EPSS C113/C213, Feb. 5, 2018
Lecture 8: Soil chemistry and properties.
Reading: Chapter 4 of Schlesinger

1. Weathering and nutrients.
    a. Plants & animals need access to chemicals (nutrients) to grow. Generally these need to be in the air or water to be taken up.
    b. Big three in terrestrial ecosystems: N, P, K
    c. Oceans are rich in K, but often poor in N and P.
    d. Many trace nutrients (Fe, Mn, Cl, Zn, Cu, etc…)
2. Activity-pH diagrams for nutrients/toxins
    a. "simple" representation of behavior of elements in solutions with variable but related chemistry. (PO_4^{3-}, $Al^{3+}aq$)
    b. High-activity – lots of element in solution at equilibrium
    c. Low-activity – less element in solution at equilibriu
    d. Other chemical properties of solution (e.g., O_2, Cl^-, HCO_3^-) are assumed. If assumption are way off, diagrams will not give useful predictions!
    e. Equilibrium assumption not always correct! $SiO_2(aq) \rightarrow SiO_2(qz)$ can take years!
3. Cation/Anion Adsorption capacity
    a. Absorb – accumulate internally; Adsorb – accumulate on surface
    b. Adsorbtion- surface charge depends on pH
        i. low-pH, more H+, surfaces become positive
        ii. high-pH, less H+ more OH-, surfaces become negative
        iii. isoelectric points (neutral surface charge)
            1. silica (quartz or amorphous): pH ~2-4
            2. kaolinite: pH ~4-5
            3. metal oxides (Fe_2O_3, MnO_2): pH ~4-8
            4. metal hydroxides ($Al[OH]_3$, FeOOH): pH ~5-9
    c. Most clays have negative surface charge at neutral pH – therefore they attract cations. More surface area = more cations attracted.
    d. Aluminum/iron oxides tend to have positive surface charges, particularly at low pH, attract anions (e.g., PO_4^{3-}, SO_4^{2-})
4. Soil Structure – controlled by inputs (rain & plant material) and output (percolation, erosion). Top-to-bottom layering →
    a. O-horizon: organic-rich material
    b. A-horizon: minerals + organic, leached & flushed
    c. B-horizon: accumulated/precipitated secondary minerals, esp. clays. q
    d. C-horizon: fragmented & weathered bedrock/sediments.

e. Typical Alfisol (temperate forest – plenty of H_2O). Find O, A, B?
f. Arid-land soils often thinner, less weathered, with accumulation of carbonate minerals due to evaporation.

5. Rates & outcomes of soil formation
   a. How can we determine how fast a soil forms, & what the original chemical composition was?
   b. Contextual & direct dating techniques
   c. Normalizing elements


Altisol,
soils.USDA.gov