SOIL QUALITY

CATIONS IN RELATION TO SOIL QUALITY AND PLANT GROWTH

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Tuesday, November 29, 2016

LAB REAGENTS

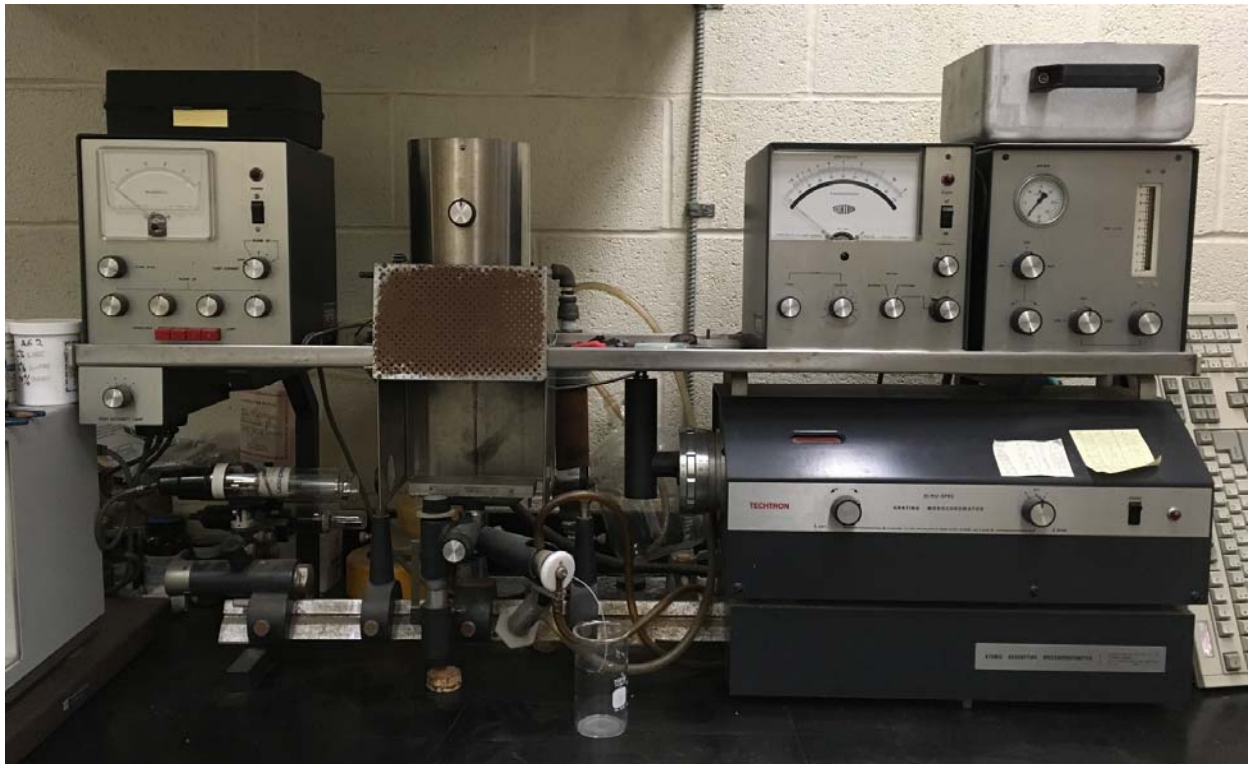
Lab Reagents:

- Ammonium Acetate (NH_4OAc) – displaces the cations from exchangeable sites on soil particles, replacing them with ammonium cations
- Lanthanum Chloride ($LaCl_3$) – releasing agent, chemical which protects measured atoms in the flame from forming compound with other molecular or ionic species which depresses the absorption.

Lab Methods:

- Weight out 3g of soil.
- Add NH_4OAc, cover and shake for 30 minutes.
- Filter and suction.
- Take an aliquot of soil extract into flask, add $LaCl_3$
- Get a ppm reading from the AAS.

ATOMIC ABSORPTION SPECTROPHOTOMETRY



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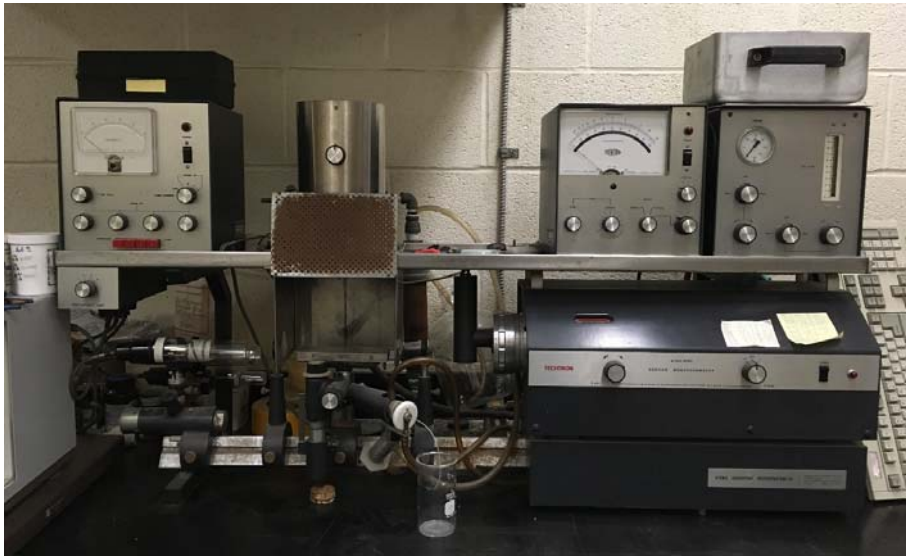

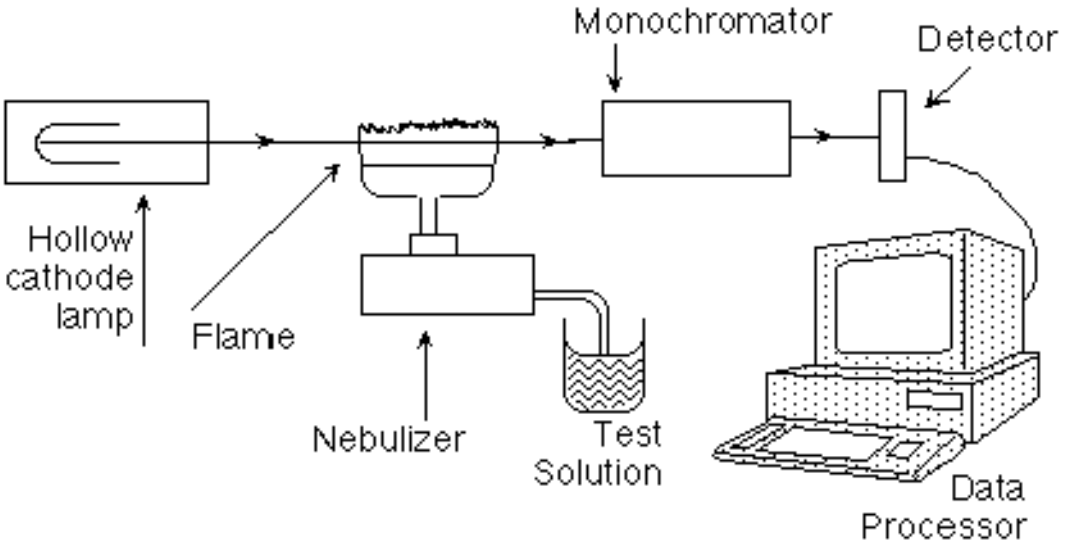

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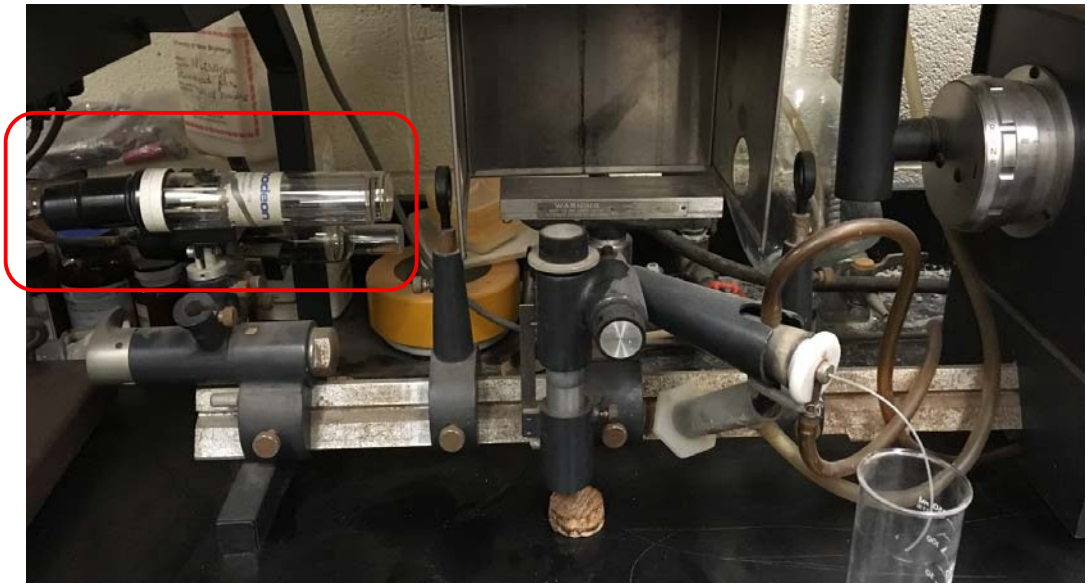
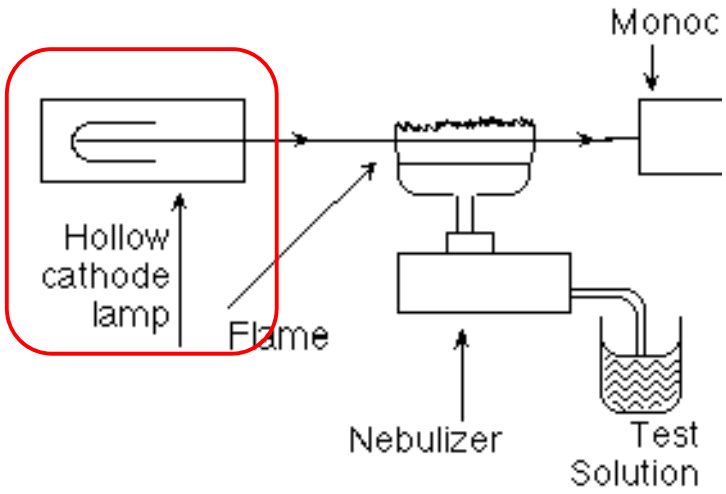
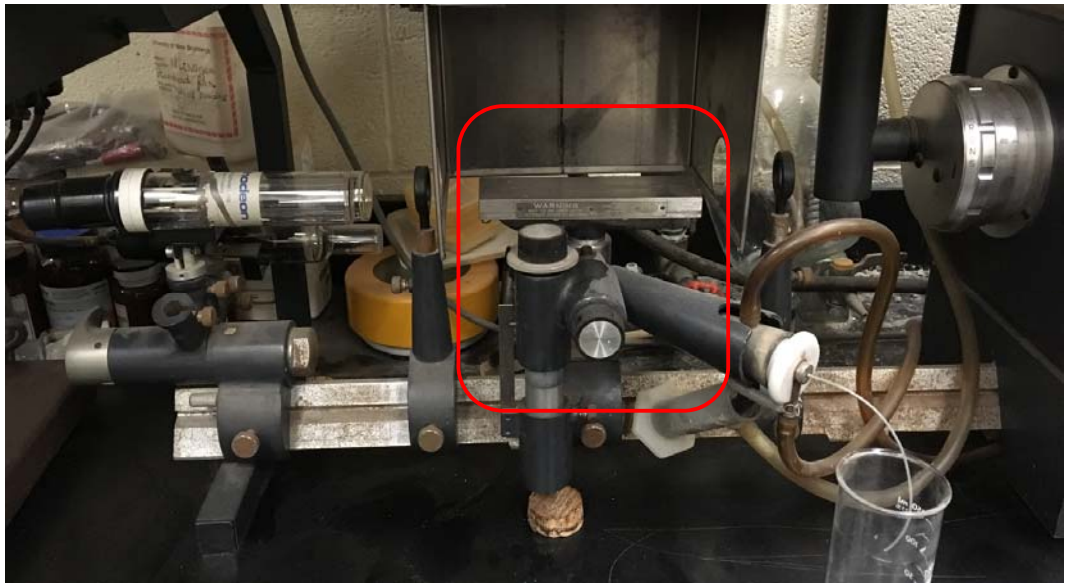
ATOMIC ABSORPTION SPECTROPHOTOMETRY

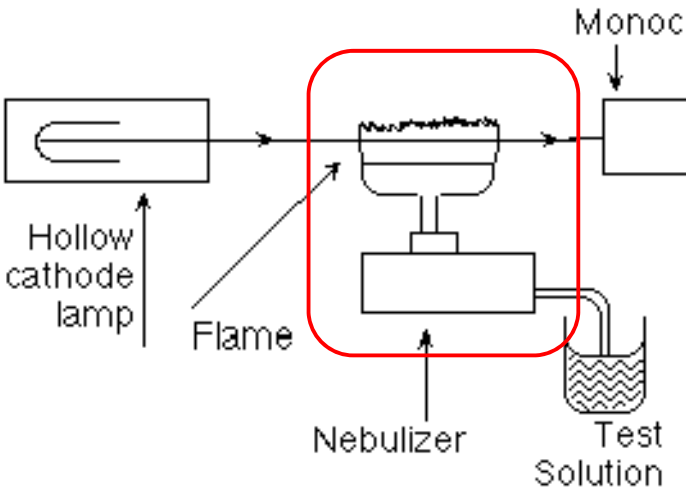




Light Source (Cathode lamp): emits atomic spectrum of specific element. We use calcium, magnesium, and potassium cathode lamps.

ATOMIC ABSORPTION SPECTROPHOTOMETRY





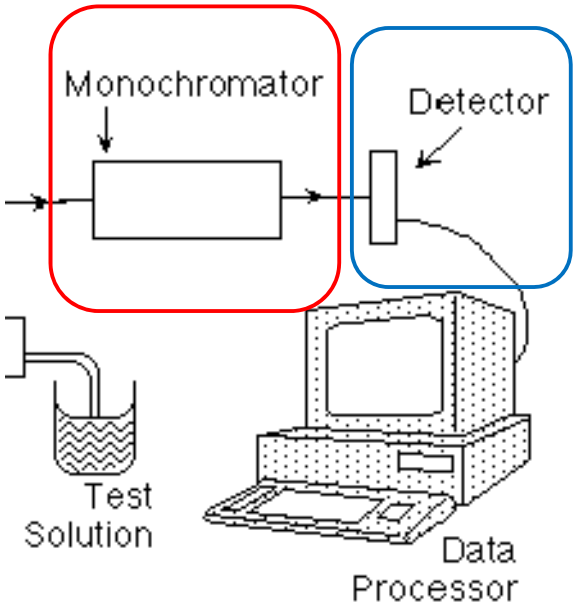
Nebulizer: Takes in the test solution and converts liquids to a mist and burns it in a flame. The elements are aspirated with the flame.

ATOMIC ABSORPTION SPECTROPHOTOMETRY

Monochromator: optical device that mechanically disperses light source to select a specific wavelength of light.

Detector: produces electrical current that is proportional to the light intensity absorbed.

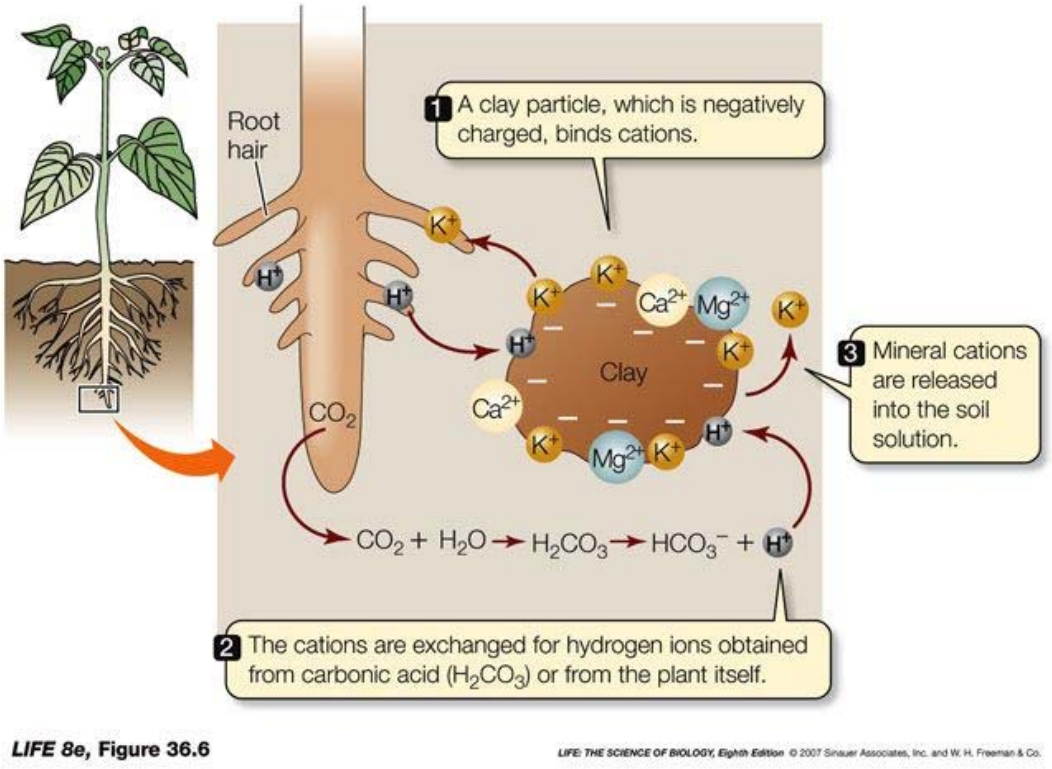
This process gives a concentration of each specific metal cation introduced into flame by aspiration.



CATION EXCHANGE CAPACITY

- The capacity of the soil to hold **cations**, including nutrient and non-nutrient ones.
- **Does CEC alone give a picture of soil fertility?**
  - If you don't know your proportions of base cations (nutrient rich), to acid cations (cause leaching), you can't tell fertility. Only potential fertility.

$$CEC\left(\frac{meq}{100g}\right) = (2 * \%OM) + (0.5 * \%Clay)$$

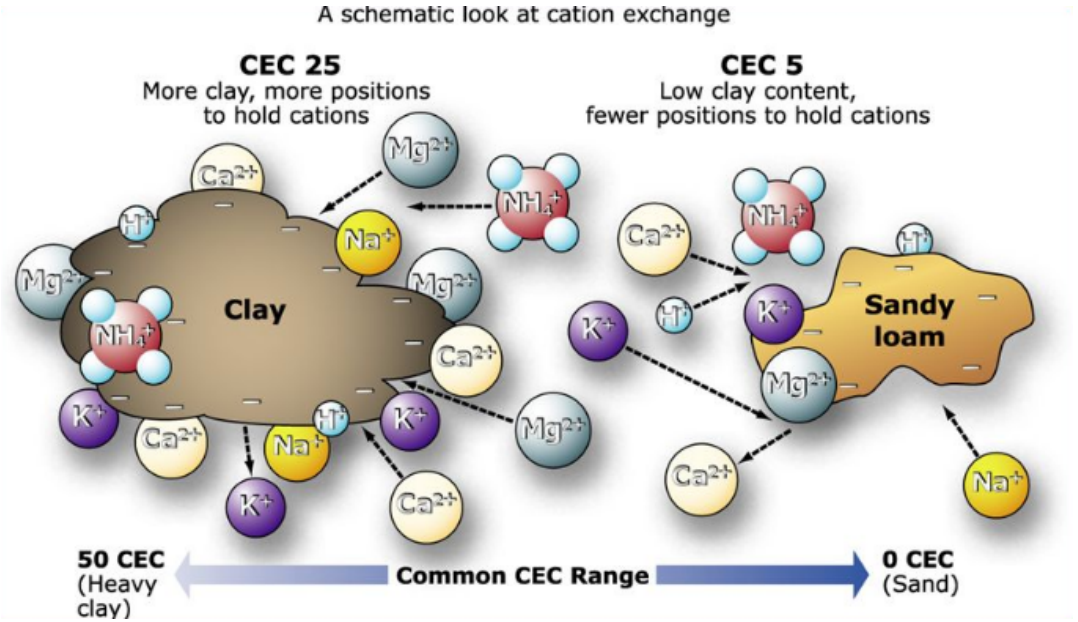


LIFE 8e, Figure 36.6

LIFE: THE SCIENCE OF BIOLOGY, Eighth Edition © 2007 Sinauer Associates, Inc. and W. H. Freeman & Co.

CEC, OM & TEXTURE

- **<u>What texture class do you think would have a high CEC?</u>**
- Clay has a much high CEC than sandy soils.
  - Increased surface area and exchangeable sites.



Grancominerals.com

CEC, OM & TEXTURE

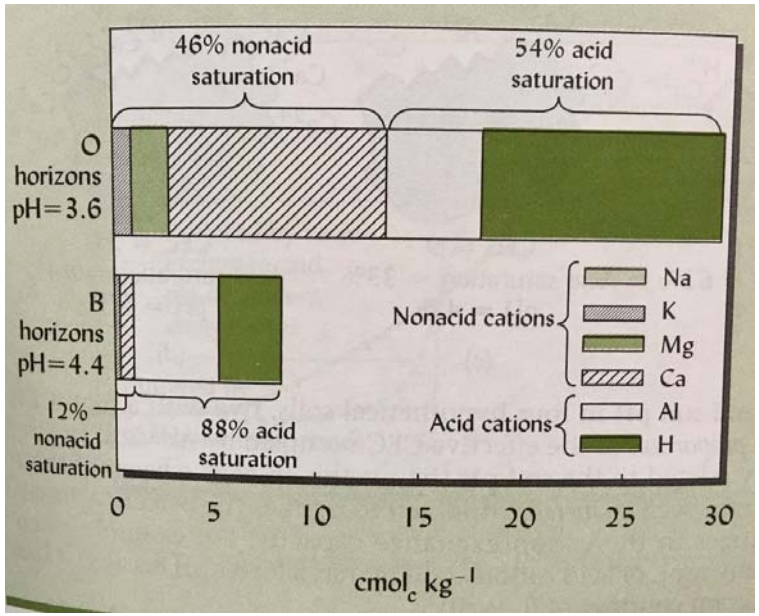
- Organic Matter similarly, is high in CEC.
  - Increased surface area and exchangeable sites.
  - Lots of negatively charged colloidal surfaces for cations to be absorbed towards.

BASE SATURATION

- Tells what percent of exchangeable sites are occupied by base cations.
- **Base cations** are:
  - Calcium Ca^{2+}
  - Magnesium Mg^{2+}
  - Potassium K^{+}
- **Acid cations** are:
  - Hydrogen H^{+}
  - Aluminum Al^{3+}

Not plant nutrients!

$$BS\% = \frac{K + Ca + Mg + Na\left(in\ \frac{meq}{100g}\ or\ \frac{eq}{ha}\right)}{CEC\left(in\ \frac{meq}{100g}\ or\ \frac{eq}{ha}\right)} * 100$$



CA, K, MG

- **Calcium:**
  - Plant elongation
  - Cell wall structure
  - Improves/regulates stomata function (closes them in heat)
- **Potassium:**
  - Stimulates early growth
  - Protein production (new tissues)
  - Improves resistance to diseases.
- **Magnesium:**
  - Aids in photosynthesis, building block of chlorophyll (green leaves).
  - Stabilized cell membranes, metabolizes carbohydrates.

* Product of rock and mineral weathering.

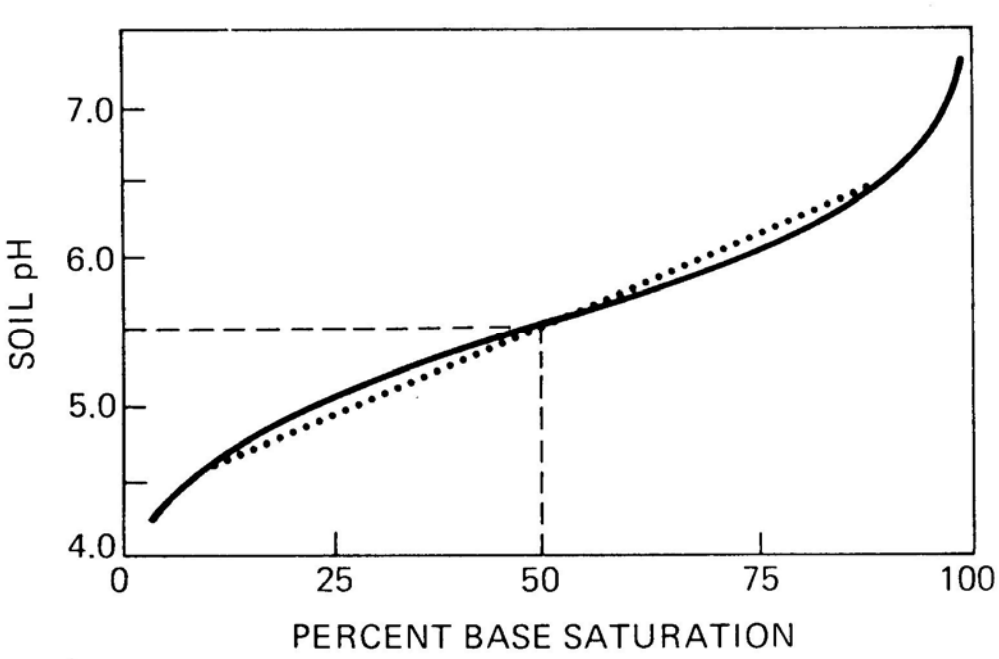
Would a fine grain volcanic basalt have more or less CEC than a grey sandstone?

BASE SATURATION AND PH

- As Base Saturation increase pH increase.
- **WHY?**
  - Increasing the base cations, lowers the amount of acid cations which are responsible for acidifying the soil.

↓ H^+ Al^{3+} ↑ Ca^{2+} K^+ Mg^{2+} = high BS, high pH, alkaline

↑ H^+ Al^{3+} ↓ Ca^{+2+} K^+ Mg^{2+} = low BS, low pH, acidic



Agronomy.lsu.edu

CEC SOIL PROFILE EXAMPLE

Horizon	CEC cmol/kg	BS %
LFH	75	17
Ae	13.5	8
Bf1	49.4	2
Bf2	20.3	2
BC	6.9	5
C	4.5	26

What does this profile tell us about soil fertility?

LFH? Ae? Bf? Trend going down?
BS? Look at the Bf horizons. Surprised? Bf is rich in Al^{3+}, H^{+}, and Fe^{3+}. Not rich horizon in terms of fertility.

CEC SOIL PROFILE EXAMPLE

Horizon	CEC cmol/kg	BS %
LFH	123.9	66
Ah1	73.1	93
Ah2	47.1	93
Bm	25.0	88
BCg	17.6	79
Cg	19.3	79

What does this profile tell us about soil fertility?

Why is this site different?

- LFH composition, probably deciduous, easily broken down making cations accessible. (↑ OM = ↑ CEC)
- Moisture (BCg and Cg = moist, gleyed soils, water can wash away nutrients but it can also bring in nutrients ex. Low CEC but high BS)