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SOIL MACROPOROSITY DETERMINATION WITH THE HELP OF ELECTRONIC MICROSCOPE

BY

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Abstract. Soil texture and structure determine porosity. This feature has a direct effect on the movement of air and water, and also on the migration of chemical compounds in the soil. Soil porosity through its multiple functions, is presented as a particularly important feature for soil fertility. In this context, the authors of this paper present the results of experimental research done on soil porosity and surface characterization, with the help of electronic microscopy.

Keywords: electronic microscope; soil; porosity; soil surface characterization.

1. Introduction

Soil texture and structure greatly influences the infiltration of water, permeability and the water retention capacity of the soil. Air and water through soil is very important because it affects the supply of air to the roots and the plant nutrients available for absorption.

Soil structure entails two major elements: porosity and aero-hydric regime of soil. That means that this conglomerates leaves some gaps between them, were water and air can circulate.

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It goes without saying that the ground water and the air are in opposite relationship (one increase and the other one decrease), usually water predominates in the deep areas and the air on surface layer. Knowing soil porosity is very important because the whole dynamic of soil depends on her.

In this context, experimental researches were carried out on soil samples taken from Podu Iloaiei town, and consisted of analyses made with the Quanta 200 3D dual beam microscope.

2. Experimental

2.1. Materials

Quanta 200 3D dual beam electronic microscope (Fig. 1) is a combination of two systems:

a) SEM is an electron microscope that produces zoomed images of a variety of samples giving a magnification of 100,000x at a high resolution in digital format;

b) FIB is an ion beam that is capable of rapid and accurate grinding of different geometry (μm) of the sample material, revealing the structure of the sub-surface sections obtained, deposition of layers, etc. Ionic system also provides a high resolution image.

Fig. 1 − Quanta 200 3D dual beam electronic microscope.

The integration of the two systems provides a powerful analytical tool to obtain any information from any sample in three dimensions. Users can switch between the two beams for quick and precise navigation and grinding.

The convergence SEM and FIB at a short working distance allows a “slip on” section and accurate analysis at high resolutions. The workstation provides optimum between processed materials, resolution and automation.

2.2. Methods

With the electronic microscope we can get images of surface morphology, surface topography, compositional contrast images, qualitative and quantitative compositional analysis and distribution of elements on the surface samples.

The soil samples were analyzed at various resolutions (Fig. 2), obtaining SEM images, which were processed after with the software ImageJ.

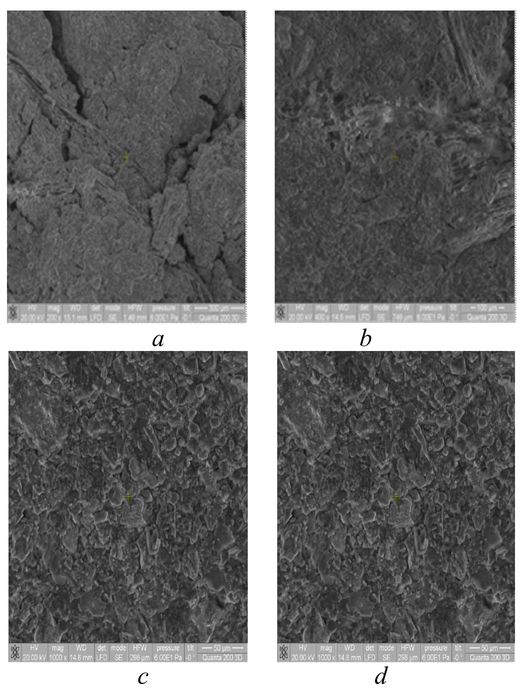

Fig. 2 – Increased soil sample image at: *a* – 200x; *b* – 400x; *c* – 1,000x; *d* – 5,000x.

3. Results and Discussions

SEM images were processed using ImageJ which allowed us to calculate porosity. We analyzed samples of the same type of soil on three different layers. SEM images generated by Quanta 200 3D dual beam microscope, helped us to find medium, minimum and maximum porosity values.

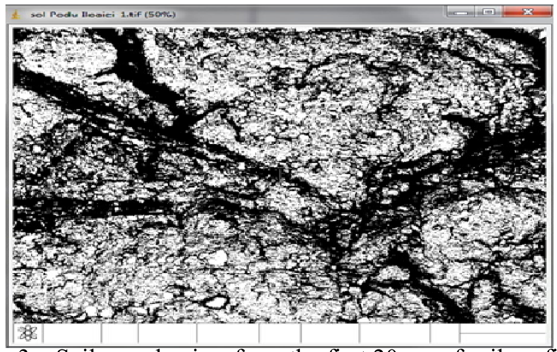

Fig. 3 – Soil sample view from the first 20 cm of soil profile.

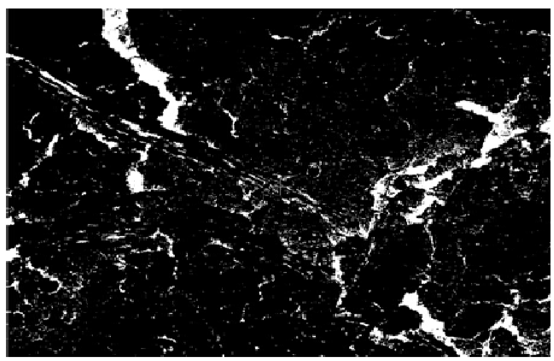

Fig. 4 – Soil sample analyses.

After the images were processed we obtain the following histograms of soil samples. They are a simple frequency chart that can express the percentage of entities (classes). On the *Y*-axis we have the variation of number of pixels in the image and on the X-axis we have the variation of gray. In section 0 we have black and in 255 we have white.

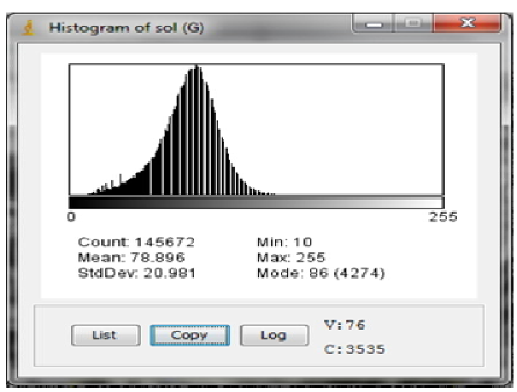

Fig. 5 – Soil sample histogram.

In the following table (Table 1) we have the porosity values calculated using the program.

Table 1
Porosity Values for the First Soil Sample

Results

File Edit Font Results

	Area	Mean	Min	Max
1	416	78.962	23	183
2	380	44.726	7	207
3	470	74.030	23	223
4	514	82.704	23	207
5	396	49.242	15	191
6	434	29.304	7	111
7	472	68.441	7	215
8	284	85.958	23	191
9	180	49.844	7	175
10	256	64.906	15	159
11	400	33.720	7	151
12	398	41.472	15	127
13	448	23.732	7	143
14	460	104.096	23	207
15	466	25.283	7	191
16	320	18.175	7	119
17	247	33.105	7	143
18	315	85.654	23	223
19	121	57.645	31	111
20	232	57.483	23	143

We made the same thing for the 2 and 3 soil samples taken from 40 and 60 cm of the soil profile. We observed that the analyzed soil presents a favorable porosity regime, meaning that transport of water and gas exchange is achieved easily, thus having a positive effect on the crops. Changes in the pore space leads to the reduction of mobility and accessibility of water.

Our samples were homogeneous and undisturbed, taken from natural settlement, so they were not submitted to compaction, therefore presents a good porosity regime.

4. Conclusions

Macro porosity, number of macropores, length, continuity, pore size distribution, tortuosity and connectivity are considered the most important features that influence the transport of water and soil solutions.

Natural and artificial processes induce significant changes on soil porosity. If the soil is subjected to a uniform pressure, it loses from macro porosity. An uneven pressure exercised over ground, causes various effects on porosity, namely fewer large pores, increasing fine pores, complete closure of macropores and closure of pores between aggregates.

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DETERMINAREA MACROPOROZITĂȚII SOLULUI CU AJUTORUL MICROSCOPULUI ELECTRONIC

(Rezumat)

Textura şi structura solului determină porozitatea. Această caracteristică are un efect direct asupra circulației aerului şi a apei, precum şi asupra migrării compuşilor chimici din sol. Porozitatea solului prin funcțiile sale multiple, este prezentată ca o caracteristică deosebit de importantă pentru fertilitatea solului. În acest context, autorii acestei lucrări prezintă rezultatele cercetărilor experimentale efectuate asupra porozității solului, cu ajutorul microscopiei electronice.