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RESEARCH ON THE POROSITY OF THE MESO-METAMORPHIC CRYSTALLINE SCHIST IN SOME SCREE IN LEAOTA MOUNTAINS

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Abstract
Scree, as the main result of the gelivation (gelifraction) processes, represents a very interesting habitat type through the ecologic particularities it has. The formation and the spreading of scree is strongly related to the type of rock that generated it. Different types of rock lead to a different behavior against gelifraction and also against meteorization and bio-meteorization (chemical and biochemical alteration). Some of the mechanical features of rocks are defining regarding the higher or lower susceptibility of generating scree. The present paper is the result of the research on the porosity of meso-metamorphical crystalline schist extracted from different types of scree located on the north-western side of Leaota Mountains. It represents the continuation of some research of similar researches on limestone scree in the previously mentioned geographical area, leading to the conclusion that one can make a comparison between the two categories of rocks (limestone and schist) regarding their porosity and the way through which this geo-mechanical feature makes its mark on their behavior against the action of external features. The present paper is part of a complex assembly of researches on the way through which the geological component of the mesovoid shallow substratum (MSS) (in our case, the scree) leads, in a direct or indirect manner, to defining ecologic particularities of this habitat type and thus it influences the distribution of some zoocoenosis components.

Keywords: chemical alteration, gelifraction, MSS, porosity, schist, scree.

1. INTRODUCTION

This paper represents the result of the studies on the total porosity and of the open porosity in the case of the clasts which compose the meso-metamorphical crystalline schist scree which spreads on the north-western slope of the Leaota Mountains. These researches are a continuation of the ones on the limestone scree in the same area. This way, one can make a comparison between the two scree types, the scree and the limestone ones. Basically, the different behavior of limestone reported to the schist against the chemical, biochemical alteration processes and against gelifraction/gelivation (Matthews, 2013) or frost-shattering (Gutiérrez, 2013); congelifraction (Kurtz, 2004; Gutiérrez, 2013), is determined by the open porosity, namely by the pores that intercommunicate and through which water circulates. Open porosity has a defining role in the capacity of the rock of absorbing water, also determining its resistance against the frost-defrost cycles and permeability, the ability of the rock of chemically and biochemically reacting to water and the micro-organic load in the alteration processes. Moreover, the capacity of the rock of absorbing water leads to the existence of a high relative humidity from depths of just several tens of centimeters, humidity which persists all over the year. This contributes to the emergence of an interesting living environment in this scree,

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an environment called the *mesovoid shallow substratum (MSS)* or *shallow subterranean habitat (SSH)*. One of the main features of the MSS is exactly the maintenance of a high relative humidity during the whole year. This type of habitat is "valued" by numerous species of invertebrates, sometimes by the micro mammals too, due to the ecologic opportunities it generates.

2. MATERIALS AND METHODS

The material of which samples were extracted, samples which were the subject of the mechanical determinations, was collected from the field, from various areas of scree composed by epi-metamorphic crystalline schist. Thus, scree surfaces were selected from the following areas: the slopes that guard Berbece's Creek, Popii Valley Creek (both tributary waters of Ghimbav), as well as Bădeni Valley, all of them with natural scree, where crystalline schist appear in outcrops (Fig. 1). This scree has emerged as a result of the gelivation phenomena; we have also extracted samples from the anthropic origin scree from the side of the forest roads that connect the Valea Caselor locality to the Andolia Canton, respectively the forest road that goes from the village of Bădeni to Leaota Peak (Fig.1). Around 300 kilos of meso-metamorphic crystalline schist was collected, randomly chosen, from that scree, but such as for their size to allow the filling of some test specimens whose sizes met the requirements of the standards on which the geomechanical analyses were carried out. According to the geological map of the area (Fig.1), this type of crystalline schist which appears in the respective scree is identic. From the material extracted from the field, test specimens were made according to the SR EN 1936:2007 standards in force, regarding the porosity determination. This standard requires that the test specimens can have a cubical (sizes of 50 or 70 mm per side) or cylindrical shape, with a diameter equal to the height, of 50 or 70 mm too. Due to the fact that the field collected samples were brittle, with numerous micro-cracks (secondary porosity) (Pârvu et al., 1979) (Fig. 2), on consecutive attempts of carving the test tubes to a cubical shape, the material broke down before reaching the shape, so that we decided to give them a cylindrical shape, with a drill core, which represented a success, with a significantly lower rate of destruction before the finalization of the test specimen shaping.
According to the requirements of the mentioned standards, we have shaped 6 specimens for each of the locations we extracted the material from. Then, we met the stages mentioned in the standards regarding the drying of the material through warming, in order to completely remove water from the pores of the rocks and then the determine the volume of the water-covered sample (m_h), the volume of the dried sample (m_d); the volume of the water-saturated sample (m_s).
Using calculus formula included in the standard, we firstly determined the open porosity (p_o), determined in percentages (%), according to the formula:

$$p_o = \frac{m_s - m_d}{m_s - m_h} \text{ x } 100$$

In order to calculate the volume of open pores (V_0) expressed in cm^3, we use the relation:

$$V_o = \frac{m_s - m_d}{\rho_{rh}} \text{ x } 1000$$

Where $\boldsymbol{\rho_{rh}}$ represents the density of water at 20°C, with a value of 0.998 g/cm^3, and for the determination of the apparent volume (V_b) we have used the formula:

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$$V_b = \frac{m_s - m_h}{\rho_{rh}} \times 1000$$

The apparent volume is the limited volume by the external surface of the test tube, including the possible gaps.

Total porosity (p), also expressed in percentages (%), is calculated through the following formula:

$p = [1- (\rho_b \times \rho_r^{-1})] \times 100$, where the significance of the symbols is:

ρ_b = apparent density of the test tube (in kg/m^3), calculated by the ratio between the volume of the dried test tube and the apparent volume;

ρ_r = real density of the test tube (in kg/m^3), determined, according to the standard, by using the Le Chatelier volumeter method.

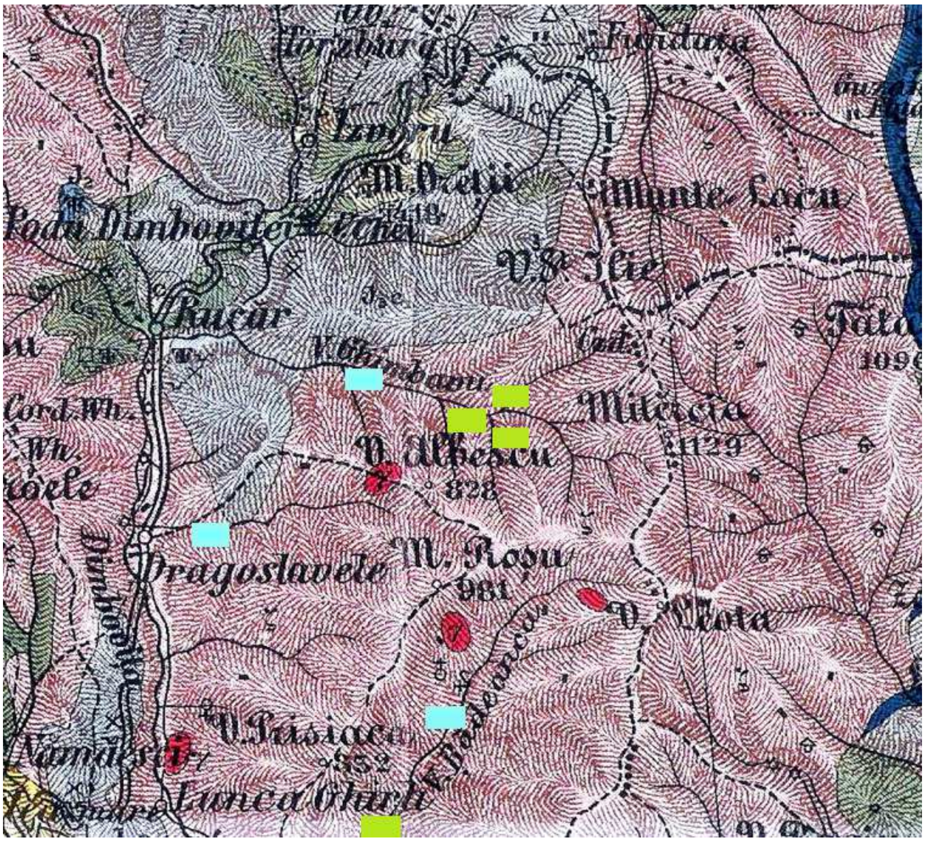

Figure 1. Distribution of the rock types in the NW region Leaota Massif (after Popovici-Hatzeg, 1899) and location of the areas from which samples were taken

Legend: crystalline shists limestone;

Areas where limestone samples were taken: anthropic scree, natural scree

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Figure 2. Micro-cracks (secondary porosity)

3. RESULTS AND DISCUSSIONS

Subsequently to the made determinations, the reached results regarding the total porosity, the real density, as well as the open porosity are:

The total porosity of analyzed crystalline schist is 0.84%.

The real density is 2704 kg/m^3.

Open porosity is 0.69%.

We mention that these values represent average calculated vales for all the analyzed samples that were extracted from the above mentioned locations.

As for the total porosity of the schist, its value reaches 0.84%, significantly lower reported to the total porosity of the limestone from the scree in the surrounding areas, north-west of Leaota. This geomechanical parameter has a value, in the case of limestone, of 1.46% (Dorobăț, 2016; Dorobăț et al., 2017).

As for the open porosity, crystalline schist in the scree we researched shows that this type of scree has more pores, with more open pores, which allows the circulation of water, the value of this parameter being 0.69%, reported to the situation of limestone, whose open porosity only reaches 0.38% (Dorobăț, 2016; Dorobăț et al., 2017). Basically, the scale of the gelivation process depends on the open porosity, which leads to the presence of scree in this mountain area. The higher the open porosity, the higher is ease of storing water in the rock or its circulation through pores, thus speeding up the chemical and biochemical alteration through the interaction between the water and the minerals in the rock. Microorganisms can also be part of this alteration process (in the case of bio-meteorization), the alteration speed of the rock increasing even up to 100 times (Ielenicz, 2004; Rădoane & Rădoane, 2007).

Higher open porosity is also responsible, in the case of analyzed crystalline schist, for the susceptibility of these rocks of splitting up more easily, due to gelivation, caused by the frosting of water in the pores. On the other hand, the ability to retain water leads to a high relative humidity that is maintained throughout the year at depths to several tens of centimeters in the scree. This is a very important feature of the MSS that distinguishes it from other types of habitats.

This property (high relative humidity, sometimes at saturation) of the MSS has been confirmed by us in the very numerous measurements made by us over several years (Dorobăț, 2015; Dorobăț & Dobrescu, 2015 a, b, c; Dorobăț, 2016; Dorobăț et al., 2017) or by Mammola et al. (2016). Moreover, the existence of numerous cracks inside the samples from the schist probe, compared to the previously analyzed limestone leads to their higher secondary porosity, which exacerbates the vulnerability of schist against gelivation or alteration (Dorobăț, 2016; Dorobăț et al., 2017).

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To the internal pressure caused by gelivation, we can add another pressure from the outside towards the rock, when the water freezes around it. In the case of limestone scree, very high inter-clastic porosity of it does not allow the stagnation of water in liquid state on its surface until freezing, but this happens more frequently in the case of schist scree, much more compact, with much smaller inter-clastic spaces, especially to the contact of clasts with the residual clay stratum below.

4. CONCLUSIONS

There is a double vulnerability of schist against the action of exogenous agents, expecially compared to the limestone;

- the first one, generated by the fact that high values of open porosity and secondary porosity (cracks, microcracks), mostly parallel to the schistosity, ease the circulation of oxygen, but especially the access of water inside the rocks and making these crystalline schist vulnerable against chemical and biochemical alteration, favoring the reaction of some minerals, such as chlorite, and also feldspars, with the watery solutions. The soluble part will be leached and the result of the process is, in time, the emergence of micro-gaps in the schist, which would lead to a weakening of the physic-mechanical features.
- the second vulnerability of schist is the one against gelivation; the soaking of schist with a larger volume of water compared to the case of limestone, due to the higher open porosity, alongside a higher secondary porosity, leads to the faster cracking of it after the action of the frost-defrost cycles. Subsequently to these processes, schist becomes less resistant against the action of the mechanic agents and it will mechanically split up easier.

As a result of chemical and biochemical alteration, there is a reach material composed of clay minerals, the residual clay. It accumulates in inter-clastic spaces and it gradually occludes them. Inter-clastic porosity of schist scree is much lower than the one of the limestone scree. This leads to the low ability of this schist scree of allowing the existence of micro-fauna components at depths lower than 50-60 cm, as the free spaces that would allow the circulation of invertebrates are completely missing.

Analyzed scree, from meso-metamorphic crystalline schist can represent a mesovoid shallow substratum, but this MSS (SSH) has a little lower ecologic role compared to the limestone scree, especially in the case of older scree, as there was sufficient time for the inter-clastic spaces to be filled by residual clay.

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