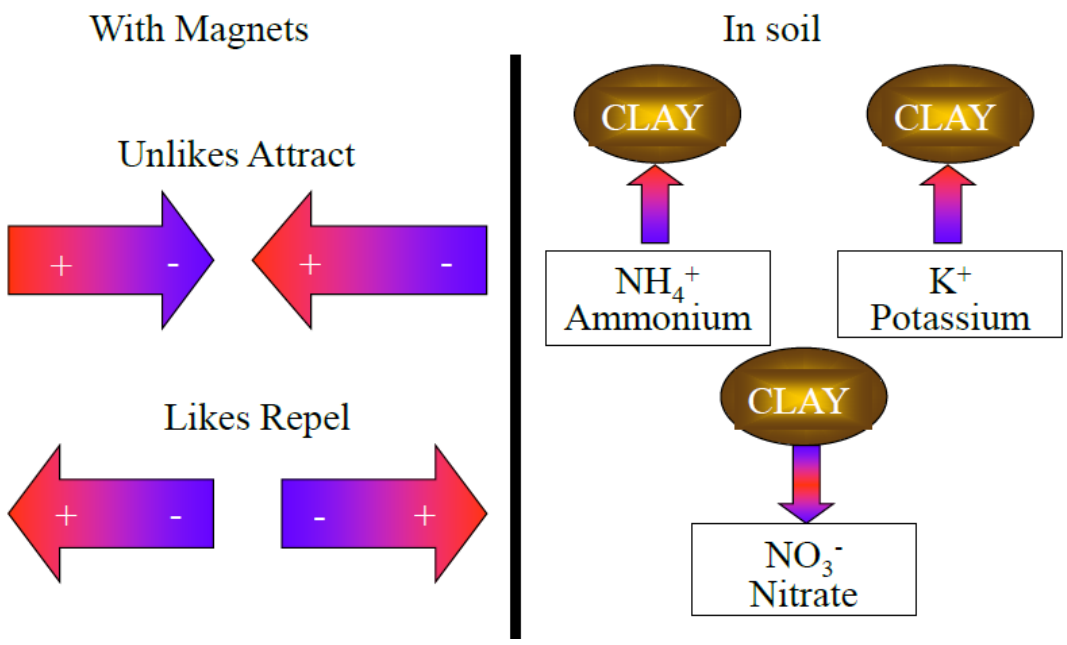
How pH-dependent charges develop at the broken edge of a kaolinite crystal. Three sources of net negative surface charge at a high pH are illustrated (left): (A) One (2:1) charge from octahedral oxygen that has lost its H^+ ion by dissociation (the H broke away from the surface hydroxyl group and escaped into the soil solution). Note that such dissociationتفكك can generate negative charges all along the surface hydroxyl plane, not just فقط at a broken edge. (B) One half (2 1⁄2) charge from each octahedral oxygen that would normally be sharing its electrons with a second aluminum. (C) One (2:1) charge from a tetrahedral oxygen atom that would normally be balanced by bonding to another silicon if it were not at the broken edge. The middle and right diagrams show the effect of acidification (lowering the pH), which increases the activity of H^+ ions in the soil solution. As more H^+ ions bond to the oxygen atoms at the clay surface, the 1+ charge of each H^+ ion either just balances a 2:1 charge on tetrahedral oxygen or more than balances a 2 1⁄2 charge on octahedral oxygen (middle). At the lowest pH shown (right), all of the edge oxygen's have an associated H^+ ion, giving rise to a net positive charge on the crystal. These mechanisms of charge generation are similar to those illustrated for humus in Figure 8.9.

3. Soil Cation and Anion Exchange

Surfaces of clay minerals and humus usually have negative charges due to either isomorphous substitution, or weak organic acids (COOH groups). These charges attract or hold positively charged ions (CATIONS) in equilibrium with other cations in solution. The replacement of adsorbed cations by other cations in solution is called cation exchange.

Cation exchange is controlled by (1) type of cations, and (2) their concentration relative to concentrations of other cations in the solution and on the exchangeable surfaces. All cation exchange processes are REVERSIBLE reactions, and take place following the principle of charge equivalence.


With Magnets
Unlikes Attract
+
-
+
-
Likes Repel
+
-
-
+
In soil
CLAY
CLAY
NH_4^+
Ammonium
K^+
Potassium
CLAY
NO_3^-
Nitrate