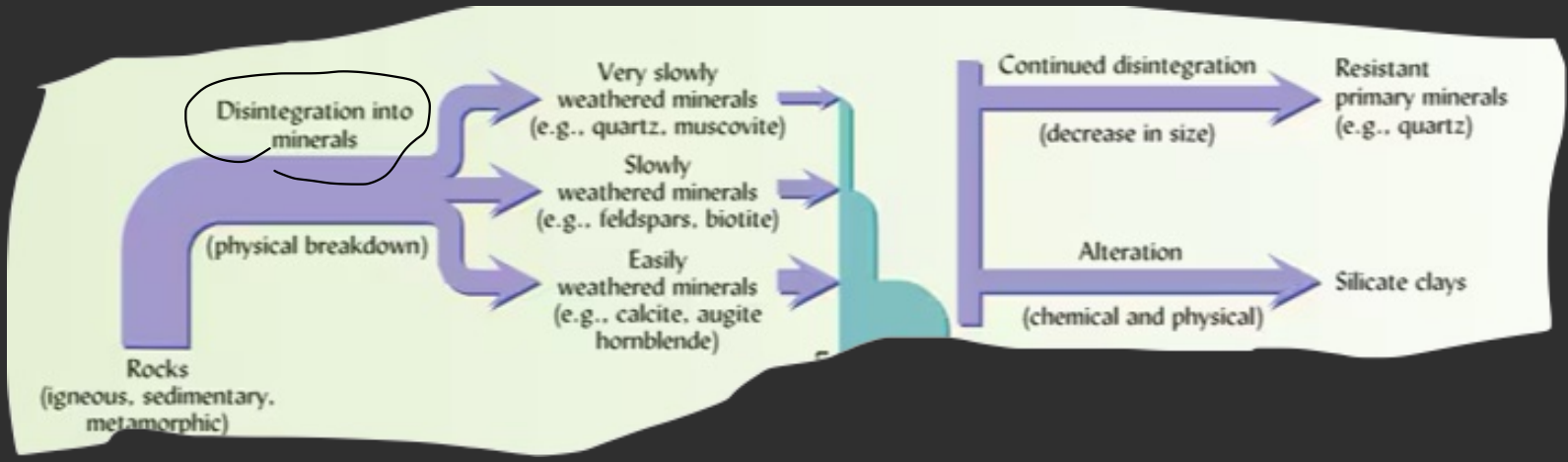
Mineral found in rock ↑

Mineral synthesized through chemical weathering ↑

Primary Minerals		Secondary Minerals		
		Goethite	$FeOOH$	Most resistant
		Hematite	Fe_2O_3	
		Gibbsite	$Al_2O_3 \cdot 3H_2O$	
Quartz	SiO_2			
		Clay minerals	Al silicates	
Muscovite	$KAl_3Si_3O_{10}(OH)_2$			
Microcline	$KAlSi_3O_8$			
Orthoclase	$KAlSi_3O_8$			
Biotite	$KAl(Mg,Fe)_3Si_3O_{10}(OH)_2$			
Albite	$NaAlSi_3O_8$			
Hornblende[a]	$Ca_2Al_2Mg_2Fe_3Si_6O_{22}(OH)_2$			
Augite[a]	$Ca_2(Al,Fe)_4\ (Mg,Fe)_4Si_6O_{24}$			
Anorthite	$CaAl_2Si_2O_8$			
Olivine	$Mg,FeSiO_4$			
		Dolomite[b]	$CaCO_3 \cdot MgCO_3$	
		Calcite[b]	$CaCO_3$	
		Gypsum	$CaSO_4 \cdot 2H_2O$	Least resistant

[a]The given formula is only approximate since the mineral is so variable in composition.

[b]In semiarid grasslands, dolomite and calcite are more resistant to weathering than suggested because of low rates of acid weathering.

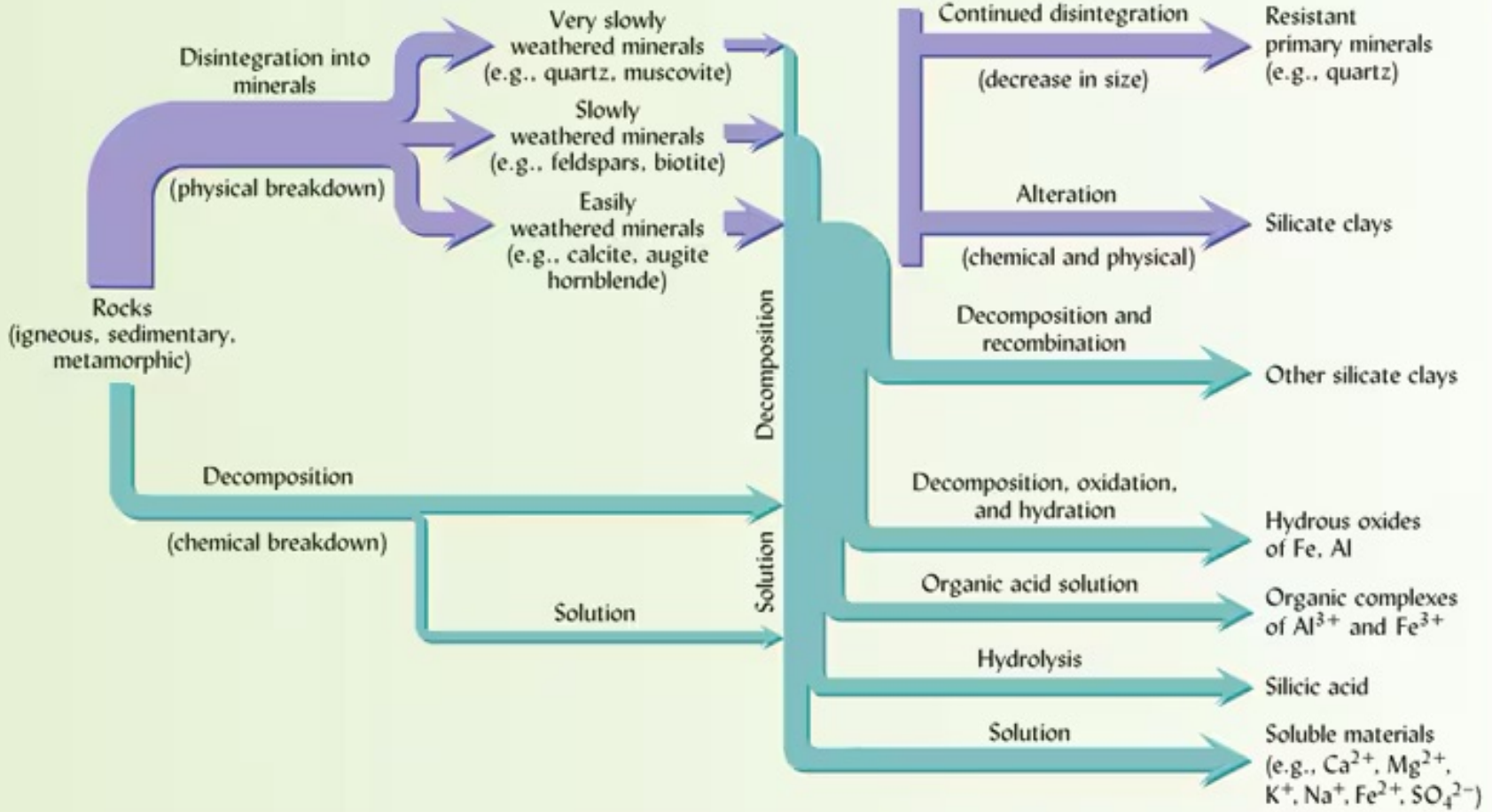


Physical weathering

→ Temperture; differential heating and cooling of minerals → Exfoliation

→ Wind, Ice, Water → freeze; thaw → Round rocks

→ Biological processes in Physical deformation


Rocks
(igneous, sedimentary, metamorphic)
Disintegration into minerals
(physical breakdown)
Very slowly weathered minerals
(e.g., quartz, muscovite)
Slowly weathered minerals
(e.g., feldspars, biotite)
Easily weathered minerals
(e.g., calcite, augite hornblende)
Decomposition
(chemical breakdown)
Solution
Decomposition
Solution
Continued disintegration
(decrease in size)
Resistant primary minerals
(e.g., quartz)
Alteration
(chemical and physical)
Silicate clays
Decomposition and recombination
Other silicate clays
Decomposition, oxidation, and hydration
Hydrous oxides of Fe, Al
Organic acid solution
Organic complexes of Al^{3+} and Fe^{3+}
Hydrolysis
Silicic acid
Solution
Soluble materials
(e.g., Ca^{2+}, Mg^{2+}, K^{+}, Na^{+}, Fe^{2+}, SO_4^{2-})

Exfoliation

Physical Weathering

- Water and wind

Wind +

Water

Wind

Water

Chemical

Ice

Biological

Chemical Weathering! Always happens faster in the presence of water

→ Hydration

H_2O

In fact water binds to

Mineral (solid)

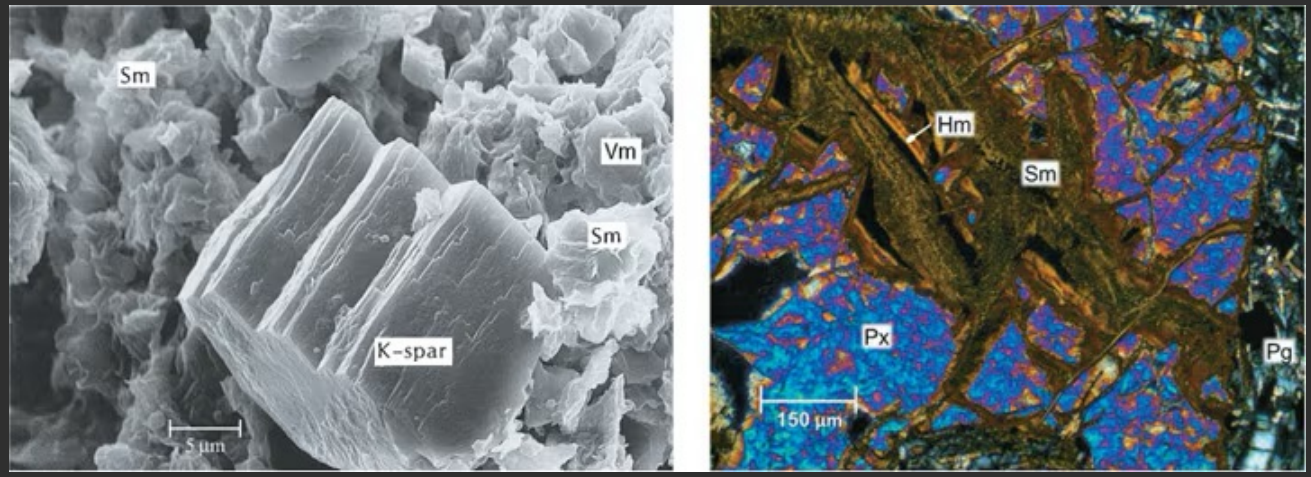
$5\,Fe_2O_3 + 9H_2O \rightarrow Fe_{10}O_{15}(OH)_9$

Hematite

Solution

Ferrihydrite

$+ 9H_2O$


Sm
Vm
Sm
K-spar
5 µm
Hm
Sm
Px
Pg
150 µm

Hydrolysis ⇌ split

→ H + OH

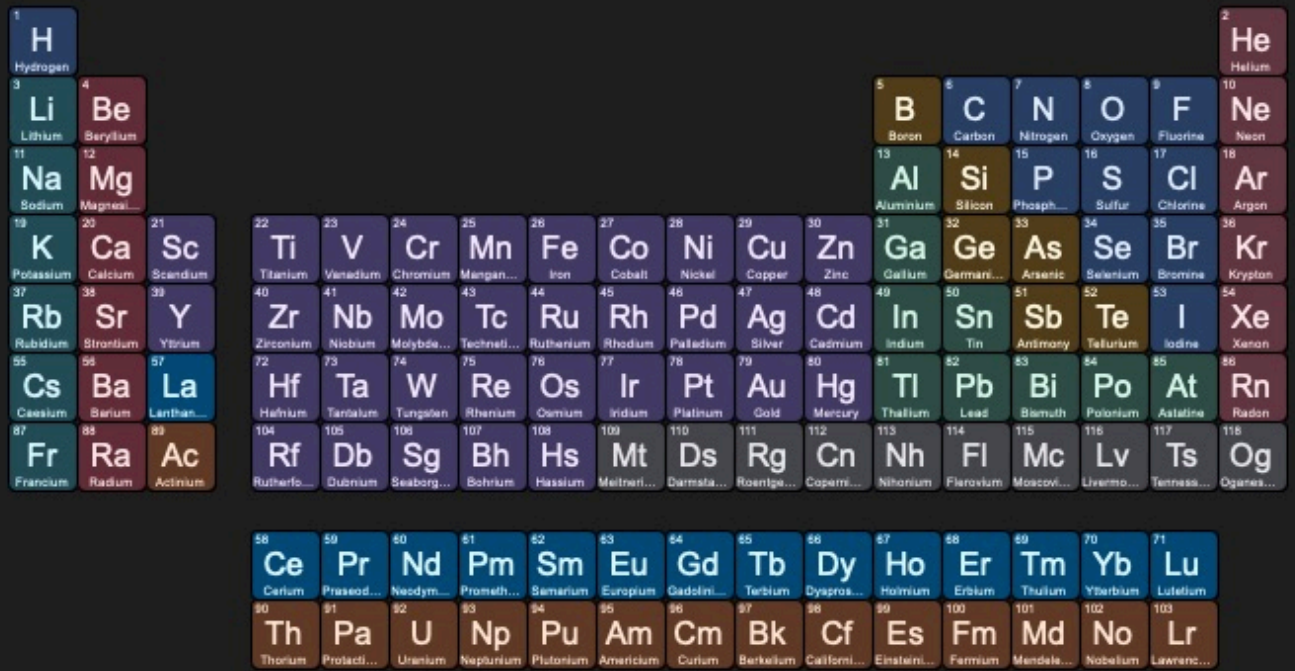
- Water splits into hydrogen and hydroxyl groups and hydrogen replaces a cation

↳ Microcline that contains K feldspar

$$KAlSi_3O_8 + H_2O \overset{\text{hydrolysis}}{\rightleftharpoons} HAlSi_3O_8 + K^+ + OH^-$$

KAlSi3O8 solid; H2O; HAlSi3O8 solid; K+ + OH- solution

Periodic Table



- Alkali metals
- Alkaline earth metals
- Transition metals
- Post-transition metals
- Metalloids
- Reactive nonmetals
- Noble gases
- Lanthanides
- Actinides
- Unknown properties