Solutions, Colloids, and Suspensions

Solution - a uniformly dispersed mixture*, at the molecular or ionic level, of one or more substances (solute) in one or more other substances (solvent).

In geochemistry, the solvent is commonly water (liquid H_2O).

For an example with regard to size, consider the Na^+ ion as a solute with a diameter of 2Å or 0.2 nanometers

Colloidal Suspension or Colloidal Solution - a mixture of substances from 1 nanometer to 1 micrometer in diameter, dispersed in a solvent. For geochemists, these are usually fine solids in a liquid, but they can more broadly be any pairing of phases.

A familiar non-geological example is milk.

Suspension -a mixture in which very small particles are more or less dispersed in a solvent, and in which the particles will not pass through a membrane filter and will settle out (or rise to the surface) with time.

As a minor caveat, remember that solutons *can,* in theory at least, settle with *geologic time.*

"There are no sharp differences between mechanical suspensions, colloidal solutions and molecular [true] solutions. There is a gradual and continuous transition from the first through the second to the third."

Wilhelm Ostwald
1853-1932
Nobel Prize winner in 1909
and "Founder of Modern Physical Chemistry"

As an example of the transitions that are possible here, consider that lowering the pH of an aqueous *solution* of humic acids (i.e., of large organic molecules) will change it to a *suspension* that settles out quickly.

* The words "uniformly dispersed" apply to the solute ions or clusters thereof, but

a) ions, especially cations, are commonly hydrated with their clustered entourages of H_2O molecules, and these cation-H_2O clusters are uniformly dispersed.

b) ions can be complexed, as in $MgHCO_3^-$ or $Cd(NH_3)_3^{2+}$, and these complexes are uniformly dispersed.

c) complexes of ions can be polynuclear, as in $Pb_4(OH)_4^{4+}$, and these polynuclear complexes are uniformly dispersed.

The quotation and much of the definitons come from the 11th edition of *Hawley's Condensed Chemical Dictionary* by N. Sax and R.J. Lewis Sr.