UNIVERSITY OF BUCHAREST – FACULTY OF GEOLOGY AND GEOPHYSICS

THESIS

Geodiversity assessment between Pârgavului Valley and Sohodolului Valley from Vâlcan Mountains (Southern Carpathians)

SUMMARY

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CONTENT

A successful geological or geomorphological landscape, however, is not simply a description; it is more like an analysis of dynamism evolution of that area. A framed image which, when seen by a geoscientist could be identified with particular or specific geological and tectonic settings. And just like any descriptive graphic, it must take into account not only the appearance but also the interpretation of various authors. A serious landscape resercher, when confronted with his subject, must ask himself several questions before he reaches for his assembly observations. What is required in each case is an intellectual interpretation as well as a simple description. Fundamental differences in interpretation are called for when investigating distinct types of landscape. This kind of approach – being guided by the qualities of the subject, searching for a distinctive features – what brings geological diversity forwards – is possibly the most well known in landscape assessment, but it is not the only one. The landscape can also be treated as succesion of graphical interpretation of tetconics and again re-expressed through sand tests to show the kinetic evolution. In this case the landscape becomes mainly a study of design and kinetics. It is possibly because of the need for geodiversity assessment and geoconservationist perspectives with an area, that often the best landscape comes about when it is to be tackled a country, or at least a region which we is well known.

The structure and spatial organization of landscapes play an important role in the formation of the spatial distribution of nature management, environmental and other problems of the Vâlcan Mountains. They largely determine the system of characteristics that reflects the degree of anthropogenic variability of landscapes, the nature and levels of their pollution. Therefore, the problem of studying the structure and organization of landscapes is relevant.

In the Vâlcan Mountains and adjacent territories, various natural landscapes are spread. It can be distinguished two main types (mountainous, plain and valley mountain), four classes (mountain-alpine, mountain-forest, forest plain and mountain valleys), several genera (alpine, massive-medium-mountain, dissected-medium-mountain, low-mountain, small-hills and others), species and individual landscapes.

The mountainous type of landscapes is widespread on the territory of Vâlcan Mountains. They differ from the plain Subcarpathian territory in the geological and geomorphological characteristics of the components of nature. This is a type of landscape with alpine and subalpine, mid-mountain, low-mountain and other genera and classes and types of landscapes with coniferous and broad-leaved vegetation groups on various soils.

The variety of geological, geomorphological and climatic regimes in different parts of the Vâlcan Mountains predetermined the current state of the basement, the composition and transit of loose accumulations, physical and chemical weathering, the spatial distribution of plants and soil groups. All these components and factors that play a significant role in the structure and spatial organization of landscapes, in interconnection and interdependence with the azonal climatic factor are the basis for the search for patterns in the structure and spatial organization.

Due to the greater difficulty of their economic development, mountainous regions have been subjected to human impact to a lesser extent than flat landscapes, but at present, almost all natural landscapes have been subjected to a greater or lesser extent to human impact and more and more traces of this impact become conspicuous.

Despite the difficulties, man continues to rather intensively explore and change mountain landscapes. Reservoirs are being created in the mountains and powerful hydroelectric power plants are being built (the recent one on Sohodol valley), minerals are being mined, arable land is expanding, the number of livestock on summer pastures is increasing, new recreation centers are being built (all of them created by natural area administration), asphalted roads are being laid. However, the economic development of the mountains does not take into account the high dynamics of natural and cultural landscapes often leading to undesirable consequences.

It should be noted that in the dynamics of landscapes, vegetation cover is of significant importance. If all the slopes of the mountains were covered with vegetation, even grassy, then the processes of physical weathering were either absent or very weak. In this case, sharp changes in the physical-geographical complexes would occur. The dynamics of landscapes would be determined most of all by abrupt changes in climate, but this is observed over long periods of time.

It is wide accepted, for Vâlcan Mountains too, that a number of natural phenomena (mudflows, avalanches, and others) have a rhythmic character and appear in intervals from 3 to 30 years, sometimes more often, sometimes less often, in some areas annually. Separate processes (formation of talus, planar erosion) are observed in the same areas constantly (annually).

Natural processes and phenomena occur simultaneously at the seasons of the year. Thus, mudflows occur more often at the end of May - June (in southern part) or in September - Octomber (in northern part), snow avalanches fall during the cold season, planar erosion develops more intensively in spring during snow melting and precipitation, especially storm character. However, the reaction of landscapes to these processes and their periodicity is not the same.

Landscapes are more dynamic and undergo various changes, where natural processes and phenomena do not occur annually, but every few years and have significant energy. For example, snow avalanches violate the structure of landscapes or destroy part of the landscape if a large amount of loose sediment arrives with snow, destroying vegetation and covering the soil. Such violations are observed when an avalanche carries a huge mass and falls with great force. Such avalanches do not fall every year and are happening at a small scale regarding the comprised surface. In many avalanche trays, avalanches occur annually and often several times during the winter. Small snowfields sometimes remain from them in summer. Therefore, in the areas of annual avalanches, the soil and vegetation, as well as the runoff, do not undergo radical changes, and for a long time, while the avalanches operate, the plant species do not change and the vegetation period continues in the same rhythm.

The southern and southeastern slope of Vâlcan Mountains is steep, with numerous outcrops of crystalline schists and granites. Numerous talus cones are observed on the slope, merging at the foot of the slope and forming a plume. Here, small amounts of loose material are formed annually, which, moving along the slope, does not make significant and rapid changes in the meadow-steppe landscape with shrubs. In this case, again, the natural state of the landscape is preserved for a long time. Any human intervention in these landscapes will lead to a sharp increase in the intensity of these processes and disruption of the landscapes.

Human activity has a significant impact on the dynamism of processes and landscapes. Insufficiently substantiated construction of industrial enterprises, operation of mines, plowing of slopes, and felling of forests among others contribute to the intensification of undesirable processes leading to a change or complete destruction of the structure and a decrease in the natural potential of landscapes. Under the influence of human activity, landscapes often acquire other features and are not restored. Felling of forests at their upper boundary leads to a change of forest landscapes to subalpine ones, which in the future do not turn into forest landscapes even without human intervention.

Modern knowledge of mountain landscapes and their sustainable development necessitate the identification of patterns of spatial and temporal dynamics, for which it is necessary to conduct research in the direction: landscapes – dynamics of natural processes – human activities – dynamics of natural and cultural landscapes. In order to obtain comparable results on the dynamics of mountain landscapes, it is important to develop programs of research and information gathering, satisfying the knowledge of different mountain regions in their distinctive areas.

The Vâlcan Mountains, located in the southwestern part of the Southern Carpathians, between the Jiu Gorge and the upper valley of the Motrului, are individualized as a distinct unit, with lower altitude and massiveness than the imposing mountain ranges bordering in the north and east (Godeanu , Retezat, Parâng), but higher than the Mehedinți Mountains, which continues to the southwest.

Their limits are generally clearly expressed in relief, being marked by pronounced unevenness at the contact between the steep slopes of the mountains and the gentle interfluves of the subcarpathian depression and the intramountain Petroșani Depression and by deep transversal valleys that separate them from the mountain ranges from east and west.

The southern boundary, which represents at the same time the boundary between the mountainous area and the Subcarpathians, is the most expressive from a geomorphological point of view, marking a categorical differentiation of the whole landscape. Lithologically, it follows the contact between the erosion resistant formations on the southern frame of the Vâlcan Mountains and the friable sedimentary deposits from the Subcarpathians. This contact was highlighted by differential erosion as a result of the last block rise of the Carpathians. At the same time, the Gornovița platform was removed from under the gravel cover, highlighting itself as a porch that dominates the depression by about 200 m (Emm. De Martonne, 1907).

In the mountainous region, the rivers, short but strongly deepened, form very narrow valleys, real keys at the exit of the mountain, while in the depression their valleys are accompanied by terraces that gradually widen to the confluence with the Jiul. However, even in the depression, the rivers are relatively narrow and deep, in relation to the wide peaks of the interfluves (relatively inverse situation compared to the relief of the sub-Carpathian depression that borders the Vâlcan Mountains to the south). The slopes of the mountains are mostly covered by forests, while on the hills of the Petroșani Depression there are meadows generally used as hayfields; the terrain is often uneven due to underground collapses due to coal mining.

The eastern boundary is marked by the Jiu Gorge, probably the most outstanding cross valley in Romania. The rock is the same on both sides of this boundary (crystalline shales in the northern and central part of the gorge, granites in the southern part). The eastern slopes of the Vâlcan descend continuously towards the narrow and crooked riverbed, beyond which rise equally steep cliffs that lead to the peaks of Parâng. Although the geomorphological differences between the two mountain ranges separated by the Jiu Gorge are not obvious at the boundary level, they appear to be very pronounced at a glance, due primarily to the higher altitude and massiveness of the Parang Mountains, reflected in the wide expanse of the alpine floor, of the glacial forms and of the Borăscu platform, which in the Vâlcan Mountains are almost completely missing.

Overall, the area of the Vâlcan Mountains, located in the outer part of the Danube domain, consists of a pre-alpine crystalline base, formed by crystallophilic and eruptive rocks, which occupy more than three quarters of the surface, and a Mesozoic and Tertiary sedimentary cover (Gr .Pop, 1973). These rocks have a different resistance to alteration and erosion, so that their alternation determines variations in the appearance of the relief, in the nature of the modeling processes and in the properties of the soil, so also in the general aspect of the landscape.

Within the crystalline base, the largest surface is held by the predominantly quartzite rocks from the Lainici-Păiuș series, especially in the upper-middle part of the southern slope of the Vâlcan Mountains, descending to its lower part in the Bistrița and Bistricioara basins. Chlorito-seric intercalations are also common in this series. The relief forms carved in these rocks are comparatively more erased, rounded, with few irregularities and moderate inclinations. Especially chlorite-siliceous shales and even micasists poorer in quartz are more easily altered and less resistant to erosion, compared to eruptive rocks and limestone.

The valleys of the rivers on the southern slope are often wider in the upper sector, where they cross these deposits, narrowing in the lower sector, where they meet harder rocks. In the northern part of the Vâlcan Mountains, insular rocks appear from the amphibolytic complex: amphibolic schists, amphibolic gneisses, chlorito-schists, to which are attached metagabroids, serpentines and crystalline limestone lenses. The resistance of these different types of rocks is varied, observing a succession of softer and more proud forms. Gnaisses and especially quartzites are very resistant giving local steep slopes and sharp peaks. Amphibolites give prominent, massive forms, while chlorito-schists are strongly affected by erosion. The limestones in this complex appear only locally and being strongly metamorphosed, they approach the crystalline schists through their effects in the landscape.

In the central and eastern parts of the main ridge and the northern slope there are epizonal crystallophilic rocks (bleached chlorite-sericite shales, quartzite shales, chlorito-epidotic shales, etc.), which are also characterized by more erased forms, the rock being covered with a thick layer of spoiled deposits. The slopes are generally unstable, degrading slightly after cutting the forest. Only quartzite shales are distinguished by the sharp, prominent shapes that appear locally near the main peak. For example, north of Nedeilor Peak, a pure, whitish quartzite with very sharp shapes, completely devoid of soil and vegetation, contrasts sharply with the gentle relief, erased around it. On the ridge northwest of Arcanu are small groups of bare rocks formed of disaggregated quartz shales, also in obvious discordance with the smooth, grassy surfaces that border them.

In the north-western half of the Vâlcan Mountains, the weakly metamorphosed deposits from the Tulişa series predominate, which extend like a narrow strip on their northeastern edge. They have a very varied composition: conglomerates, quartz arches and sandstones, crystalline limestones, silty and chloritic shales (L. Pavelescu, M. Pavelescu, 1964). They generally behave like hard, erosion-resistant rocks, in which the rivers on the northern slope have dug very narrow valleys. Of these, crystalline limestones are particularly important in the landscape. Due to the weak metamorphosis, they have properties and effects similar to those of sedimentary limestones, favoring the development of calcareous vegetation, as well as the appearance of karst phenomena. The greatest development and the most imposing aspect have on the Oslea ridge and towards its northern foothills, while to the east they are found only as a very narrow and discontinuous strip on the northern frame of the mountains, still having noticeable effects on both vegetation and and in relief.

On the western and southern sides there are massive granitoid intrusions, with various structures and textures, which determined the individualization of some characteristic types: Șușița type granitoids in the south-eastern half of the mountains, Tismana type granites in their southern part. west and Frumosu type granitoids in the central-western part (the upper part of the Motrului basin, with an extension south of Oslea, to Arcanu). Granitoids give heavy, massive shapes, with convex, stable slopes. Crystallophilic complexes and granitoid rocks are crossed by vein rocks of various types (lamprofire, aplite, pegmatite, andesite, etc.) which, however, do not stand out particularly in the appearance of the relief.

The Mesozoic (Jurassic-Cretaceous) sedimentary deposits have a large extension on the southern side of the Vâlcan Mountains. They are represented by conglomerates, sandstones, limestone, marl-limestone, marl-clays. Of all, the most widespread are the limestones of Middle Jurassic-Lower Cretaceous age, which are imposed in relief by lofty shapes, pronounced cliffs and a wide range of karst forms and phenomena (sinkholes, lapis lazuli, gorges, caves, karst springs, etc.). The limestones occupy considerable areas in the part between Șușița Verde and Sohodol, penetrating a lot inside the massif. To the west, the limestone strip narrows, unfolding predominantly at the edge of the mountain, while inland it appears only in the form of patches ("klippe"), at Piatra Boroștenilor, Cioclovina, Dealul Ruschiu, Dealul Sohodol, to take from again a large extension in the southern part of the upper basin of the Motr. To the east of Șușița Verde there is also a relatively wide strip of limestone at the edge of the mountain, to the east of the Hărăbaru river and a narrow strip in the central part, on the Varnița - Gropu line.

Geomorphological mapping with the use of morphostructural analysis has made it possible to illuminate in a new way many problems of geomorphology: the origin of river valleys, ridges, intermontane depressions, various types of slopes, leveling surfaces and pediments; the reasons for the restructuring of the river network and the associated redistribution of correlative deposits, the correlation of terraces and topography steps, the primary genesis of mountain.

In areas with block tectonics, in the process of differentiated movements of individual blocks, an alternation of ridges, massifs, depressions is created, and a stepped mountain topography is formed. Depressions-grabens in such a territory, depending on the amplitude of movements, can be filled with loose sediments, or they can represent "lagging" blocks, dissected by erosion along ruptured faults, and single-height ridges are also stepped. This is proved by the presence in the basement terraces and floodplains, channel drops in bedrock, lack of slope and alluvial deposits, with the exception of coarse gravel.

The correlation of levels in the blocks of mountains is often difficult and, in the absence of sediments, is possible only on the basis of a set of morphological data based on an in-depth regional study. Morphostructural analysis is helping to establish the absence of alignment surfaces in the folded mountains.

The practical use of morphostructural analysis in geomorphological mapping increases if the auxiliary and final maps are consistent with each other in terms of basis, content and sequence. In this case, all cartographic materials – maps, diagrams, profiles – provide the basis for compiling metallogenic, assessment and forecast maps. This is facilitated by the identification of faults and faults according to various data – geophysical, geological, geomorphological – and the use of analogies of natural situations. Mapping of block morphostructures is one of the ways to search for ore deposits, assessments of erosional and denudation cut, conditions of preservation and burial of deposits, assessments of seismicity and geotechnical conditions, study the dynamics of tectonic movements (for example, signs of weakening faults).

As Emmanuel de Martonne (1907) remarks, in the Vâlcan Mountains there are no large bridge-like surfaces, as in Godeanu, the irregularities of the relief being quite obvious. However, the rarity of the rocky cliffs (at the level of the ridge) and the deep soil prove a certain maturity of the relief. The smooth surfaces of the peaks reach widths of tens and up to hundreds of meters, especially on the Nedeile and Prisloapele mountains, near the Coarnele peak, on

Dealul lui Frate. Only on small areas there are prominent rocks (cliffs), usually located on the side of the watershed (for example, on Arcanu or Șigleu), with relative altitudes of a few meters, related to the emergence of harder rocks, resistant to erosion.

Most of the secondary peaks and the upper part of the slopes are in contrast with the lower part, because while the peaks have broad, more or less vaulted spines, and the upper part of the slopes is slightly inclined, their lower part is steep, in some places even precipice. Pronounced steep slopes, generally dug at the head of the layers that slope strongly to the north, are found on the right of Balomir and on the right of Sohodol at Lupeni. They are oriented to the south, to the main peak of the mountains. In some cases, such as Mount Straja, precipice slopes reach close to the summit, especially at the source of young valleys affected by intense erosion processes. Elsewhere, in the upper sector, the valleys have a gentle appearance, but in the middle they deepen strongly, forming in some parts insurmountable gorges (for example, on the Balomir valley). The gentle slopes are almost entirely covered by soil and forest vegetation. Only from place to place there are rock fangs of different sizes, blocks detached from the place of origin or boulder seas, as can be seen on the northwest side of Mount Straja.

The interfluves on the southern slope, prolonged and very gentle, can keep a series of sinuosities, still remaining with the general north-south orientation. They have very large areas and defragmentations.

The slopes of the valleys on the southern slope are generally strongly inclined, forested, with a rectilinear profile. In some parts it approaches the vertical with rock occurance. On their base, rubble trains accumulate. Until the construction of forest roads, with the help of modern means of blasting rocks, most of these valleys were impassable, not even on footpaths. The presence of several series of rivers is clearly visible. Some spring from under the main peak of the Vâlcan Mountains, with relatively large, strongly branched basins (Motru, Bistrița, Sohodol) or narrow, elongated basins (Șușița Seacă, Șușița Verde, Bratcu). Other rivers originate in the upper-middle part of the southern slope (Pocruia, Tismana, Bistricioara, Viezuroiu, Vâjoaia, Hărăbaru, Porcu) or even in its lower half (Sohodolul Pocruiei, Sohodolul Popeștilor, Balta, Valea Tânără, Valea Bătr social).

The terrain geomorphology has been used since antiquity in military operations for defense and attack. The names themselves in military tactics and strategies speak of this – the dominant heights, open and closed fortifications. The confinement of many long-term fortifications to certain relief forms or complexes of relief forms can be more or less easily traced. Fortresses and castles were erected on antecedent areas of valleys, outlier forms of relief

– erosion and abrasion outliers, terrace areas on mountain slopes, over cliffs of cuest, on the sides of incised meanders.

The steepness and height of the slopes of the landform played a significant role in choosing the location of the fortress (castle) or of mainsons (conace). Land areas with an ascending type of geomorphology development were more saturated with fortifications on natural foundations. On the low-lying plains with a predominance of a descending component in the development of the terrain, it was necessary to erect artificial hills – embankments and place fortresses on them or heap the territory of the fortress. To block the most important trade routes, fortresses were built on saddles. All these mentioned above find their ruins and traces still hosted in the southern part of Vâlcan Mountains.

There are different forms of human influence on landscapes and on the landforms of the earth's surface. There are two main types of ethnic groups according to their impact on landscapes – persistent – ethnic groups that are part of the biocenosis, fit into the landscape and thereby limited in their reproduction; this mode of existence is inherent in many species of animals, as if stopped in their development, and – succession – ethnic groups that multiply intensively, settle beyond the boundaries of their biochore and change their primary biocenosis. Persistent include modern and past ethnic groups, whose lifestyle is close as possible to nature. The influence on the relief and landscape is carried out by persistent peoples mainly due to muscular strength using the simplest devices (see stonemasons from Vaidei, Șușița Verde). Successional ethnic groups, when influencing the landscape, use a wide arsenal of technical means. A very significant specificity is really manifested here, in comparison with the zoogenic impact, and for this kind of anthropogenic landform creation.

There are obvious analogies and differences between zoogenic and anthropogenic landform creation. According to the principle of a landform formation agent, it is possible to combine these types of impact on the landform (muscular anthropogenic and technologic) into one type – anthropogenic – and consider it as a type of genetic complex of a wider class – organogenic, including biogenic and anthropogenic types of landforms.

Morphological landscape and morphological landscape can become the basis for assessing the natural and recreational potential of the territory. The implementation of this task is possible based on some methodological sequence. First, it is necessary to conduct a comprehensive analysis of the basic and additional properties of the terrain that are essential for a particular type of recreation. Secondly, the choose of informative indicators of these properties and development of a system of their private assessments. Thirdly, in the study area, it is needed to identify recreational areas, typify them depending on the type of recreational activity, in their aisles assess the topography depending on the selected private and general indicators of recreational attractiveness and create a matrix of these indicators. Fourth, to present the results of assessing the natural and recreational potential in the form of a cartographic database, including layers of thematic digital maps: recreational areas, geomorphological assessment of the recreational potential of recreational areas, etc.

Geomorphological features of the territory (position in the river basin, dissection, exposure, absolute and relative altitude, as well as passability, aesthetics, stability of the geomorphological landscape) play an important role in choosing a place for building holiday houses, hotels or other types of buildings for recreational purpose. One of the main functions of a territory is recreational. In relation to the populated area from a rural zone, recreational areas can be extravillan and intravillan. Initially, at the stage of the recreational functions were performed only by extravillan areas.

Extravillan areas in the old days and still nowdays were used as places of folk festivities as reported by Conea (1937, "nedeile"). This types of activity can be considered a local geotourism through which inhabitants and their guest show their appreciation to the surroundings. In southern slope of Vâlcan Mountains as well as in Mehedinți and Parâng Mountains, these are located in several kartsic areas not far away of Dobrița, Boroșteni, Runcu, Schela and Topești villages. All of them represent strategic points for comprehensive panorama of administrative-territorial units to which those villages belong. Those placea are used as a space for folk festivals and gatherings. These examples testify to the old tradition of residents of Oltenian subcarpathian villages to make extensive use of the most beautiful and picturesque countryside places for mass recreation.

The extent and great thickness of the limestone deposits determined a wide extension and a great variety of karst forms and phenomena.

The simplest karren or limestone pavement, corrosion hieroglyphs, are scattered almost everywhere where limestone appears. They are generally in the form of small twisted ditches, in which the saxicola vegetation finds shelter.

Often the karren evolved under a layer of soil and residual clay, being then exhumed totally or partially due to land degradation. The partially fossilized karren appear in the landscape as rows of limestone cliffs (representing the ridges between the karren), while their trench is filled with residual clay on which a rendzinic soil and meadow vegetation have often formed. On the more intensely degraded lands, these ditches are also exposed, and the ridges that separate them are strongly disaggregated. In some places, due to the widening of the lapies, the ridges between them shattered, as a result of the narrowing of their base, forming a ruinous, chaotic microrelief.

The sinkholes are found especially on slightly sloping lands, especially within the Gornovița erosion surface. They are usually circular in shape, with a diameter of 15-20 m or even more and depths of 4-10 m. In some places there are also pit caves (vertical caves) – for example, in the Gropului Sec basin, in the place called "La grădini" and in the Șușița Verde basin. The more complex forms – uvala and polje, are rarer, unlike the Mehedinți Mountains and Plateau, where they are quite common. Of these, in the vicinity of Sohodol Pocruiei there is a valley several hundred meters long with a meadow along which a stream sinks into a lawn under a limestone wall. Smaller uvala can also be found northwest of Izvarna and Costeni and west of Gornovița, along the erosion platform.

The gorges are very representative for the karst relief from the Vâlcan Mountains. On the northern frame, although the limestone layer is relatively thin (7-8 m), a series of obvious but small gorges are formed, dug by the waters of Braia, Sohodol, Baleia and its tributaries on the left. A small sector of gorges also appears on the western side, along the Motr, between the Red Steiul from the Vâlcan Mountains and the extensions of Pietra Cloșanilor from the Mehedinți Mountains. In the southwest corner there are small gorges dug by the Cheia brook and the Sohodolul Pocruiei. Tismana and Bistrița, although at the exit of the mountain cross the limestone strip, have relatively wider valleys, without a typical gorge aspect, but with steep and rocky slopes. The most typical, widest and deepest are the gorges along the Sohodol River and its tributary, Gropul Sec, which make up the most spectacular gorge complex in northern Oltenia. Along the Sohodol, the gorges run for more than 12 km, being interrupted in two places by the appearance of non-calcareous rocks (V. Sencu, 1972). Several gorge sectors are also found along Șușița Seacă and Șușița Verde between Vaidei and Curpen has slopes with typical gorge features, although the bottom of the valley is relatively wide here.

In addition to these surface forms, in the limestone and dolomite parts of the Vâlcan Mountains there are also many caves.

Overall, the karst geomorphology from the Vâlcan Mountains presents a special complexity, the analyzed forms being associated in the most varied ways and thus giving a specific note to the landscape.

The current appearance of the Vâlcan Mountains reflects the long action of the modeling processes, which determined the appearance of soft, erased shapes at the level of the interfluves, while the slopes are strongly inclined and intensely fragmented. But both on the peaks and on the slopes, the action of the morphogenetic processes continues even today, with varying intensities and forms, influencing both the pedogenetic processes and the distribution of the vegetal cover. These processes do not, however, essentially modify the old forms (as often happens in the subcarpathian regions with pronounced instability), but only create a specific microrelief, increasing the landscape variety of the Vâlcan Mountains.

The disintegration and alteration processes, very active in the Pleistocene, but continuing with relatively high intensity even in the current period, led to the formation of a cover of alteration deposits on most interfluves. Its thickness and physico-chemical characteristics vary depending on the nature of the rock and the degree of inclination of the slopes. Thus, for example, on crystalline epizonale shale, the alteration crust contains numerous fragments of rock, generally flat, included in an earthy material.

The geomorphology of the earth's surface is a complex formation. Its origin is closely related to the interaction of endogenous and exogenous factors. However, in each period of time and in any point of geographic space it is possible to single out one or more leading factors that determine the morphological appearance of the territory

The systems approach draws attention to the object of research as a complex whole. In the previous stage of the development of science, as it can be seen at Murgoci (1882) in his reasearch about Southern Carpathians karst, much attention was paid to the parts. The relationship between the parts has not been specifically studied. The relationship between the parts was taken as a logically possible relationship.

The groundwater feeds numerous springs, which appear at variable altitudes on both the northern and the southern slope of the Vâlcan. In the non-calcareous sectors, several main lines of springs can be found, depending on the morphohypsometric steps.

A special situation is presented by the sectors with calcareous rocks, where the distribution of the springs is related to the particularities of the water circulation in these rocks, generally strongly tectonized. At the base of the limestones that make up the Oslea ridge, on the southern slope, there are several abundant springs, of which the one that constitutes the source of Bistrița (at about 1.700 m) stands out.

The territory of the Vâlcan Mountains is part of the Jiu river basin, with the exception of a few streams on the western slopes of the Oslea and Turcineasa mountains, tributary to Cerna.

In order to use the water resources from the Vâlcan Mountains, a series of large-scale works have been undertaken in recent years, within the Cerna – Motru – Tismana hydropower system, which has led to important changes in the regime and flow of these dam waters. On the northern slope, on Valea de Peşti, an accumulation lake was built to supply water to the localities from the Petroșani Depression. The karst springs at the foot of the southern slope, with abundant flow, uniform drainage regime and drinking qualities were captured for water supply of the cities of Târgu Jiu (springs from Runcu) and Craiova (springs from Izvarna).

In the southern Vâlcan Mountains, the Sohodolului Valley belongs to the catchment area of the Sohodol River, whose course stretches over a distance of 18 km south of the tip of §igleul Mare to Izbucul Jale§, north of Runcu and Rachqi villages. Although along its entire length the Sohodolului Valley has the morphology of gorges, by which hence the generic name of Sohodolului Gorges, the actual gorges are separated by areas of metamorphic rocks in several distinct sectors: Runcului, Vidra and Patrunsa Gorges. The Sohodolului Gorges Nature Reserve is a protected area with a schematic boundary corresponding to Runcului Gorges. The Vidra Gorges have the same status of a protected area as the Sohodolului Gorges Nature Reserve, but without any boundaries set up officially. The two nature reserves are part of the site of community importance (SCI) North of the Western Gorj, whose primary purpose is the protection of biodiversity. In terms of territorial administration, Sohodolului Valley is located in Runcu rural commune, in the Gorj county. From geological point of view, the Sohodolului Valley is located in the Lower Danubian Units of the Central South Carpathians. The geodiversity elements belong almost entirely to the Mesozoic sedimentary cover, which is mainly carbonatic and presents numerous karstic shapes and phenomena. Geodiversity is related with biodiversity, as an impact on the abiotic environment is felt equally by the biotic environment.

The Sohodolului Valley (Fig. 1) runs from north to south between the Sigleul Mare tip and Tismana - Stane§ti Depression, where the confluence of Runcu and Sohodol rivers results in the Jale§ River. Considering that the groundwater in karstic areas is powered from allogene areas, consisting of non-karstic rocks, and the limits of the two nature reserves in the area did not include the rest of the important elements for geodiversity, it is necessary to suggest a new delimitation, which would include a larger geosite. The relief of the Sohodolului Valley is dominated by the Gomovija erosion platform, which has two levels. The first level, between 400 and 700 m, has a slight gradient, while the second level, between 750 and 1100 m, has a sharp slope.

This geosite has a landscape value and also a geo-educational one, and represent the support for geotourism development. The existence of an area of biodiversity overlapped (Fig. 1) only over the current area of the site, doesn't provide adequate and necessary integration of geodiversity which is characteristic for Valcan Mountains area, and it will not lead to a proper recovery of the benefits that would result from the application of geotourism in the area. Geodiversity provides the necessary foundation of life, in general, of ecosystems and life forms that make up these ecosystems. Their existence and survival depends on bedrock, soil types and surface geological processes. Studies have shown that biodiversity is directly related to geodiversity, being dependent on it, and more than that, a larger number of elements of geodiversity ensure the existence of a more diversified biodiversity. If the given importance of biodiversity is higher than the interest for geodiversity conservation, this could become a threat to the protection of geodiversity elements because the purpose and role of geoconservation will be diminished.

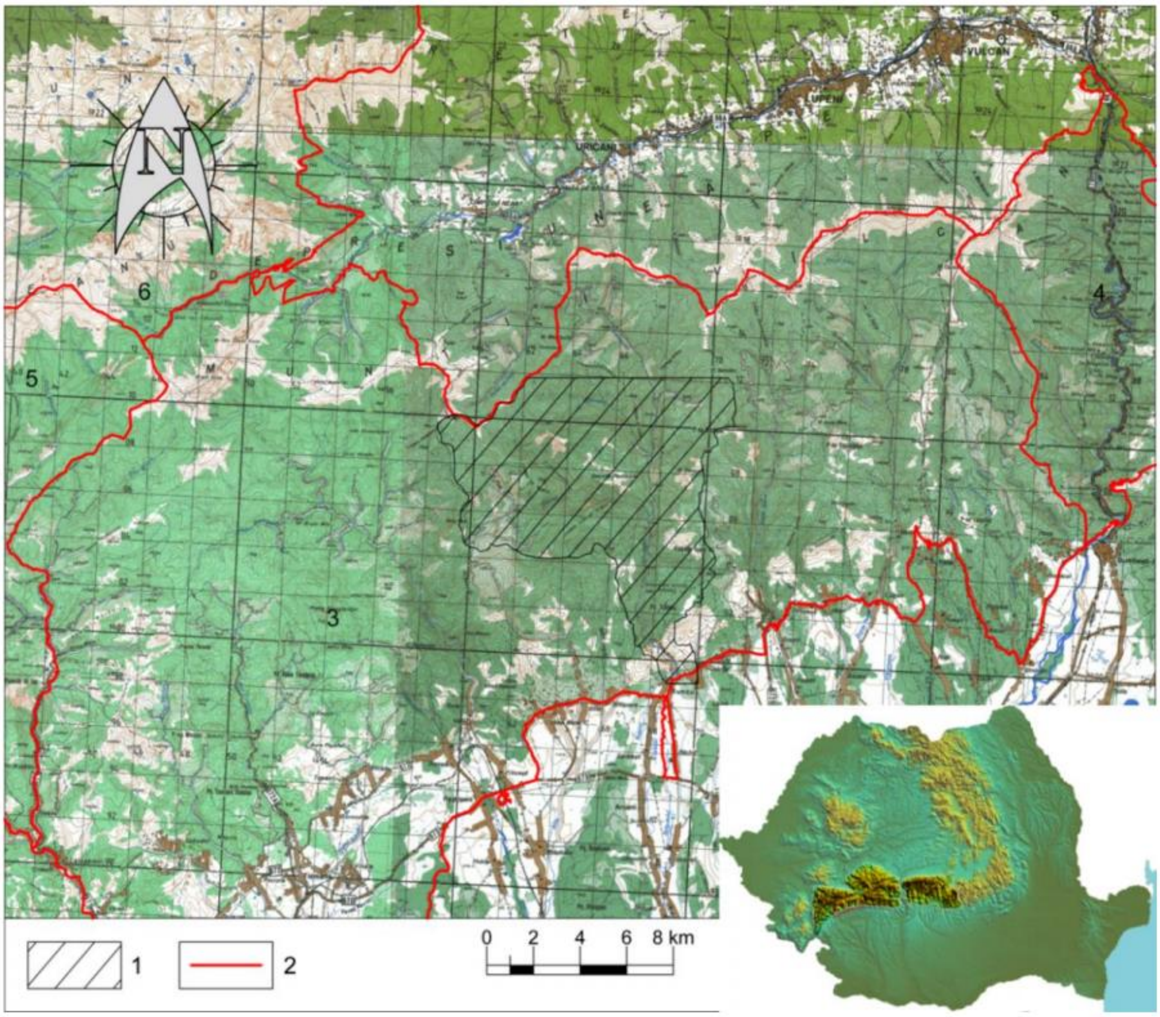

Figure 1. Topographic map of the Valcan Mountains, using topographic maps scale 1:100.000 of DTM 1996, sheets Deva, Petrosani, Orsova, Tg. Jiu. 1 - Study area; 2 - limits of natural protected areas; 3 - SCI North of the Western Goij; 4 - Defielul Jiului National Park; 5 - Domogled-Valea Cemei National Park; 6 - SCI Tarcu Mountains.

Geodiversity should be understood under three main aspects. This classification comprises the geodiversity values identified by Gray (2004). The first one regards the rocks, minerals and fossils, as well as their tectonic features. The second aspect discusses the geomorphological component of geodiversity. The third one shows the links between geological diversity and natural protected areas, biodiversity and local communities (Roman, 2014a). Other aspects related to geodiversity are those of cultural heritage, with an emphasis to the evolution of researches during the last century, geoeducational methods and tools (Andra§anu, 2009; Roman & Vasiliu, 2014 & 2015) and sustainable development of an area through geotourism (Roman, 2014b).

The Sohodolului Valley cuts through the sedimentary cover and crystalline basement of Lower Danubian Nappes on the southern slope of Valcan Mts (Fig. 2). The sedimentary cover includes mainly the stratified rocks of Jurassic and Cretaceous and belongs to Cema Unit and Cosustea Nappe. The metamorphic basement comprises the Lainici-Paius series, which is intruded by the §u§ita granite and belong to Valcan Unit (Stefanescu, 1988). Valcan Unit and Parang Unit form the Lainici Nappe, which is in upper position to Schela Unit within the Alpine Units of Lower Danubian. Cerna Unit, Cosustea Nappe, Lower Danubian Units and Upper Danubian Units form Danubian Complex, also known as the Marginal Dacides (Sandulescu, 1984). Danubian Complex and Moesian Platform represent a part of the European-Asian margin, which was separated from the Getic micro-continent by the Severin-Ceahlau ocean basin. In the Getic depression, below the molasse of Moesian Platform, Cosustea Nappe is lying tectonically over the formations of Cema Unit and Severin Nappe lies over Cosustea Nappe (Stefanescu, 1988). The crystalline schists of Getic Nappe are lying partially on Severin Nappe and on Cosustea Nappe. On the southern slope of Valcan Mts, several „allochthonous covers” were separated between Obar$ia Clo$ani and Schela (Stan el al., 1978). These klippe are interpreted either as the result of a decollement before the emplacement of Getic Nappe (Sandulescu, 1984), or these covers were displaced due to the overthrust of Getic Nappe or/and Severin Nappe. In fact, these are out-of-sequence thrust sheets, which had a displacement over Cosustea Nappe and after this overthrusted the Cema Unit. According to Morley (1988), the out-of-sequence thmst sheets do not obey the foreland propagating or in-sequence pattern (deformation style). The same author claims that out-of-sequence thrust sheets should be considered common and part of the normal deformation sequence. The out-of-sequence thmst sheets of Sohodolului Valley are remnant of Cema Unit broken up as horses. Even till recently these overthrust sheets were considered as nappes (Seghedi & Oaie, 2014). A nappe or a thmst sheet is defined as a rock unit, which had a displacement of tens of kilometres on a surface close to horizontal (Merle, 1998). In addition to this definition, as a difference between nappe and thmst sheet, there should be known that a nappe is detached from its roots, which are difficult to be identified, and that it overlays large areas.

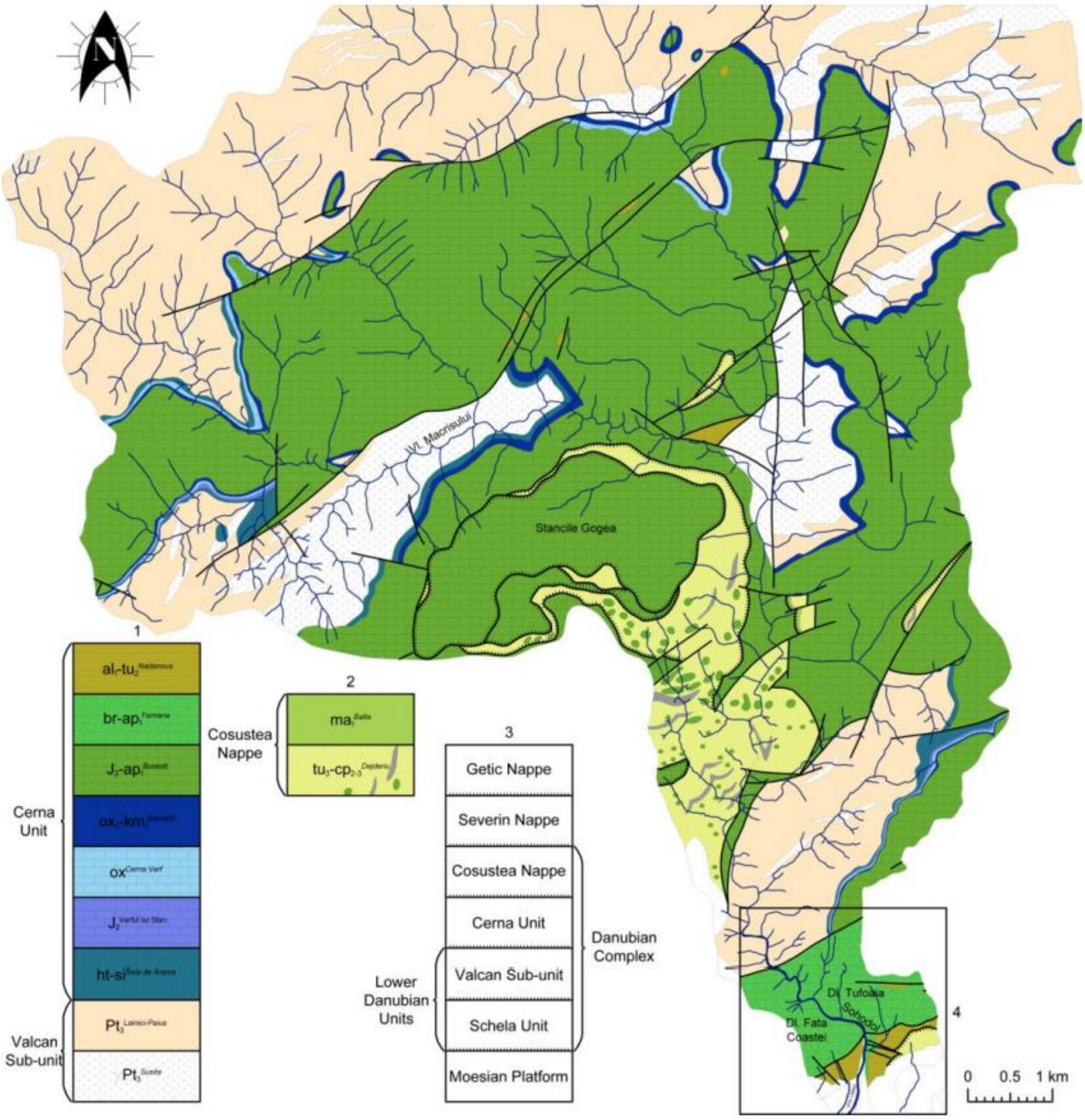

Figure 2. Geological map of Sohodolului Valley modified after Pop (1973, 1975), Stan et al. (1979) and according to Stanoiu (1996, 1997, 2000, 2008) and Pop et Bucur (2001) and Stefanescu (1988). 1 - Schematic stratigraphic column of Cema Unit and Valcan Subunit; 2 -Schematic stratigraphic column of Co$u$tea Nappe; 3 - Schematic tectonic column of Lower Danubian Units. 4 - Runcului Gorges.

As in the studies of the last three decades, it was proved that Moesian Platform is overthrusted by Lower Daubian Units, the term "autochthonous" should be used with inverted commas for the Danubian complex and in order to show the tectonic relations with the Getic Nappe. The same thing should be done when we refer to the "allohtonous covers" or "Cerna

Nappe” from the southern slope of Valcan Mts. The development on a long distance is not known for the so called “Cema Nappe”, and, also, the overlapping of these thmst sheets on the Cerna Unit and Cosustea Nappe didn’t highly altered the blocks involved. The term “overthrust sheets” is more appropriate for the out-of-sequence thrust sheets, rather than “nappe”, which can be confusing as it shows no independent evolution. The out-of- sequence thrust sheets from Sohodolului Valley resulted through the propagation in-sequence thrusting (with time) of Getic Nappe and Severin Nappe from hinterland to foreland during the Laramide events. The stratigraphic successions of the Cema Unit were cut upward relative to the direction of transport and, consequently, older rocks were placed over younger rocks. The continuous and closed branch-line of Cosustea Nappe makes it entirely demarcated, while the branch-lines of the out-of-sequence thrust sheets from Stancile Gogea are discontinuous and closed with a curled and isolated aspect. The geological constitution of the Sohodol Valley is the result of epeirogenic and orogenic movements. The rock types (limestones, sandstones and shales) of Cema suggest passive continental margin deposits. The stratigraphic successions of Cema unit contrasts with those of Cosustea Nappe, which include sequences of greywacke, shales, tuffs and lavas (Seghedi & Oaie, 2014). The deposits of Cerna Unit suggest a shallow-water environment, while the deposits of Cosustea Nappe are specific to deep marine environments (Seghedi & Oaie, 2014).

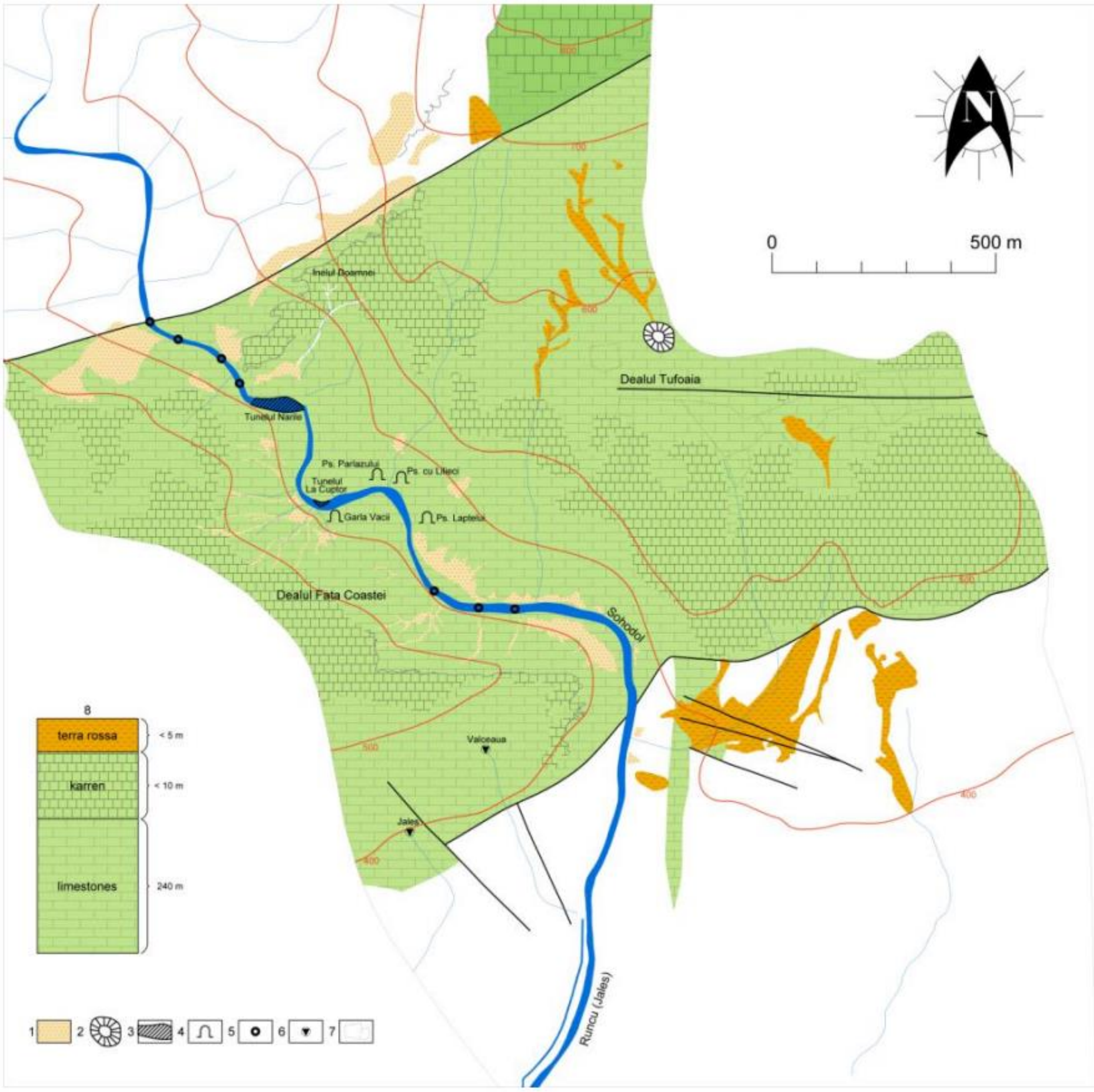

Figure 3. Karst map of Runcului Gorges. 1 - scree talus; 2 - dolina; 3 - tunnel; 3 - cave; 5 -ponor; 6 - spring; 7 - marching camps; 8 - schematic column.

A characteristic feature of Runcului Gorges which is related to karst (Fig. 3) is represented by scree talus deposits, largely a product of glacial erosion and subsequent soil loss. These deposits can be separated in two main scree talus types, depending on the inclination degree of exposed slopes and the active weathering process of limestone: large proluvial cones, which are less fed with debris, and incipient proluvial cones, which are developing on erosional stair-stepped terraces. The main source of these “stone rivers” is the unearthed karren, which was discovered from the already washed red soil (terra rossa).

The link between geodiversity and natural protected areas are well defined through the Geoparks recognised by the European Geoparks Network and Global Network of National

Geoparks under the auspices of UNESCO. A Geopark corresponds generally to the definition of Natural Park and a geosite is similar to a nature reserve. While a Geopark refers to a bigger area, which comprises a natural zone and an anthropic one, a geosite is a natural surface delimited inside or outside of an existing National or Natural Park (*, 2007; **,2000).

The Pârgavului Cave is located in the Vâlcan Mountains (South Carpathians) and develops in Lower and Middle Jurassic limestones. Due to various carbonate facies, the dissolution acted selectively; thus, cave passages show different morphologies. The Mesozoic tectonics events combined with the hydrogeological conditions existing during the Quaternary, created a unique imprint on various geomorphological aspect of the cave. Speleothems are present in the sub-horizontal part of the cave. The progressive incision of the underground river led to the formation of several generations of shelfstones.

The Pârgavului Cave (750 m alt.) develops in Lower, Middle, and Upper Jurassic limestones on the southern slopes of Vâlcan Mountains (Fig. 1) and is situated north of Topeşti and Vâlcele villages (Goran 1982). The entrance of the cave is located at the base of a cliff, 30 m above the resurgence that drains the subterranean spring. On the plateau above the cave, several sinkhole and shafts, which facilitated the infiltration of rainwater into the karst system, were identified. This area of Vâlcan Mountains is a gentle monocline, descending toward the SE. The elevation of Vâlcan Mountains ranges between 400 and 500 m in the southeast and 800–900 m in the center and northeast. The total length of the cave passages reaches *3600 m and its vertical development is 119 m (+110 m; −9 m).

Metamorphic (Upper Proterozoic), magmatic, and sedimentary rocks of Marginal Dacides (Danubian Unit) tectonic unit outcrop in the region (Fig. 2) (Pop et al. 1975; Marinescu et al. 1989; Bădescu 2009). The Tismana Granite (Upper Paleozoic) penetrates the metamorphic rocks. The Mesozoic begins with the Lower Jurassic in Gresten facies, which consist of quartzite sandstones (with elements of feldspar, metaquartzite fragments, muscovite, and rarely, biotite) (Pop 1973; Bădescu 2009). On average, the rocks contain 80% quartz and approximately 16% feldspar.

The Upper part of Lower Jurassic consists of limestones and marls. The Lower Jurassic is overlain by Middle Jurassic carbonate deposits (Carozzi 1960). These deposits present numerous lateral facies variations, which can easily be observed in the Pârgavul Cave. The limestones are represented by biosparite, pelsparite, and micrite, which occasionally contain remains of bivalves, gastropods, corals, and foraminifers. Dolomite rocks appear alongside the limestones. Differentiating between the Middle and Upper Jurassic deposits is difficult, as paleontological evidence are sparse or do not exist.

Figure 4. Location of Pârgavului Cave

The Upper Jurassic is represented by limestones and dolomites (150–200 m thick), sometimes interbedded with chert layers, which frequently contain an argillaceous horizon (0.2–10 m thick) at the base. These deposits are overlain by 50 m of micritic limestone of Lower Cretaceous (Neocomian) age and 300 m of Barremian-Aptian limestones (Urgonian facies). The Upper Cretaceous is composed of arenite and lutite deposits in wildflysch facies.

The Tertiary includes Neogene molasses of the Getic Depression, which also comprises deposits of Sarmatian, Meotian, and Pontian age. During the Alpine neo-Cretaceous tectogenesis (Laramide) or post-Cretaceous the sedimentary deposits experienced folding and faulting.

The hydrographic network is relatively well developed, with valleys oriented NNW-SSE, along which the landscape is fragmented in hills and ridges. The watercourses flowing over the carbonate deposits originate from the impermeable rocks (igneous and crystalline schists). The vicinity of Pârgavului Cave is dominated by Pârgavului Valley and its tributaries, as well as by Piscurilor and Pârgașului valleys, which cross the impermeable unit of Tismana Granite, the metamorphic rocks, and other Lower to Upper Jurassic and Lower Cretaceous deposits. The main water source is Pârgavului resurgence, which collects its waters from the Șesul Pietrei Plateau and Padina Crovurilor (Iurkiewicz and Mangin 1994; Iurkiewicz 2010) (Fig. 2).

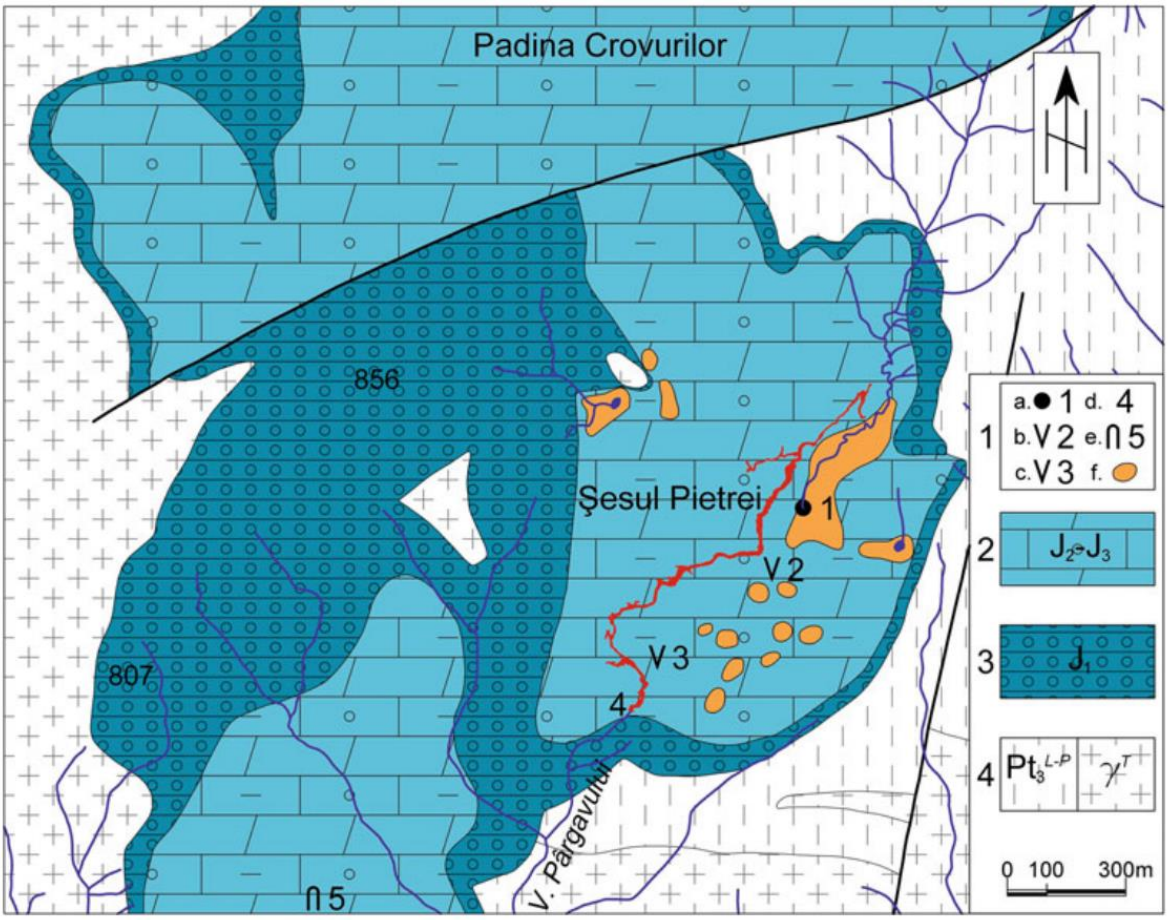

Figure 5. Geologic map of Pârgavului drainage basin (after Pop 1973; Pop et al. 1975; Marinescu et al. 1989). 1a Poiana Ponor (swallow hole), b Avenul Mare din Șesul Ponor (pit), c Peștera de la Cunună (pit), d Pârgavului Cave, e Șura Plaiului Cave, f sinkhole, 2 J2–J3 Middle to Upper Jurassic limestones, 3 J1 Lower Jurassic sandstones, 4 Pt3 Upper Neoproterozoic metamorphic series of Lainici-Păiuș, c Tismana Granite (Paleozoic)

The first section of Focul Viu Gallery is dry, 2–3 m wide and 3–5 m high, and the stream flows at a lower impermeable level. Not far from the entrance, a relatively well-decorated and ascending passage to the left called Bear's Gallery (Galeria Ursului), houses a whole skeleton of *Ursus spelaeus*.

The main gallery continues south–north for 300 m and changes direction (east to west) in the vicinity of a small shaft. Immediately after this change in direction, the stream reappears and will be present throughout the rest of the cave. Further on, is the well-decorated Gallery of Lakes (Galeria Lacurilor), with some small canyons and rills carved in limestones as a result of differential weathering between calcareous sandstones and limestones. After passing several tight sections in which the ceiling is approximately 1 m high, the Sumps' Tributary (Afluentul Sifoanelor) is reached; this point marks the end of the gallery with sub-horizontal floor. From the cave entrance to the Sumps' Tributary, the vertical relief of the cave is only 10 m. Beyond this point, the cave has a completely different morphology, a change that is discussed in the next section.

The Pârgavului Cave develops within the entire sequence of Jurassic carbonate deposits. The geological map of the cave and cross section are shown in Fig. 3. The first portion of the cave follows a disjunctive tectonic fault oriented N–S. In the Bear’s Gallery, quartzite sandstones`and silty limestone beds are interbedded, giving the cave walls a particular rugged outlook. During the phreatic phase along this section, the water has generated elongated ceiling grooves with rounded edges. There are no specific orientations of these grooves, probably because the water moved very gentle in an epiphreatic regime (Bleahu 1974).

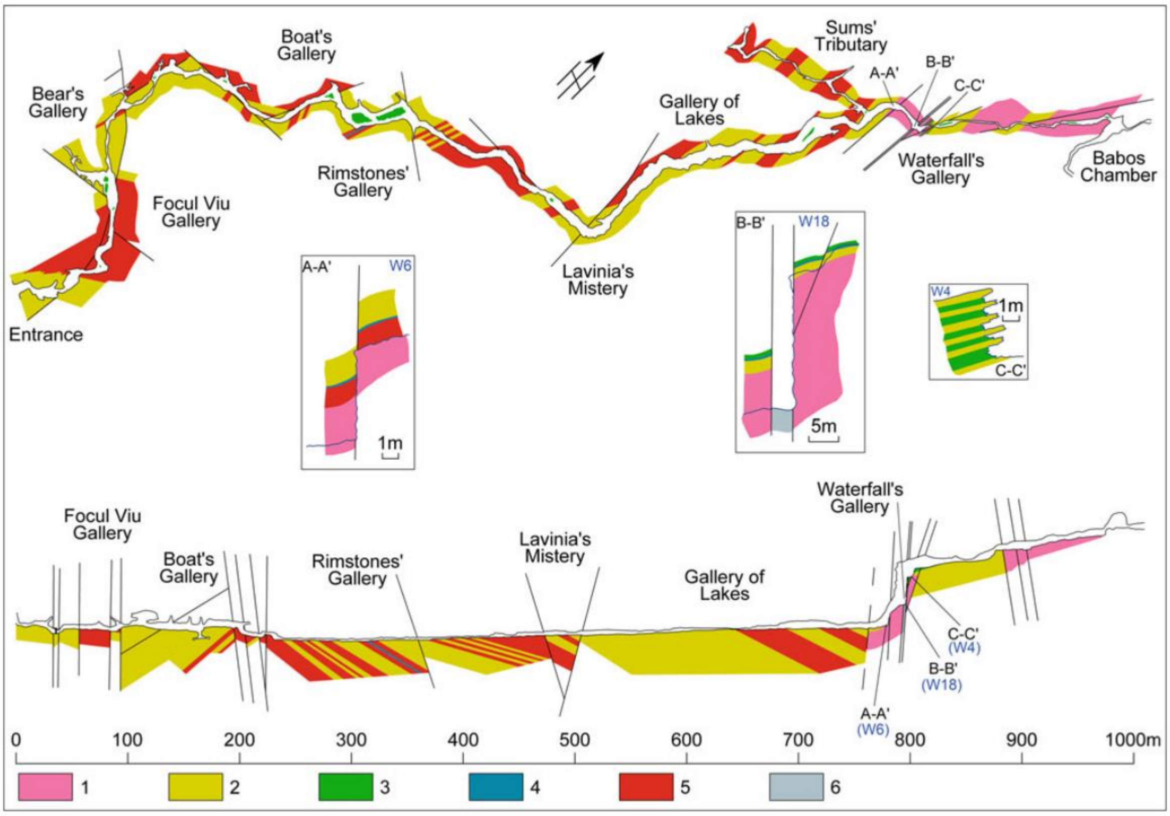

Figure 6. Plan and cross section of the Pârgavului Cave. 1 Quartzitic sandstones and micro-conglomerates (Hettangian), 2 sequence of sandy limestones and/or grayish calcareous sandstones, black spathic limestones, and spotted grayish limestones (lower Jurassic), 3 grayish marly limestones (Bajocian), 4 black chert (Callovian-Oxfordian), 5 whitish and grayish fine limestones (Tithonian), 6 fault breccia/clay

The dissolution of the dolomites results in gray surfaces with small ellipsoidal stains or relict micritic zones (Bădescu 2009). The gallery continues in an E–W direction for a relatively long distance, crossing through arenitic limestone, dolomitized limestone, and micritic limestone. Affected by a NW–SE fault, the interbedded chert layers are revealed, providing the only stratigraphic reference in this section of the cave. After a well-developed section in finely grained limestones and dolomites, follows another change in the gallery's direction that occurs along a fault oriented N–S, at Lavinia's Mystery. The Gallery of Lakes develops NE–SW and remains the same until Sumps' Tributary. On this well-decorated passage, we cannot distinguish any tectonic feature that would explain the genesis of the gallery.

The direction of displacement for the fault's compartments is clearly highlighted by the fault pipes, which are easy to observe, as they affect a chert level showing interesting models of kink folds. These features are best view in front of the 6 m waterfall (W6, see A–A′ section in Fig. 3). Upstream from the 6 and 18 m waterfalls and all the way to the Baboș Chamber, the stream flows almost exclusively on impermeable deposits (see B–B′ cross sections in Fig. 3). About 40 m from the 4 m waterfall, a directional strike-slip fault that continues until the entrance to the Baboș Chamber is responsible for another waterfall.

This thesis presents two study cases. First of them is an assessment of Sohodolului Valley geodiversity under several aspects. The first one regards the geology and tectonic setting and presents a geologic map redrawn on a new topographic base highlighting details about the relations between Cosustea Nappe and Cema Unit. The karstic map of Runcului Gorges, one of the most important parts of Sohodolului Valley, is the contribution of this paper from geomorphological point of view. The karst and geomorphologic features (scree talus, terra rossa, karren) were the object of GPS measurements carried out on the entire surface of the gorges. Threats to geodiversity were discussed, as well as the need of an adequate management and conservation, as the areas established for the protection of biodiversity show more threats than security.

The Pârgavului Cave, due to various carbonate facies, shows different morphologies. The Mesozoic tectonics events combined with the hydrogeological conditions existing during the Quaternary created a unique imprint on various geomorphological aspect of the cave. Speleothems are present in the sub-horizontal part of the cave. The progressive incision of the underground river led to the formation of several generations of shelfstones. The Pârgavului Cave is the longest cave known at this moment from Vâlcan Mountains and itsmap presented here represents the most up to date cartographic data for the region.

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