

Benno P. Warkentin
Oregon State University
Department of Crop and Soil Science
Corvallis, OR USA

1. Rationale

- Today's education, conservation and research on natural resources are focused on watersheds.
- Soils have necessary and unique functions in watersheds, so soils education is a vital component.
- It is in the soil holes (pores) that we seek understanding of the functions.
- However, soil science teaching still focuses on the solid skeleton of soils, not on soil functions.
- This contribution suggests a change, focusing on the holes where the action is.

2. Unique Functions of Soil Holes in Watersheds

- Provide the diversity of habitat required by the micro and macro soil biota (including roots).
- Decomposition and recycling of organic materials added to soils.
- Storage and release of nutrients from decomposition of organic matter.
- Routing, storage and release of added water.
- Incoming energy routing, storage, and release.

3. A Soil Scientist's Motto

"The reality of the Building does not consist of roof and walls but in the spaces within to be lived in."
 Lao-tse, 6th Century BPE.

The essence of soil consists of the spaces where things happen, not of the skeleton.

4. The Porous Soil System

Pictures of micro and macro holes, and their connections.

5. Definition of Soil

"Soil is... (the) life sustaining, biologically active, porous and structured medium at the Earth's surface formed by... (inorganic and organic) particles, air and living organisms." Nieder (2004)

6. Soil Architecture (Structure)

A hierarchal arrangement, from smallest (clay size) to largest (clods), creating stable spaces between.

Table 1. The hierarchical levels of soil structure.

Levels of Structure		
Solids		Pores
5000 µm Aggregates and peds	Cracks 1000 µm Inter-ped	Transmission
500 µm Micropeds	100 µm Inter-microped	
50 µm Conglomerates or clusters	10 µm Inter-cluster	Storage of plant available water
1 µm Domains	0.05 µm Inter-domain	
0.05 µm Clay crystals	0.005 µm Inter-grain	Bonding
0.002 µm Clay platelets		



Figure 1. The soil we see.

7. So How Do We Alter Our Thinking?

- Think about soil functions rather than about the skeleton visible to the eye.
- Think about soils from the inside out, rather than from the shell in.
- Teach soil science at university and school levels on the basis of soil functions.

8. References

Blum, W.E.H. 2002. Soil pore space as communication channel between the geosphere, the atmosphere and the biosphere. 17th Congress of IUSS, Bangkok. CD-ROM, Trans. 2014.

Blum, W.E.H., et al. 2006. Soil, human society and the environment. pp. 1-8 in E. Frossard, W.E.H. Blum, and B.P. Warkentin (eds.) *Function of Soils for Human Societies and the Environment*, The Geological Society, London.

Brewer, R. 1964. *Fabric and Mineral Analysis of Soils*. Wiley, New York, p. 298.

Kutilek, M. and D.R. Nielsen. 2007. Interdisciplinarity of hydropedology. *Geoderma*, 138:252-260.

Lao-tse (L., Erh, 6th century B.P.E.). Seen on a plaque at Taliesin West, Phoenix, AZ, USA.

Nieder, R. 2004. Future of soil science. *In The Future of Soil Science*, A.E. Hartemink (ed.) IUSS, pp. 97-100.

Warkentin, B.P. 2008. *It's the holes: On teaching about soils*. Manuscript in preparation.

Figure 2. Crumbly clod and compacted clod. Different sizes of holes.

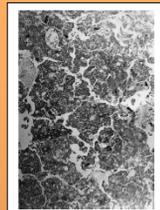


Figure 3. Thin section prepared from undisturbed samples from 0-10 cm layer of a sandy loam soil. The subangular blocky structure and the continuity of elongated pores in a vertical sense are very evident. The white areas represent the pores. Frame length 35 cm.

From Kutilek and Nielsen, 2007

Figure 4. Craze planes in thin section.

From Brewer, 1964

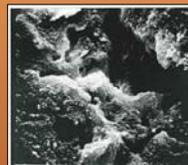
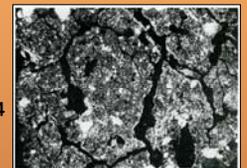


Figure 5. Holes at the micro level. Bas in 10 µm.

From Blum et al., 2006



Figure 6. Schematic of continuity of pores of different size.

From Blum et al., 2006

Acknowledgment

Tracy Mitzel, Department of Crop and Soil Science, Oregon State University prepared the poster.