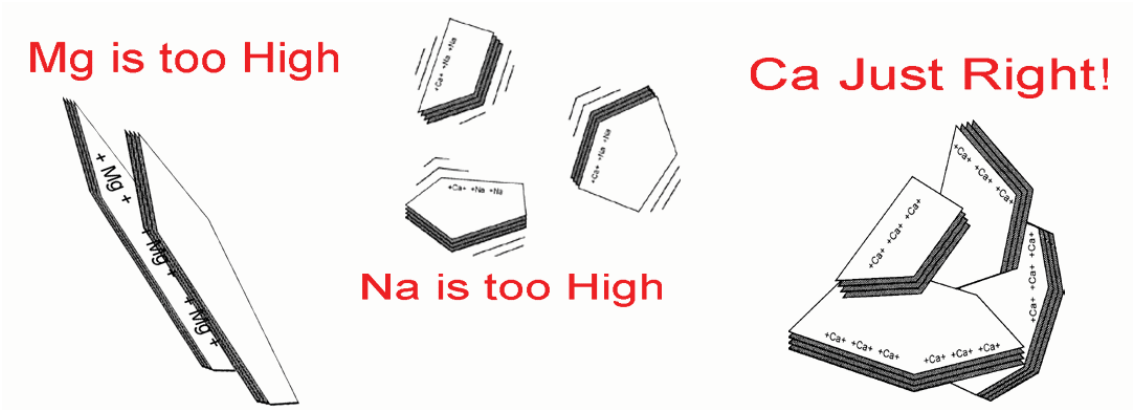
Soil Aggregates

Soil aggregates need to have the proper balance of "inorganic" chemicals (Ca, Mg, K & Al) to form proper aggregate structures.

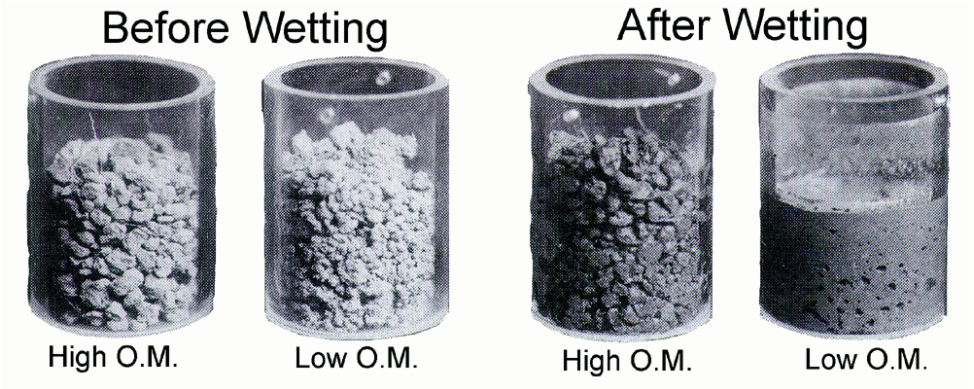


Soils with a high level of magnesium (1:1 ratio with Ca) will tend to be tight in structure. The magnesium has to charges to bind with each clay particle (colloid) as does the calcium, however magnesium does not hold apart the colloids as far as calcium.

We have covered in detail the negative effects of high sodium on colloid in a section titled "Alkaline, Saline & Sodic Soils". The single charge of sodium and all the water associated with sodium does not completely neutralize the negative charges of the clay and the clay "pushes" apart, ruining the aggregate structure.

The right amount of calcium and magnesium on the clay particle makes the best balance of inorganic chemistry to hold the aggregates together. But is this all that is needed?

The inorganic part of soil aggregate formation is critical; however it does not provide the necessary ingredients for STABLE aggregate formation. For this we need the other part of soil fertility, organic chemicals or *organic matter*.

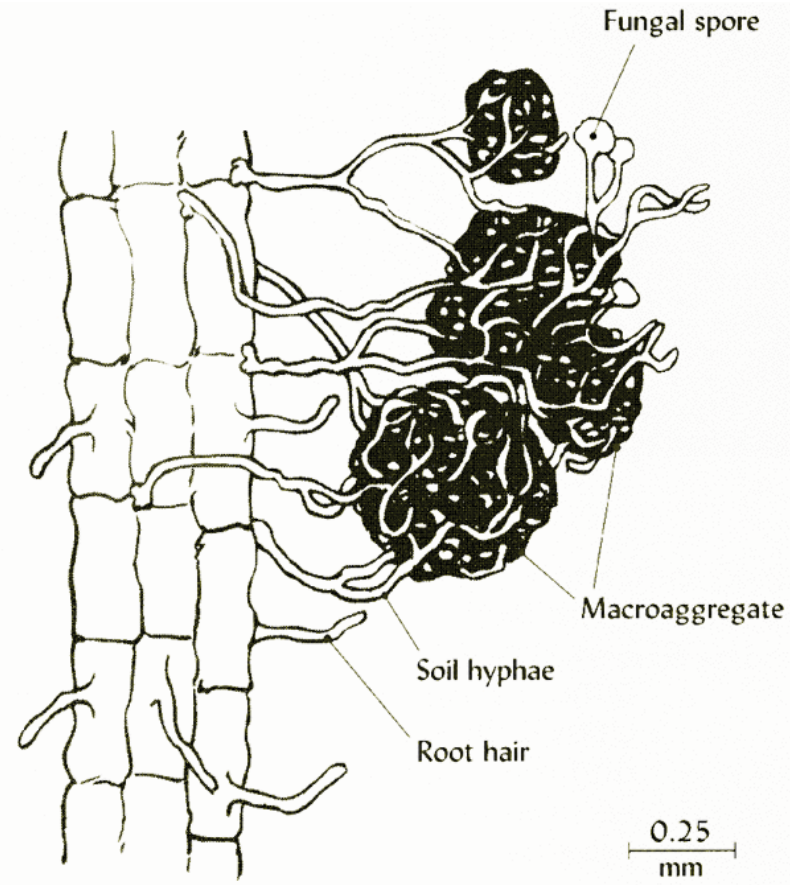


As the illustration shows, soils with low organic matter have the ability to form aggregate structures, however with driving rains or irrigation these structures collapse.

Aggregate Stability

As stated, minerals the inorganic chemicals are essential for aggregate stability. However, stability requires three distinct, but interwoven biological systems to form these tiny "chemical manufacturing" plants in the soil:

1. Microorganisms, especially the threadlike *hyphae* of soil fungi, enmesh soil aggregates and act as a system of "cables" which hold these particles together. Another very important group of fungi is those that are associated with the roots of plants called mycorrhizae (root fungi). These are especially important in forming large stable aggregates in the vicinity of root hairs that act as important storage facilities of water, nutrients and biologically produced chemicals for plant growth.

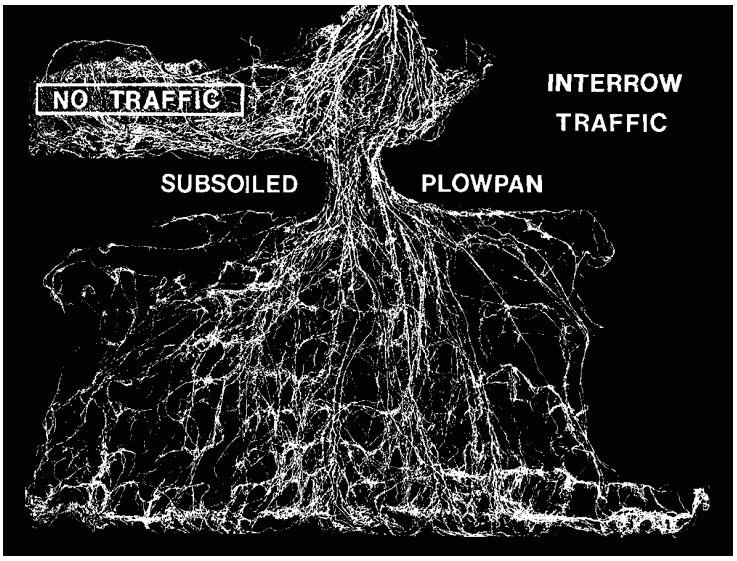


2. Root hairs of plants, fungi and bacteria have the ability to manufacture special chemicals called polysaccharides, which help glue soil particles together. Microbes can also produce more complicated organic chemicals like "gums" which also help bind soil particles.

3. Part of organic matter that is incorporated into soils (or left on top as residues) is partially decomposed and "built" into stable organic compounds called humic acids. For the most part, these compounds are resistant to further microbial breakdown. These chemicals are combined with clay and calcium and make up the most important "stable humus" component of fertile soils. Many soils were once very high in these compounds, but continuous cultivation and lack of knowledge on "protecting" these valuable compounds has lead to their destruction and decline. However, proper management can build these compounds back up.

Protecting & Building Aggregates

Although every soil, soil type and crop growing condition presents its own set of unique problems and opportunities, there are important methods to be followed that can protect and build stable soil aggregates.



1. Reducing tillage, especially from moldboard plowing and rototilling. These two types of tillage methods should be avoided because although they mix the topsoil well, their action "flattens" the soil aggregate structure underneath the working zone of the implement. A graphic illustration of this effect is shown to the right, courtesy of the USDA Tillage Machinery Laboratory.

2. This picture can also show the effects of tillage and soil traffic when moisture conditions of the soil are either too wet or dry.

3. Keeping the soil covered with crop residues adds organic matter to soils and protects the upper layer of soil aggregates from destruction by large irrigation droplets or rain.

4. Organic matter incorporated into the soil is always important, in the form of compost, raw manure or crop residues.

5. Cover crops and a green manure crop is always an over looked tool in building and correcting soil fertility problems. It is even possible to grow crops that suppress or kill soil borne pathogens. This is an especially valuable tool in areas where high dollars per acre are spent on fumigation. The cost of green manure crops in combination with improved microbiological management has the possibility of costing the same or less, but building soil fertility for a more productive crop.

6. Improving the condition and ability of soil microorganisms to produce soil forming organic compounds. As we will deal with in more detail in a later topic, plants also play an important role in the production of organic chemicals in the soil.