**Cation Exchange Capacity** - The *cation exchange capacity* (CEC) of the soil is determined by the amount of clay and/or humus that is present. These two colloidal substances are essentially the cation warehouse or reservoir of the soil. Sandy soils with very little organic matter (OM) have a low CEC, but heavy clay soils with high levels of OM have a much greater capacity to hold cations.

The disadvantages of a low CEC include the limited availability of mineral nutrient to the plant and the soil's inefficient ability to hold applied nutrient. Plants can exhaust a fair amount of energy (which might otherwise have been used for growth, flowering, seed production or root development) scrounging the soil for mineral nutrients. Soluble mineral salts (e.g. potassium sulfate) applied in large doses to soil with a low CEC cannot be held efficiently because the cation warehouse is too small.

Water also has a strong attraction to colloidal particles. All functions that are dependent on soil moisture are also limited in soils with low CEC. Organisms such as plants and microbes that depend upon each other's biological functions for survival are inhibited by the lack of water. Where there is little water in the soil, there is often an abundance of air, which can limit the accumulation of organic matter (by accelerating decomposition) and further perpetuate the low level of soil colloids.

High levels of clay with low levels of OM would have an opposite effect (a deficiency of air), causing problems associated with anaerobic conditions. The CEC in such a soil might be very high, but the lack of atmosphere in the soil would limit the amount and type of organisms living and/or growing in the area, causing dramatic changes to that immediate environment. Oxidized compounds such as nitrates ($NO_3$) and sulfates ($SO_4$) may be reduced (i.e., oxygen is removed) by bacteria that need the oxygen to live, and the nitrogen and sulfur could be lost as available plant nutrients. Accumulation of organic matter is actually increased in these conditions because the lack of air slows down decomposition. Eventually, enough organic matter may accumulate to remedy the situation, but it could take decades or even centuries.

The CEC of a soil is a value given on a soil analysis report to indicate its capacity to hold cation nutrients. CEC is not something that is easily adjusted, however. It is a value that indicates a condition, or possibly a restriction that must be considered when working with that particular soil. Unfortunately, CEC is not a packaged product. The two main types of colloidal particles in the soil are clay and humus and neither is practical to apply in large quantities. Compost, which is an excellent soil amendment, is not necessarily stable humus. Over time compost may become humus, but the end product might only amount to 1-10 percent (in some cases, less) of the initial application.

Remember that each percent of organic matter in the soil is equal to over 450 pounds per 1,000 square feet (20,000 lbs/acre). Compost normally contains about forty to fifty percent OM on a dry basis, and weighs approximately 1,000 pounds per cubic yard (depending on how much moisture it contains). If the moisture level is fifty percent, it would take two cubic yards of compost per thousand square feet to raise the soil OM level one percent (temporarily). Large applications of compost to the surface of the soil, however, can do more harm than good. Abrupt changes in soil layers can inhibit the movement of water and restrict the soil's capacity to hold moisture. Obviously, building organic matter in the soil is not something that can or should be done overnight. Natural/organic nitrogen sources, in general, will do more than synthetic chemicals to raise or preserve the level of OM, because of the biological activity they stimulate. Colloidal phosphate contains a natural clay and is often used to condition sandy soils with a low CEC. Low phosphorus conditions should be present, however, to justify its use.

If a soil has a very low CEC, adjustments can and should be made, but not solely because of the CEC. A soil with a very low CEC has little or no clay or humus content. Its description may be closer to sand and/or gravel than to soil. It cannot hold very much water or many cation nutrients; plants, therefore, cannot grow well. The reason for the necessary adjustment is not the need for a higher CEC, but because the soil needs conditioning. A direct result of this treatment will eventually be a higher CEC.

During the process of soil building, the steward must be aware of the soil's limitations. Soil with a low CEC cannot hold many nutrients, so smaller amounts of fertilizer should be applied more frequently. Feeding a lawn growing on soil with a low CEC is analogous to feeding an infant. It doesn't eat a lot but must be fed often. As the CEC of the soil improves, larger doses of fertilizers can be applied less frequently.