

Soil Structure Examined

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SCIENCE

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Introduction

‘Dirt,’ which is a non-technical term for the solid part of soil, is considered by many to be something that needs to be cleaned up and discarded. It is the *loss of structure* (the removal of the pore space between the soil solids, or the detachment of solid particles from their matrix) that turns a valuable substance (soil) into an annoyance (dirt). With this article, we discuss soil structure and its importance in the value and utility of soil. We have chosen a format based on common questions associated with soil structure.

Soil Structure Defined

Soil is considered by many to be simply a mixture of solids, liquids, and gases. This is analogous to speaking of a building as a mixture of wood, steel, glass, brick, and air without regard to the relationship of the components and the functional nature of the assembled building. So it is with this in mind that we highlight the difference between ‘dirt’ and ‘soil.’ The term ‘soil’ implies structure whereas ‘dirt’ does not. When we talk about a building’s attributes or uses, we not only speak of the material from which the building is constructed, but also (implicitly) of the structure of the building (see Figure 1). We might be referring to the number of rooms, the dimension of the

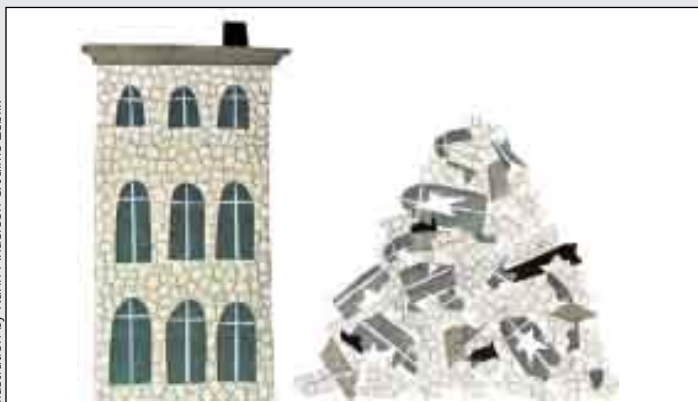


Illustration by Karin Anderson & Jaime Zebill.

Figure 1. These buildings are a simple analogy for soil structure. The building on the left has a structure that allows utilization for different functions: perhaps there is a restaurant on the bottom floor, apartments on the second floor, and an art studio on the top floor. In contrast, the pile of rubble on the right has no utility because it lacks structure. Note that chemical analysis of the components of both buildings would find no differences. Thus, structure adds complexity and utility not measured by chemistry alone.

rooms, and how the rooms are connected to each other. But the organization of the materials and the existence of spaces within the building are absolutely essential to a building’s function and categorization as a building.

Similarly, ‘soil’ must have some organization to its components, and spaces among them, to be functional as a soil. Roots and other living soil organisms do not live

in the ‘dirt’ any more than we live in the brick, wood, stone, or steel girders of a building. Rather, soil-dwelling organisms exist in the ‘rooms’ created by the structure of the soil just as we live in the rooms of a building. Furthermore, if a room is not connected to another room, it has little to no value for our activities—the same is true for the spaces in the soil, which must be connected to other spaces to be usable (inhabitable) by roots and other organisms within the soil.

Macropores are not inherently stable.

Questions about Soil Structure: How does soil structure come to exist?

Soil structure is the product of the interplay of many physical, electro-chemical, and biological forces acting on and within the soil. For crop productivity, the most critical component of soil structure is the configuration of the pore space. Biological organisms play a major role in the development of soil structure and the resulting stabilization and maintenance of pore space. Indeed, soil structure is generally very poor to nonexistent if biological activity is missing (if the strata or material is largely devoid of biological activity and organic matter, it is excluded from the category of soil).

Physical and chemical forces also play a significant role in the localized development of fractures or cracks within the soil that correspond to lines of weakness. Soil structure is a result of the continual flow and transformation of energy (mechanical and chemical) within the soil system. The agents of energy transformation are primarily biological organisms, but also include physical phenomena such as wetting-drying and freeze-thaw cycles.