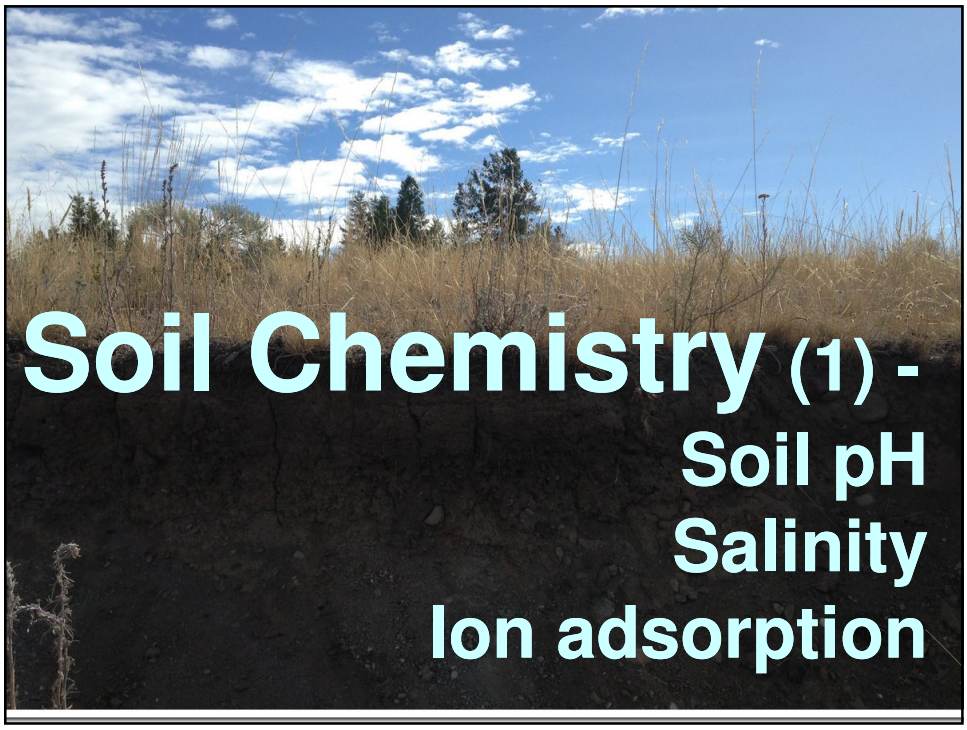
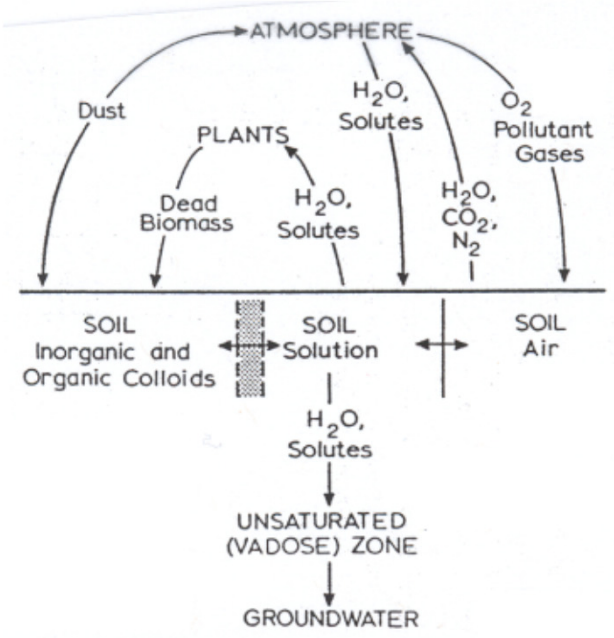

APBI 200
SOIL COMPONENTS

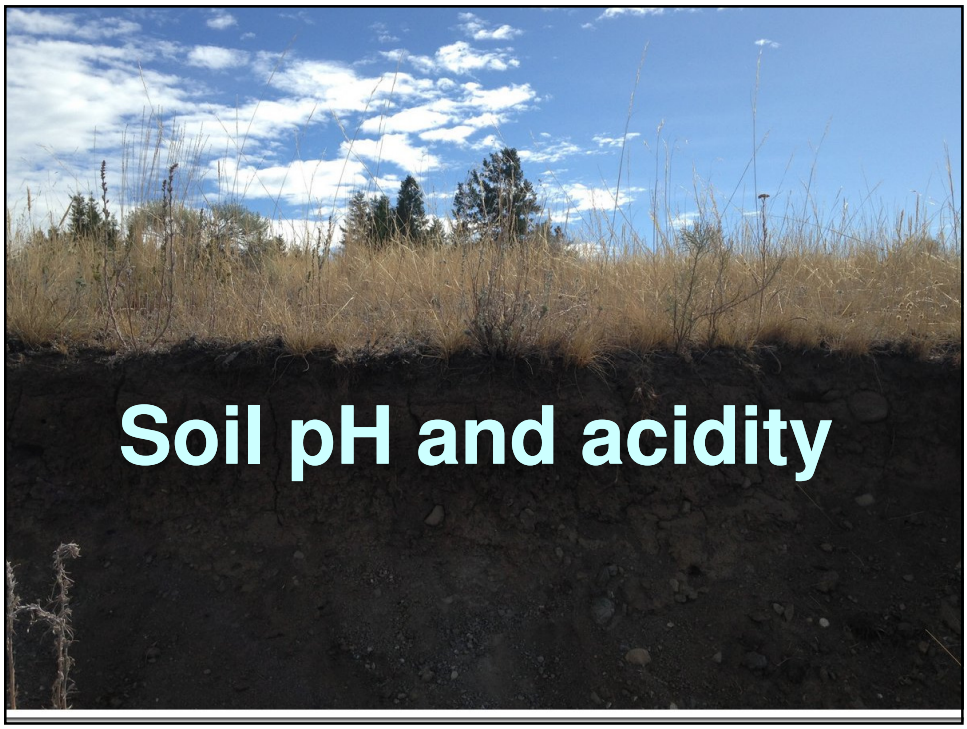

Soil Chemistry (1) -
Soil pH
Salinity
Ion adsorption

Soil chemistry is the branch of soil science that deals with the chemical constituents, their properties, and reactions in soils



Lecture outline

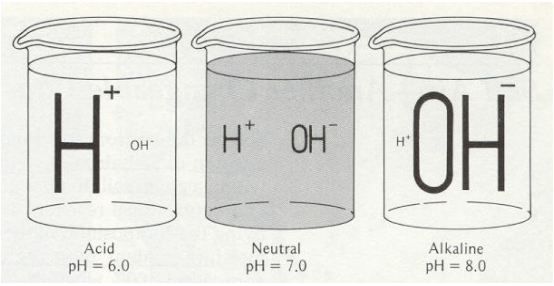
- Soil pH and acidity
- Soil salinity
- Ion adsorption



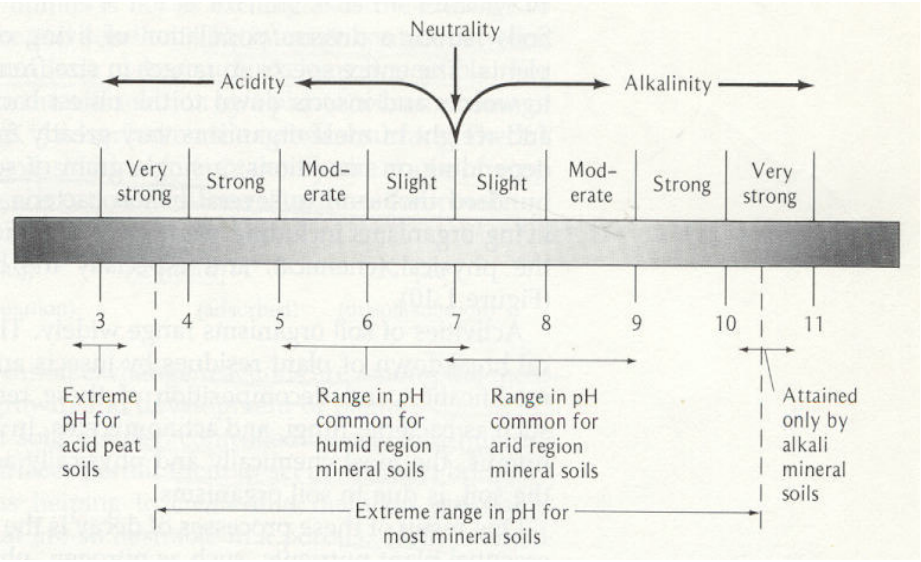
The pH is defined as:

$$pH = \log \frac{1}{[H^+]} = -\log[H^+]$$

- **Neutral soil** - pH 7 (when H^+ and OH^- ions are equally abundant)
- **Acidic soil** - pH<7 (more H^+ than OH^- ions present)
- **Alkaline (basic) soil** - pH>7 (more OH^- than H^+ ions present)



Ranges in pH usually found in soils



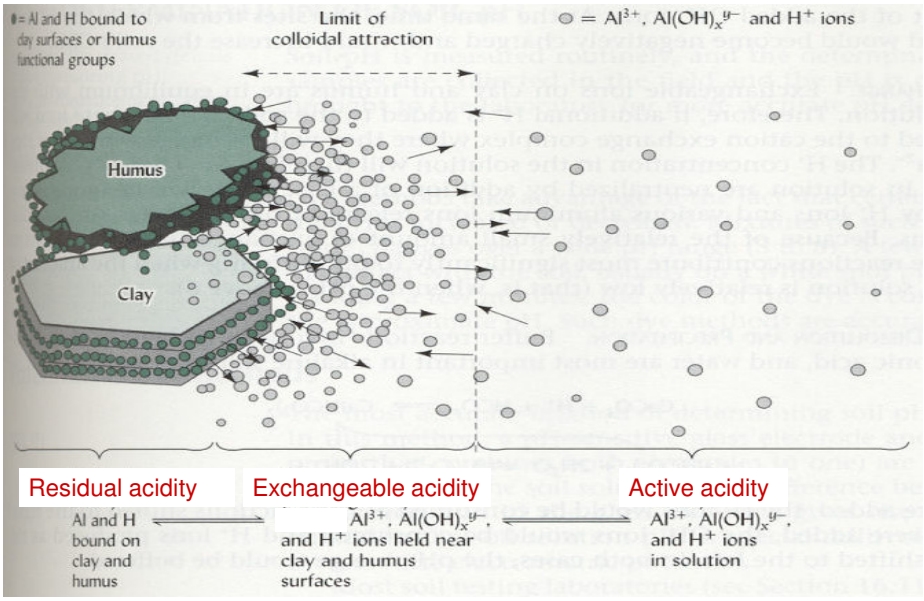
Role of aluminum in soil acidity

$$Al^{3+} + H_2O \leftrightarrow AlOH^{2+} + H^+$$

Pools of soil acidity:

- **Residual acidity** is associated with H^+ and Al^{3+} ions that are bound (non-exchangeable) on soil particles
- **Exchangeable acidity** is associated with H^+ and Al^{3+} ions that are easily exchanged by other cations in the soil solution
- **Active acidity** is due to H^+ and Al^{3+} ions in the soil solution

Classification of soil acidity

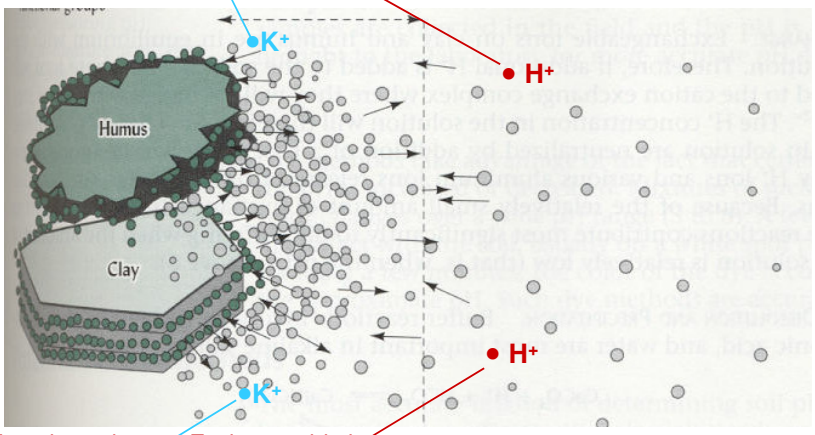


Buffering capacity

pH-buffer is a material, which contributes to system's resistance to change in pH when acids or bases are added

Most soils have a significant buffering capacity mostly due to clays and organic matter

$$R\text{-}COOK + H^+ \leftrightarrow R\text{-}COOH + K^+$$



Ions bound on colloids

Exchangeable ions held near colloidal surfaces

Ions in soil solution

$$K\text{-clay} + H^+ \leftrightarrow H\text{-clay} + K^+$$

- **Salinity** refers to the salt content in the soil
- **Salinization** is the process of increasing the soil salinity

Salt Lake, Kelowna B.C.

Salts will accumulate at the soil surface when internal drainage is inadequate to remove excess salts

Electrical conductivity (EC) is the capacity of a substance to conduct (transmit) electrical current

Sodium status in soil

Exchangeable sodium percentage (ESP)
Identifies the degree to which the exchange complex is saturated with sodium

$$ESP = \frac{Exchangeable\ sodium}{Cation\ exchange\ capacity} \times 100$$

Classification of halomorphic soils

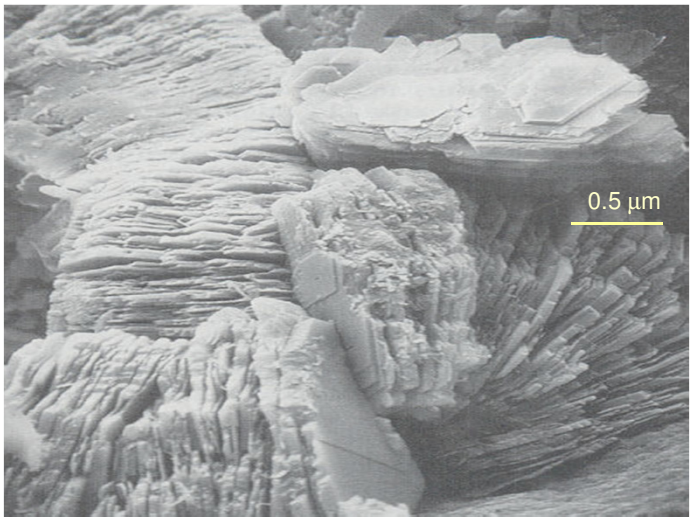
Category	EC of saturated extract		ESP	pH
	(S/m)	(mmho/cm)		
Saline	>0.4	>4	<15	<8.0
Saline-sodic	>0.4	>4	>15	~7.5 to 8.5
Sodic	<0.4	<4	>15	>8.5

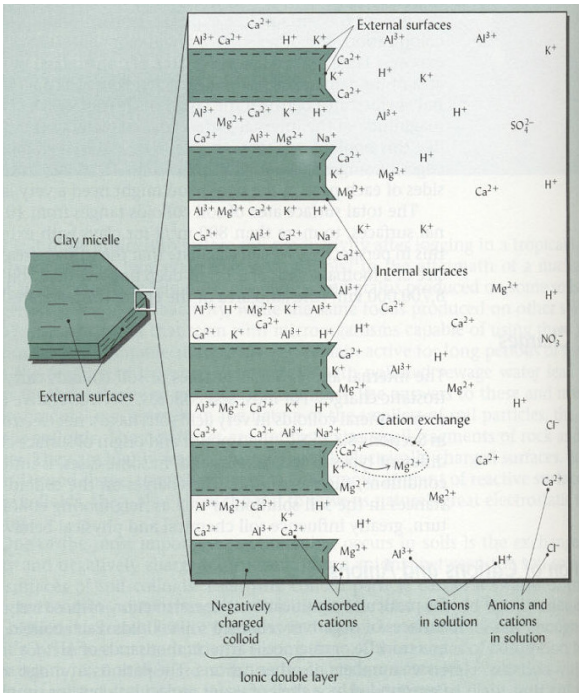
Photo: Wikimedia

What are consequences of soil salinity?

- Detrimental effects on plant growth (remember osmotic potential)
- Reduction of water quality
- Soil erosion ultimately, when crops are too strongly affected by high amounts of salts
- Damage to infrastructure (roads, bricks, corrosion of pipes and cables)
- **Sodic soils → dispersion, surface sealing, decrease infiltration**

Soil colloids act as a "*bank*", retaining essential plant nutrients





Clay micelle, adsorbed ions, and ions in the surrounding soil solution

The relative strength of ion adsorption onto negatively charged solids is indicated by the **lyotropic series**

$$Ca^{2+} > Mg^{2+} > K^{+} \approx NH_4^{+} > Na^{+}$$

Coulomb's Law:

$$F = k\frac{e_1 e_2}{Ks^2}$$

F = force of attraction or repulsion between 2 ions [N = kgm/s^2]
e_1, e_2 = amount of electrical charge on an ion [C]
k = proportionality constant = 8.9x10^9 [Nm^2/C^2]
K = dielectric constant
s = distance of charge separation [m]

Ionic radii of alkali metals