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ASAC 1101 : FUNDAMENTALS OF SOIL SCIENCE (2+1)

Level : B.Sc (Ag), I semester

Dr. PEDDA GHOUSE PEERA S.K.

SOIL SCIENCE AND AGRICULTURAL CHEMISTRY

**M.S.SWAMINATHAN SCHOOL OF AGRICULTURE,CUTM,
PARLAKHEMUNDI**

Topic

**Weathering- Types, Weatherability
Chemical weatherability**



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Weathering



Ray R. Weil

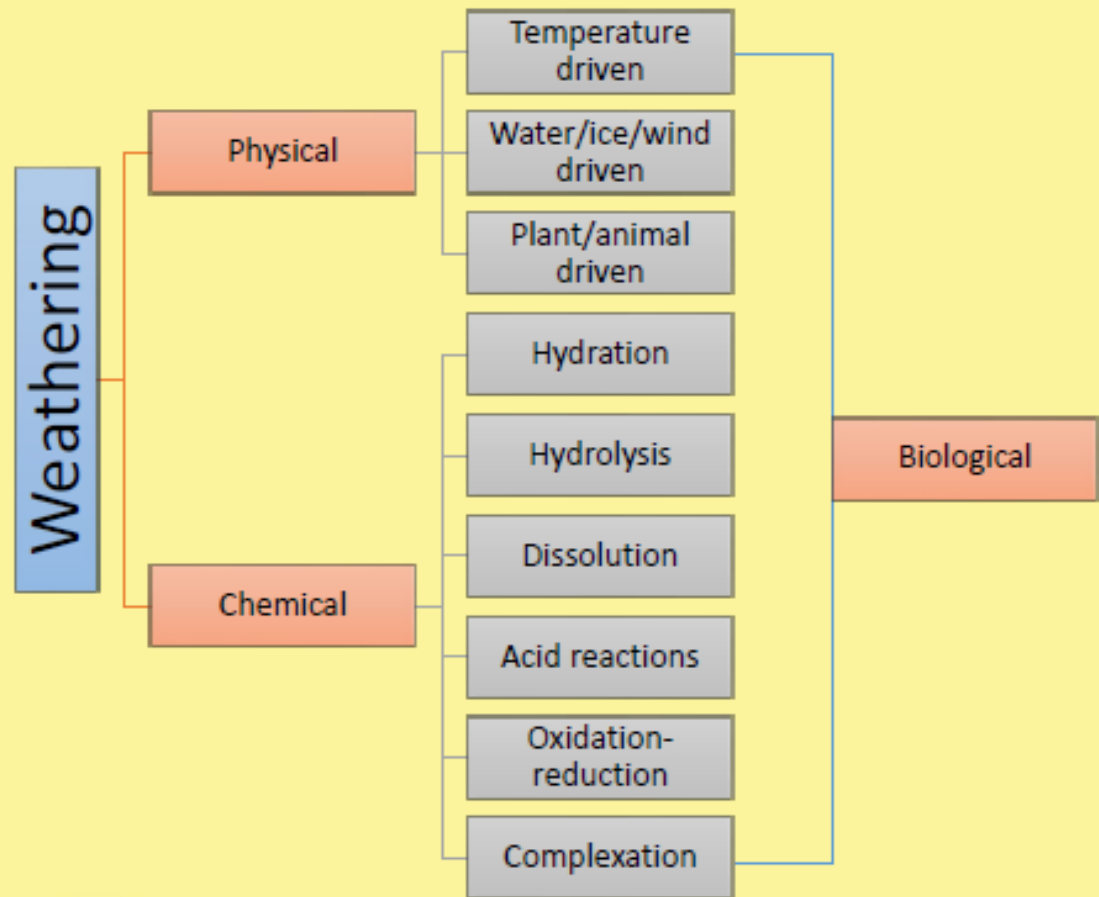
- Slate rock (1798) on the left – resistant to weathering
- Marble rock (1875) in the right – susceptible to weathering



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Types of weathering





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Different agents of weathering

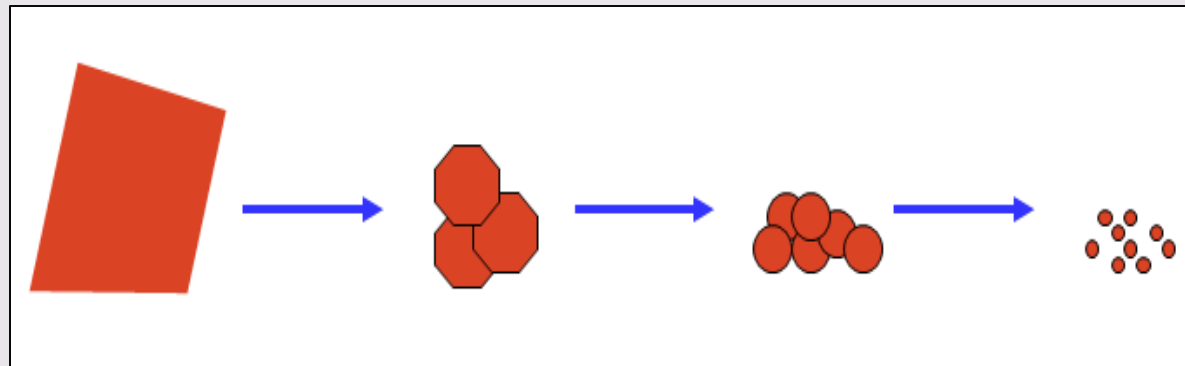
Physical/ Mechanical (disintegration)	Chemical (decomposition)	Biological (disint + decomp)
1.Physical condition of rock	1.Hydration	1.Man & animals
2.Change in temperature	2.Hydrolysis	2. higher plants & their roots
3.Action of H ₂ O	3.Solution	3.Micro organisms
-fragment&transport	4.Carbonation	
- action of freezing	5.Oxidation	
- alter. Wet & drying	6.Reduction	
- action of glaciers		
4.Action of wind		
5.Atmosph.electric pheno		



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Physical/Mechanical weathering (disintegration)

No change in chemical composition--just disintegration into smaller pieces

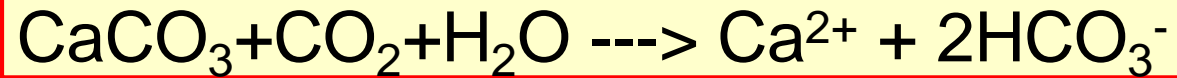




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Chemical weathering (decomposition)

Breakdown as a result of chemical reactions





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Physical/Mechanical weathering (disintegration)

Physical breakup

- **pressure release**
- **water: freeze - thaw cycles**
- **crystallization of salt in cracks**
- **thermal expansion and contraction**

All this increases the total surface area exposed to weathering processes.



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Physical/Mechanical weathering (disintegration)

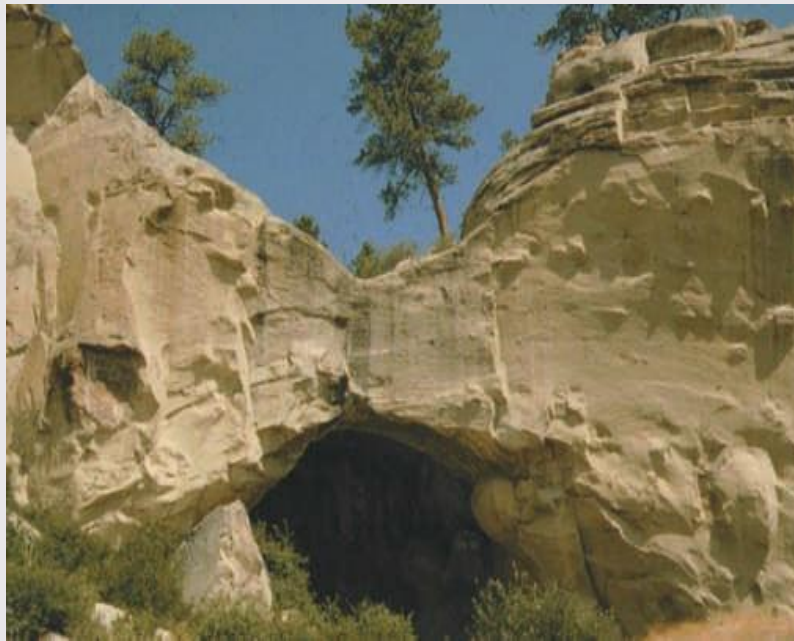
- What causes Mechanical Weathering?
- **Temperature:**
 - Rocks expand/contract (cycle).
 - Causes exfoliation (flaking)
- **Frost wedging:**
 - Water seeps into small cracks, freezes and expands, which enlarges cracks. (cracks in sidewalk, potholes in road)
- **Organic Activity: (caused by living things)**
 - Plant roots can loosen rock, make cracks larger (grass in sidewalk) → called **root-pry**
- **Abrasion: wearing away of rocks by particles carried by wind, water, etc.**
 - Rough edges of particles 'scrape' off parts of rocks.
 - Rocks in a riverbed are scraped by moving objects in the water
 - they become smooth



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Physical/Mechanical weathering (disintegration)



Ray R. Weil

Water driven



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Ice driven



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Physical/Mechanical weathering (disintegration)



<http://uregina.ca>

Exfoliation



gis.ess.washington.edu

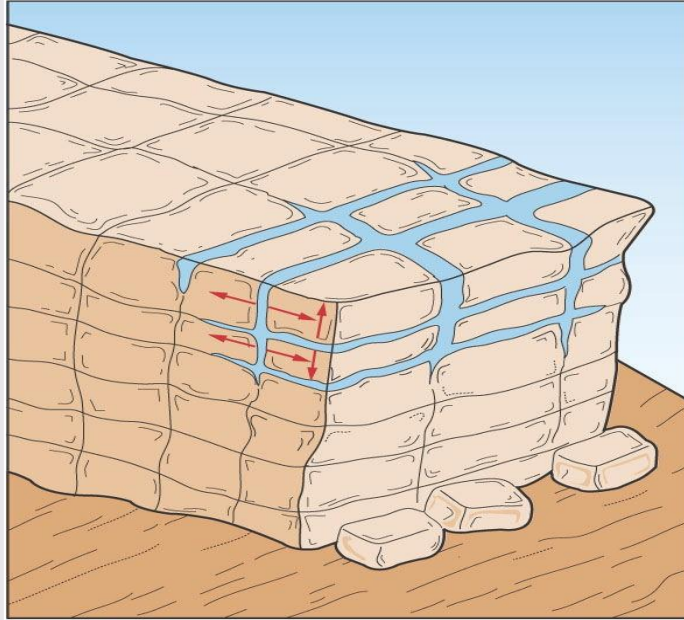
**Exfoliated Domes,
Yosemite**



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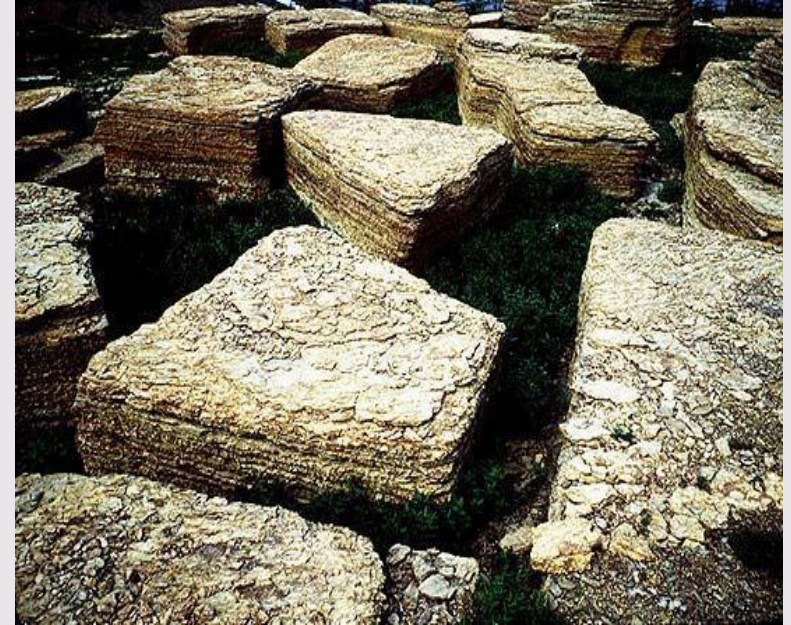
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Physical/Mechanical weathering (disintegration)



© 2004 Thomson - Brooks/Cole

**Frost
Wedging**



**Frost
Wedging**

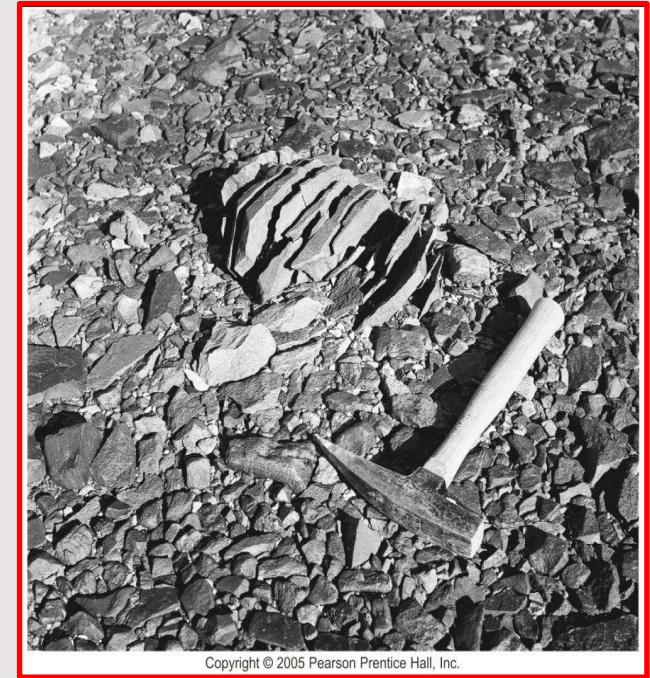


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Physical/Mechanical weathering (disintegration)

- Thermal expansion due to the extreme range of temperatures can shatter rocks in desert environments
- Repeated swelling and shrinking of minerals with different expansion rates will also shatter rocks



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gis.ess.washington.edu

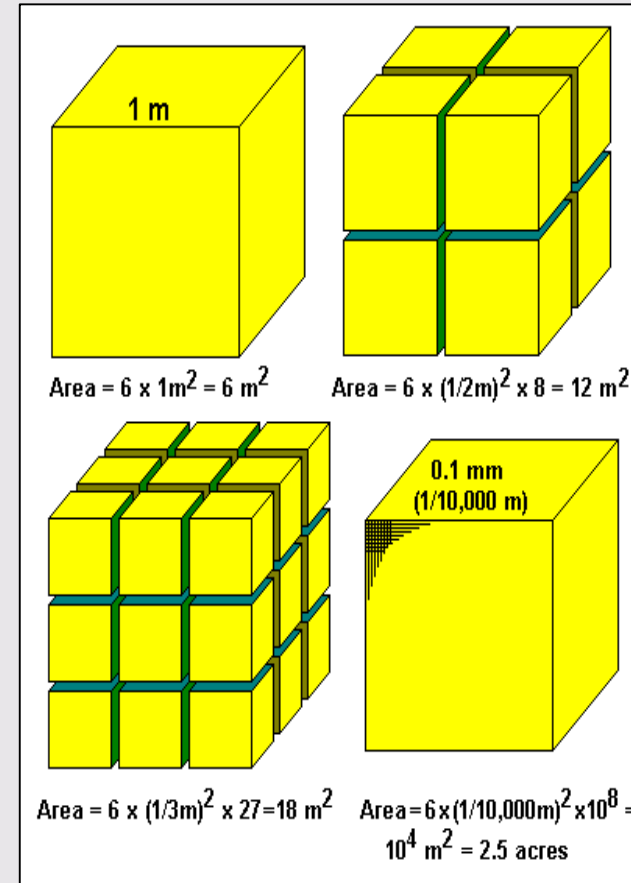


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Role of physical weathering (disintegration)

- 1) Reduces rock material to smaller fragments that are easier to transport
- 2) Increases the exposed surface area of rock, making it more vulnerable to further physical and chemical weathering





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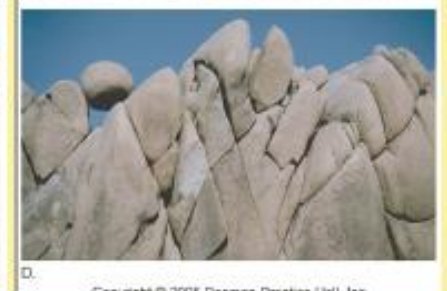
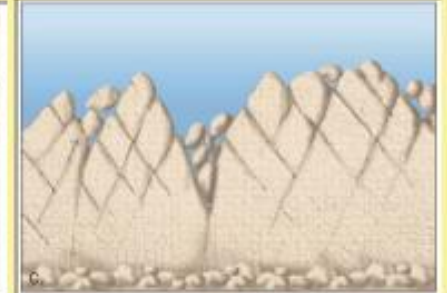
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Rate of physical weathering (disintegration)

Joints in a rock are a pathway for water – they can enhance mechanical weathering



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Chemical weathering (decomposition)

Transformation/decomposition of one mineral into

another Mineral breakdown

- **carbonate dissolves**
- **primary minerals --> secondary minerals
(mostly clays)**

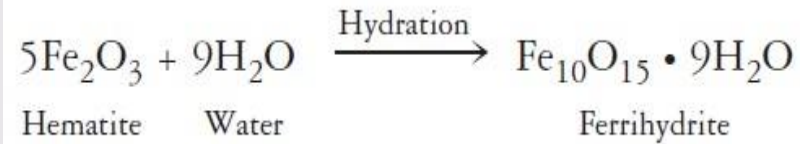


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Chemical weathering

- Hydration: attachment of water molecules to crystalline structure of a rock, causing expansion and weakness



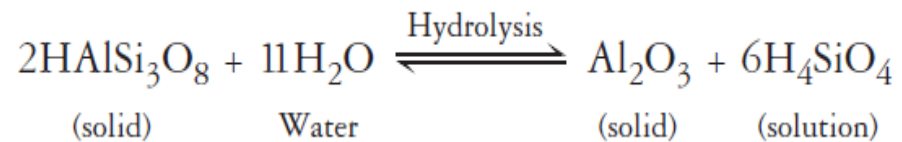
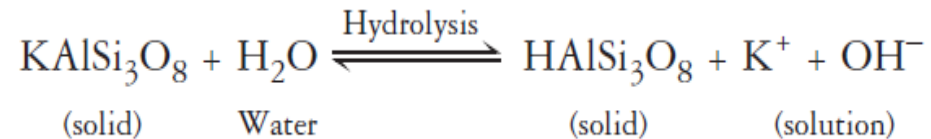


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Chemical weathering

□ **Hydrolysis: combination of hydrogen and oxygen in water with rock to form new substances**

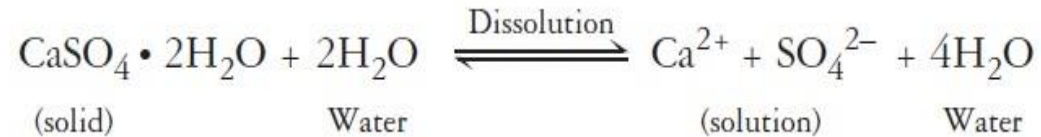




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Chemical weathering

□ **Dissolution: process by which rock is dissolved in water**



Strongly influenced by pH and temperature

- **When water becomes saturated, chemicals may precipitate out forming *evaporite* deposits**
- **Calcium carbonate (calcite, limestone), sodium chloride (salt), and calcium sulfate (gypsum) are particularly vulnerable to solution weathering**

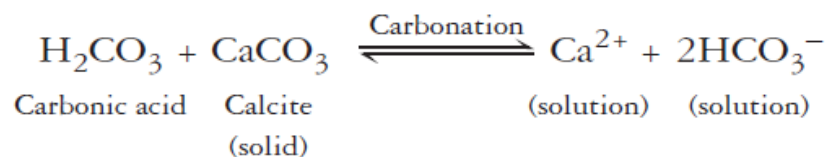
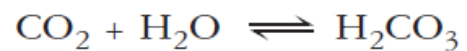


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Chemical weathering

□ Acid reactions/Carbonation



+ H_2CO_3
(acid)



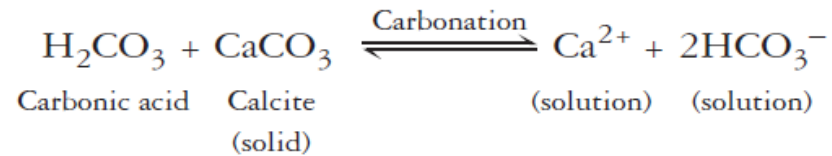
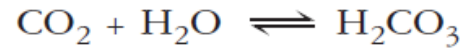


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Chemical weathering

□ Acid reactions/Carbonation



+ H₂CO₃
(acid)

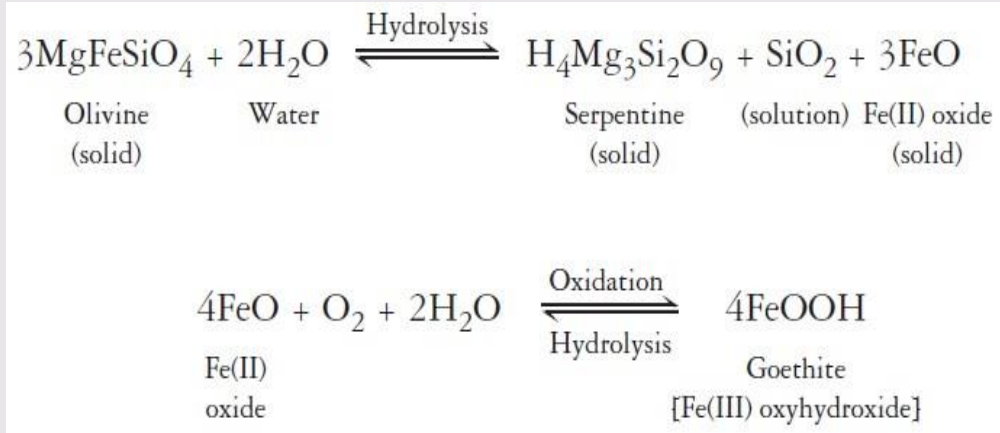




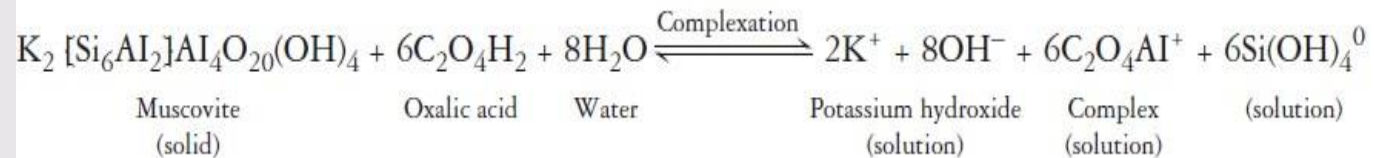
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Chemical weathering

☐ Oxidation-Reduction



☐ Complexation





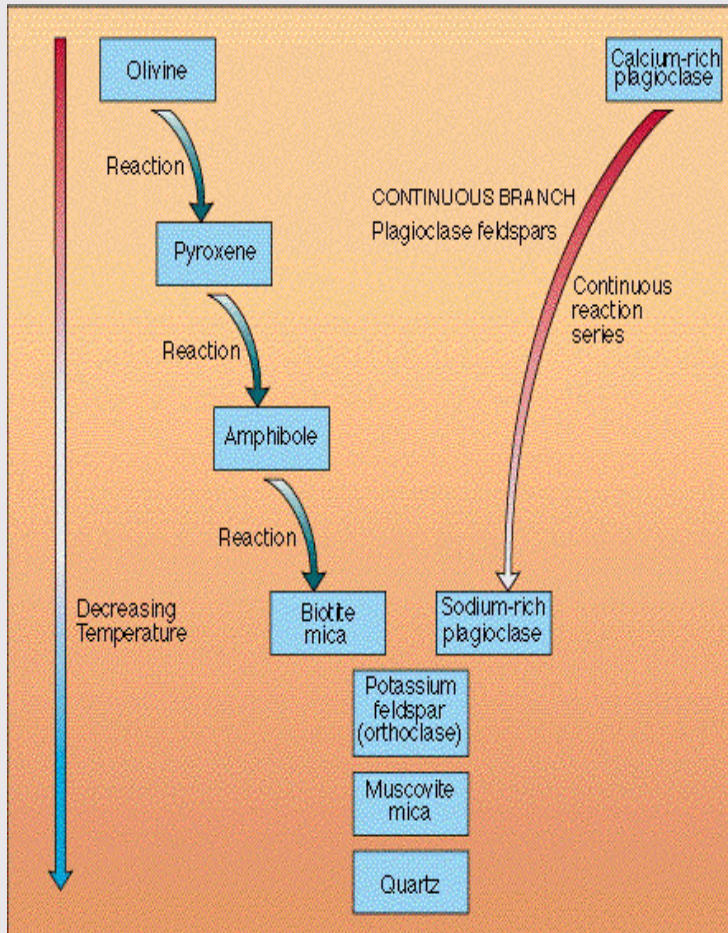
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Resistance to weathering

First to
Crystallize

Bowen's Reaction Series

Last to
Crystallize



Fast
Weathering

Goldrich Stability Series

Slow
Weathering

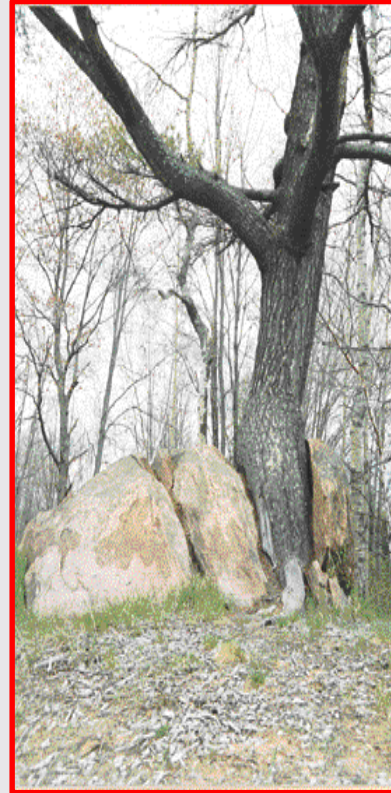


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Biological weathering

Can be both chemical and mechanical in nature.

- roots split rocks apart
- roots produce acids that dissolve rocks.
- tree throw
- burrowing animals



<https://sciencing.com/biological-weathering-5633317.html>



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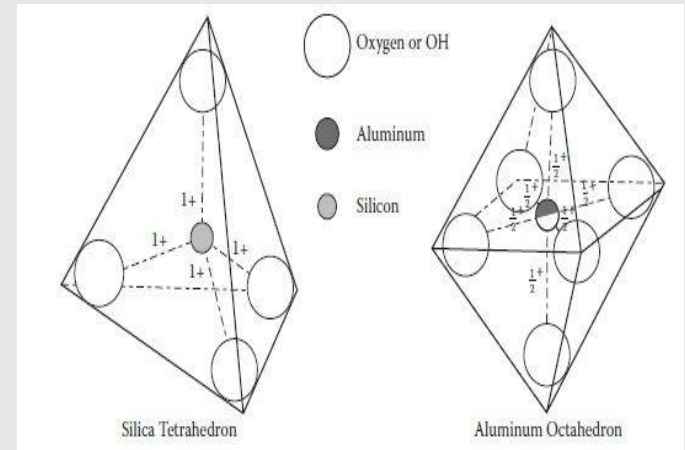
Stability and weathering of soil minerals

The relative resistance of mineral to weathering processes is determined by its internal structure

Depends on the strength of the atoms or ions binding their neighboring ions in the crystal lattice of the mineral

Four major types of binding forces between atoms in crystals: **ionic, homopolar, metallic, and van der Waals forces.**

The bonds in the crystal structure of soil minerals are considered to be mostly **ionic**





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Stability and weathering of soil minerals

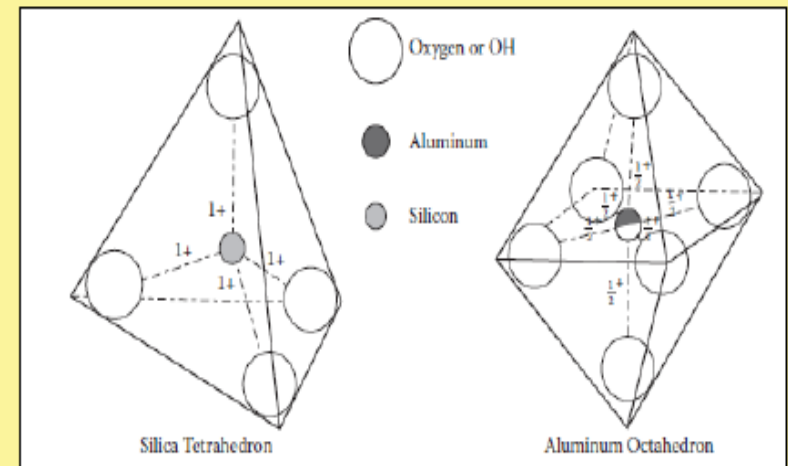
Stability and weathering of soil minerals

The major coordination polyhedra in soils are Al-octahedra and Si-tetrahedra

Share crystal edges, faces, or vertices (points of intersects).

Edge and face sharing reduce the distance between the ions in the polyhedron, and hence increase repulsion between ions with similar charges → destabilize the crystal structure

A major force for destabilization of an ionic crystal is considered the **Coulombic repulsion force** between cations





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Weathering

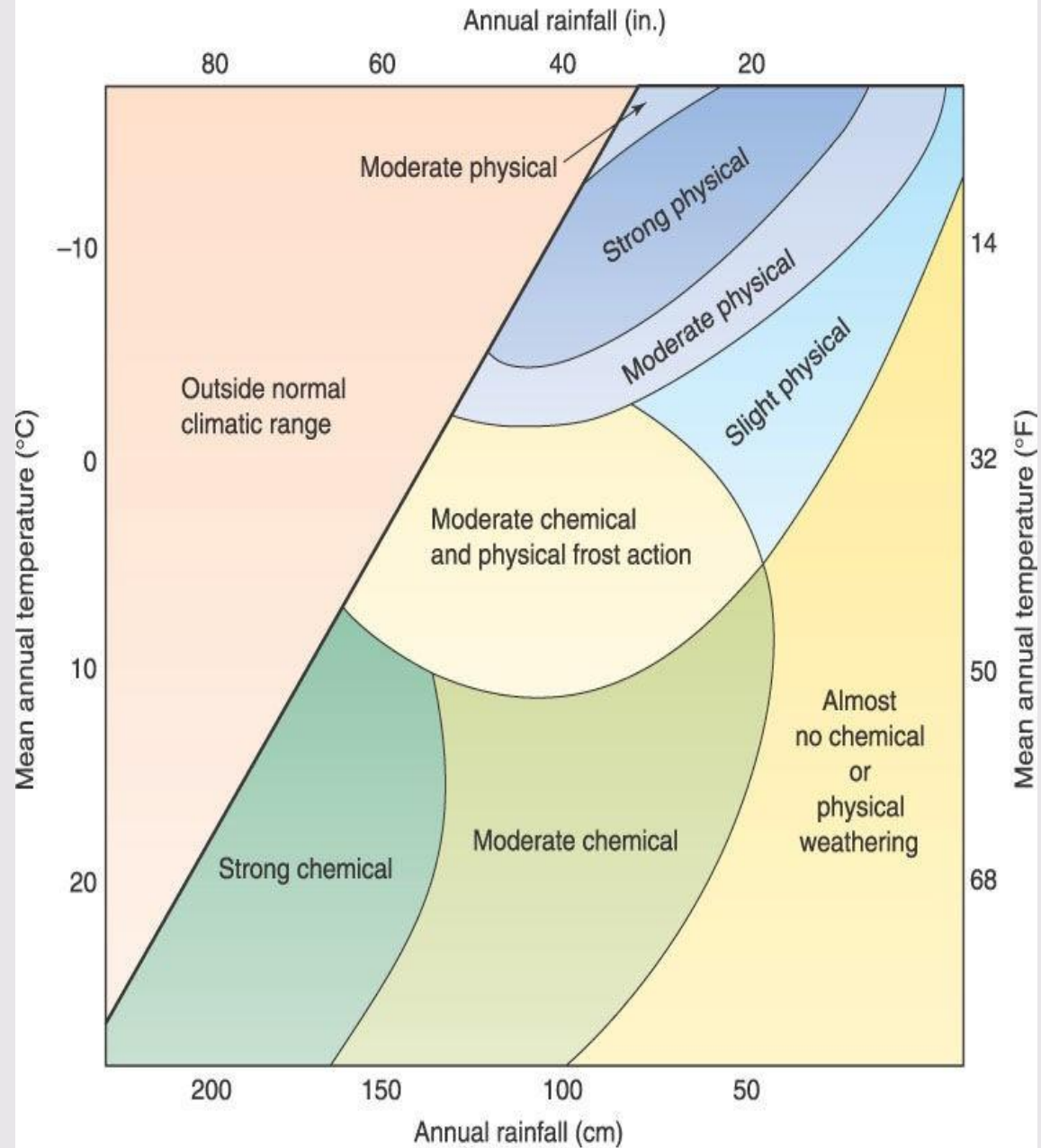
- **Climate**
 - **Temperature and moisture characteristics**
 - **Chemical weathering**
 - **Most effective in areas of warm, moist climates – decaying vegetation creates acids that enhance weathering**
 - **Least effective in polar regions (water is locked up as ice) and arid regions (little water)**
- **Mechanical weathering**
 - **Enhanced where there are frequent freeze-thaw cycles**



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THEORETICAL WEATHERING REGIONS

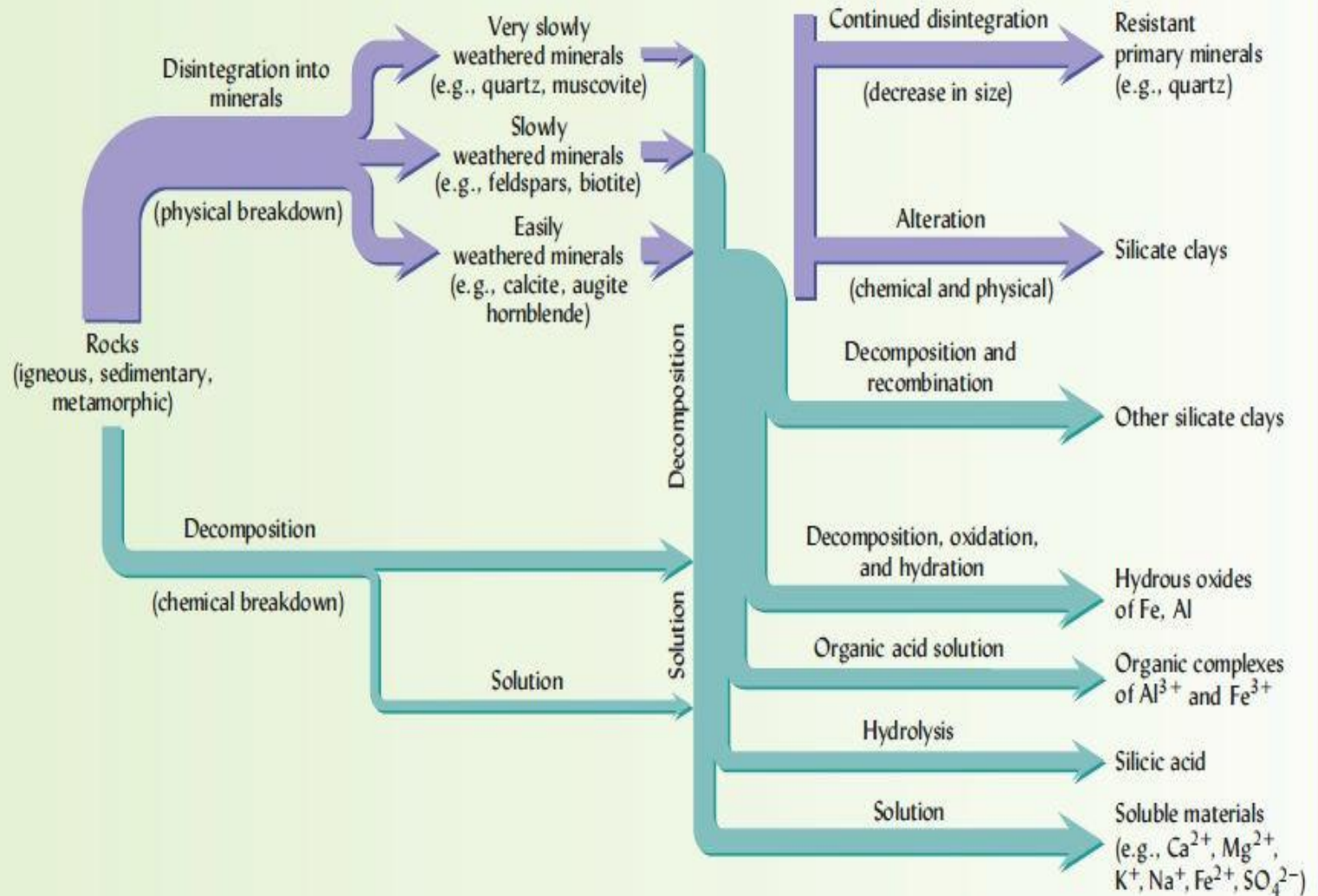




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Pathways of weathering

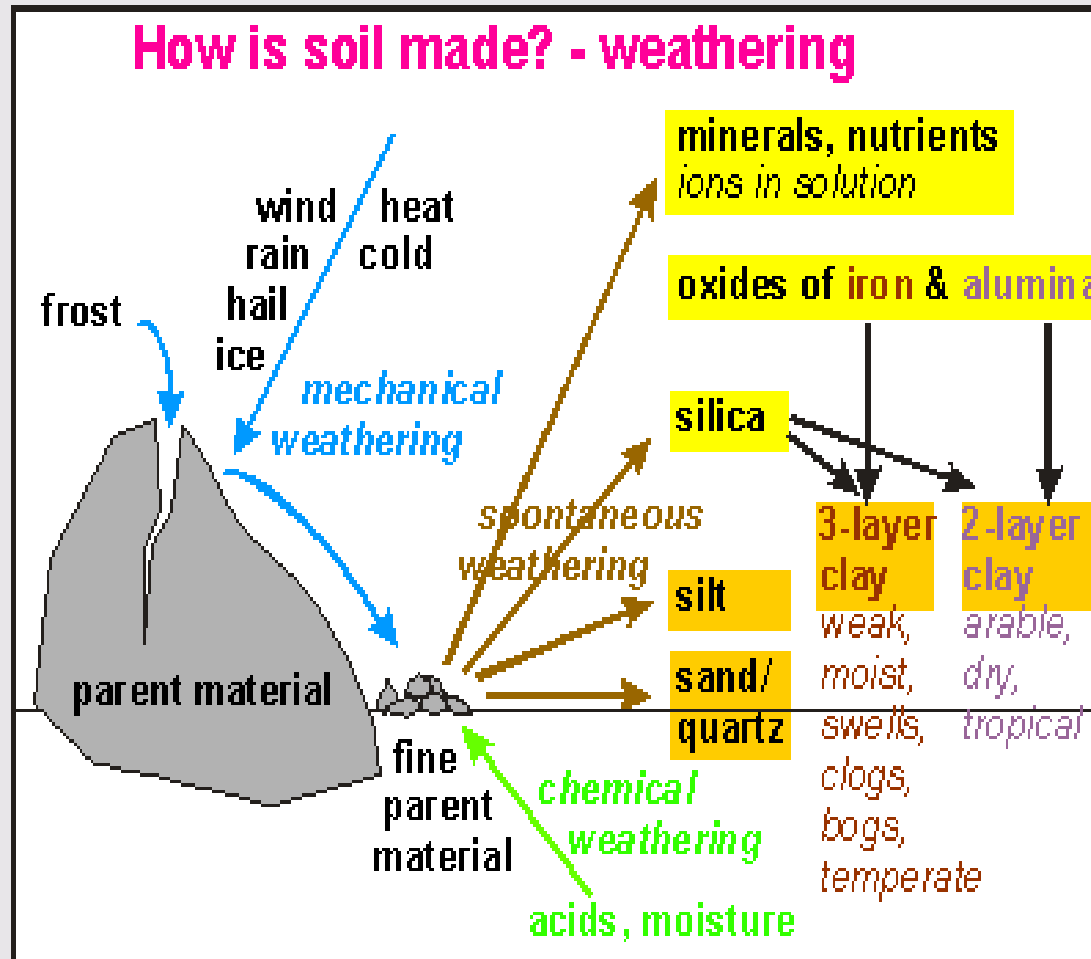




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Weathering at a glance





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End of session