SOIL STRUCTURE: FRIEND OR FOE?

Birl Lowery [1/]

Soil structure controls many soil functions including water and air (gas) flow in soil. Although soil structure has received considerable attention by soil scientists, structure is one of a limited number of soil properties that have not been sufficiently quantified, and to date there are no good methods or techniques for doing so. Soil structure is generally unstable in time and it is nonuniform in space, and it is affected by changes in climate, biological activity, and soil management practices (Hillel, 2004).

Soil structure is defined by the Soil Science Society of America (SSSA) (1996) as the combination or arrangement of primary soil particles (sand, silt and clay) into secondary units or peds. Soil structure can be granular, blocky, prismatic, platy, or it could be structureless and classified as single grain or massive (Fig. 1). These secondary units, which are generally referred to as aggregates are further described based on their size, shape and grade. Grade is the degree on distinctness expressed by aggregates. Soil aggregates are formed as a part of natural soil forming processes. Soil structure is classified as *structureless*, *weak*, *moderate*, or *strong*. This classification is based on soil aggregation. Again according to SSSA (1996) *structureless* soil has no observable aggregation, *weak* has poorly formed indistinct peds, *moderate* has well-formed distinct peds, and for *strong* the peds are distinct and easily separated.

Soil porosity or pore spaces, which is the space between and within aggregates, is that part of soil that houses soil water and/or air. Water and air flow through interconnecting soil pores. Sandy soils permit rapid air and water flow but these soils are often characterized as *structureless* (Fig. 1 and 2A). Sandy soils are classified as having single grains with large pore spaces which are responsible for the good water and air fluxes (Plaster, 2003) (Fig. 2A). Similar flow conditions are found in granular soils (Fig. 2B). Like sandy soils, some fine textured soils can be *structureless* as well, but unlike sandy soils they tend to have massive structure and have limited capacity to transmit water and air (Fig. 3). While massive clayey soils have extensive porosity, the pores are very small and not generally well connected, and as such they do not transmit water or air readily. Platy is another structure that limits water and air movement through the soil profile (Fig. 1). On the other hand, soils with *moderate* or *strong* prismatic or blocky structure, or a combination of both, will have good water and air transmitting capacity and are well drained, yet they have good water holding capacity (Figs.1 and 4). In the past, we have viewed these as excellent soils with ideal hydrological properties for any land use. However, we are now coming to the realization that these soils can be subject to extremely rapid water movement resulting in possible contamination of groundwater when they are located in certain landscape positions such as closed basins (Samuelson, 1999).

[1/] Professor; Dept. of Soil Science, Univ. of Wisconsin-Madison, 1525 Observatory Dr., Madison, WI, 53706-1299. e-mail: blowery@wisc.edu

References

Hillel, D. 2004. Introduction to environmental soil physics. Elsevier, Academic Press, New York. 494 p.

Plaster, E.J. 2003. Soil science and management. Thomson, Delmar Learning, Clifton Park, NJ. 384 p.

Samuelson, J.R. 1999. Atrazine and nitrate leaching in a glacial landscape. M.S. thesis, Univ. of Wisconsin, Madison, WI.

Soil Science Society of America. 1996. Glossary of soil science terms. Soil Science Society of America, Madison, WI.

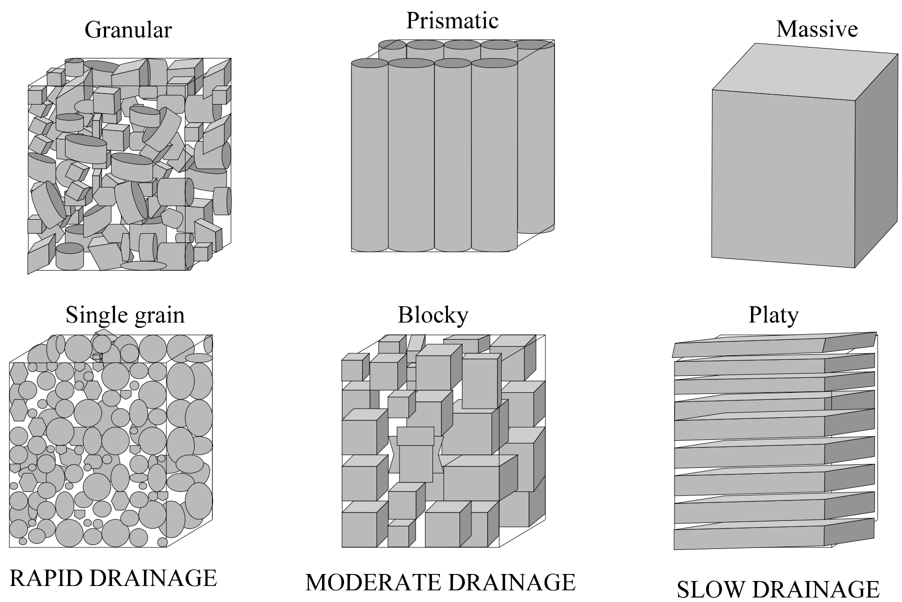

Figure 1. Illustration of different types of soil structure and indication of structure impact on drainage.

A B

Figure 2. Example of single grain (A) and granular (B) soils.

Figure 3. Example of massive soil.

A

B

Figure 4. Example of blocky structure (A) and macropore (B) (Courtesy Brian Lepore, 2005).