

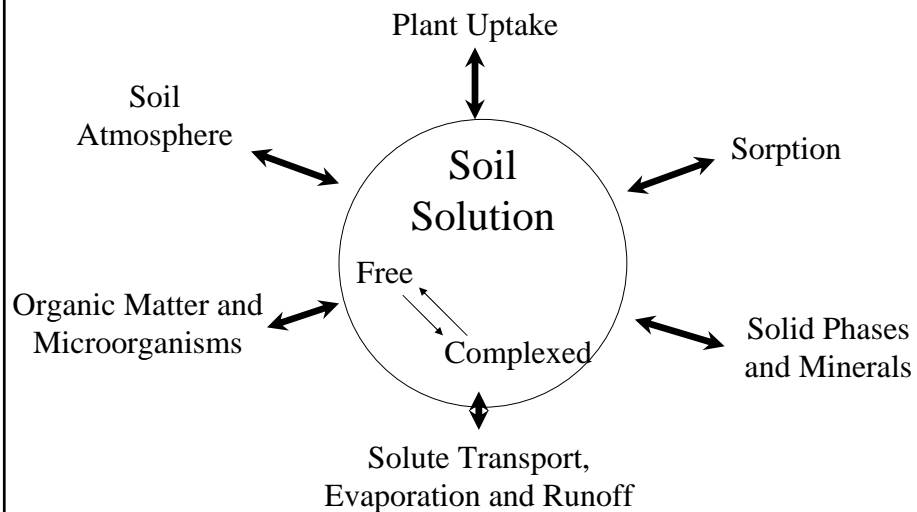
Soil Solution

- What is it?
- Methods
 - Extraction and Analysis
- Chemical Speciation
- Definition:

The aqueous liquid phase of the soil, and its solutes.

Glossary of Soil Science Terms

Soil Solution



From Sparks

Soil Solution

The chemical reactivity of soils is dominated by aqueous phase processes

- hydrolysis
- hydration
- redox
- dissolution / precipitation

Hydration

- Water molecules are polar
 - Liquid water is slush
- Hydration is stronger when the ion is smaller and/or the charge is higher.
- A Na^+ cation will have a larger hydrated radius than K^+ , and it will be more difficult (take more energy) to remove the water.

Ions in solution

- Thermodynamics applies only to substances that behave as ideal gases.
- In solution, ions do not behave ideally because of hydration and because they get in each others way.
- Activity is the term used for effective concentration--so that thermodynamics will work.
- $a_i = \gamma_i m_i$ a is activity, m is molality, γ is the activity coef.
- The Debye-Huckel equation calculates γ using the ionic strength (I) of the solution.
- $I = 1/2 \sum z_i^2 M_i$
- I can also be estimated from conductivity (Table 5.12)

Debye-Huckel equation

- $\log \gamma_i = -A z_i^2 (I^{1/2} / 1 + B a_i I^{1/2})$
- In water at 298K: $A = 0.5$ $B = 0.33$
- a_i depends on the size of the ion (values from table)
- z is the valence
- Example: What is the activity of H^+ in 10^{-3} molar HCl?
- Homework: What is the activity of Ca^{2+} in a solution of 0.01 molar $CaCl_2$?
 - a_i for Ca is 6 angstroms (\AA) or 6×10^{-10} m
- Other homework: Problem 12, Chapter 4

Hydrolysis

- ionic potential = Z/r
- cations with $IP < 0.03$ stay hydrated
 - do not hydrolyze
- cations with $0.03 < IP < 0.1$ hydrolyze
- ions with $IP > 0.1$ form stable oxyanions

Soil Solution

- Intensity Factor
 - concentration of the ion in soil solution
- Capacity Factor
 - ability of the soil solids to resupply the ion as it is depleted from solution

Weathering, bioavailability, mobility,
geochemical cycling (nutrients, etc.)

Measurement

- *In situ* measurement of soil solution is not practical.
- Soil solution composition varies with soil moisture content.
- Soil solution composition varies with CO₂ and O₂ concentration (respiration).

Extract solution from soil, then analyze

Extraction Destructive

- Column displacement (miscible)
- Syringe pressure
- Centrifugation
 - high speed
 - low speed
 - immiscible
- Saturated paste

Extraction Non-destructive

- Lysimetry
 - Tension ceramic (or plastic) cup
 - Zero tension--saturated flow only
 - Wick--unsaturated flow

Measurement Errors

- Results affected by:
 - Storage of soil prior to extraction
 - | drying
 - | storage temperature
 - Extraction method
 - | speed of centrifugation may affect composition
 - | lysimetry—differences in tension result in differences in composition

