BABEŞ-BOLYAI UNIVERSITY

FACULTY OF ENVIRONMENTAL SCIENCE AND ENGINEERING

PhD THESIS

-ABSTRACT-

CORRELATIONS BETWEEN GEOLOGY, GEOMORPHOLOGIC PROCESSES AND RARE PLANT SPECIES STATUS IN THE TRANSYLVANIAN BASIN

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SUMMARY

Keywords: geology, plant species, correlations, Transylvanian Basin, statistical analysis, geomorphological processes, anthropogenic impact

Note: The numbering of figures and tables in this summary is the one used in the original thesis.

INTRODUCTION

The existing relationship between the geologic substrate and vegetation is known and documented. It is also known the role of communities and indicator species in the characterization from a geological point of view of a territory and their importance in applied studies such as geological surveys.

From this point of view the study *Correlations between geology, geomorphologic processes and rare plant species status in the Transylvanian Basin* is part of a line of interdisciplinary studies based on methodologies and concepts both ecological and geological.

Geological substrate, through the lithological composition, structure and tectonic influences the course of the geomorphological processes and they in turn will put their stamp on plant communities, affecting their composition and dynamics. The study of these relationships can be approached in two ways, with or without anthropogenic influence. The study includes a component having conservationist view that these species are rare items of great value, recognized in national and international law.

CHAPTER I – CONSIDERATIONS ON THE TRANSYLVANIAN BASIN GEOLOGICAL SETTINGS

This first chapter is intended as a basis for the next chapters by presenting the conceptual aspects and geological characterization of the Transylvanian Basin.

According to Sergeev (1984) geological environment can be defined as "any rocks or soils that make up the top of the lithosphere, considered as a multicomponent complex systems and below the direct impact due to human activities resulting in changes in natural geological processes and the emergence of anthropogenic processes that alter the geologic conditions of a particular area.”

This definition captures three key elements of the geological environment as a subject, that is about (1) rocks and soil; (2) naturally occurring or anthropogenic processes and (3)region (Sergeev, 1984).

The chapter continues with a detailed presentation of the geotectonic evolution of the Transylvanian Basin, the foundation and its sedimentary layer. Basin characteristics are presented as height, thickness of sedimentary layer or the presence of tuff horizons.

The Transylvanian Basin is the largest intra-Alpine sedimentary basin in Romania. It represents a regional sedimentation surface currently delimited by the Carpathians, this surfacing being less obvious only in the north western part where there can be found the so called “hidden mountains” of Transylvania(SZADETZKI-KORDOSS, 1930), zone also known as “intra-yoke”(MUNTEANU MURGOCI, 1924). This sector however functioned as a physiographic threshold separating the sedimentary area of the Transylvanian Basin from the Şimleu one respectively from the western located Great Pannonian Depression. In addressing the basin history of the region that we have direct relevance to this study, we consider mainly the watersheds found today as formations and deposits not involved in folded structures. In other words, the vertical sequence known by vertical drilling and geophysical investigations (especially seismic and gravimetric explorations) plus a series of drilling data (CIUPAGEA ET AL. 1970; SĂNDULESCU ET VISARION, 1978), we are able to distinguish two basic elements: first igneous metamorphic elements and sedimentary structures directly involved in creased structures with age ranging between Precambrian and Mesozoic, respectively undisturbed mega-sequences of tectonic undisturbed sediments incumbent upon the end of the Cretaceous respectively Cenozoic.

Transylvanian Basin stratigraphic section locally exceeds 5 km, on its thickness being able to distinguish four stratigraphic mega-sequences: (a) Terminal Cretaceous (rift, gravitational collapse), (b) Paleogene (sag), (c) Lower Miocene (flections), (d) Medium Miocene and Superior Miocene (back-arc tectonics dominated by gravitational tectonics) mentioned above in accordance with KRÉZSEK AND BALLY (2006).

Starting with the Maastrichtian and continuing with the Cenozoic, in the Transylvanian Basin sedimentation area install a series of pools that appear uninvolved in today’s structures. In other words the continental Maastrichtian was already deposited over the structures covering them in an inconsistent manner.

Taking the special significance shown for our research, we will stop for a more detailed picture of the lithology and stratigraphy of the basin, giving a special role to the Sarmatian sedimentary deposits, respectively to the alternance of clays, sands, sandstone, limestone and sometimes of volcanic tuff.

CHAPTER II GEOMORPHOLOGIC SLOPE PROCESSES

First, in this chapter we consider some aspects related to geology as a triggering factor of geomorphologic processes. It is the geology-process-shape relationship, so obvious in the cuesta relief and the petrographic characteristics of the substrate which in turn influence the type of processes and resulted forms of Higher Quaternary morphogenesis.

Below are the main morphogenetic processes and agents that affect the slopes of the Transylvanian Basin. This approach is necessary to characterize and identify the main geomorphic processes affecting the slopes of the Transylvanian Basin and hence its vegetation.

The chapter deals with two main categories of processes, erosion and gravity processes and their associated forms. The presentation begins with the definition of morphogenetic factors and agents followed by processes classification and detailing in the context of the Transylvanian Basin slopes.

Morphogenetic processes are classified according to several criteria. One of the most used criteria orders then by their origin and the place of their action. This criterion led to the following classification: exogenous, endogenous and extraterrestrial processes.

Erosion

In the most common understanding the erosion includes all exogenous processes, except for alterations and gravitational movements, which involve training altered materials via a mobile agent, the removal of bedrock particles from the impact of transported materials, their wear and transport (THORNBURY, 1954).

Main erosion factors are represented by: lithology, tectonics, climate, vegetation and anthropogenic factors.

Gravitational processes

By mass movement we understand downward and lateral movement of materials on a slope under the influence of gravity. The process does not require a transport medium such as water, air or ice. Sometimes the term landslide is used to describe these processes although the real meaning of the term landslide refers to the downward movement of materials as a result of loosening of the mass of material along a slip plane (DIKAU, 2004).

Table no. 2.2. Classification of gravitational processes (after VARNES, 1978)

	Roci/Bedrock	*Grohotişuri/Debris<80% nisip sau materiale mai fine)*	*Pământ/Earth* *(>80% nisip sau materiale mai fine)*
Prăbuşiri/Căderi (Falls)	Prăbuşiri de roci/ (*Rock fall*)	Prăbuşiri ale grohotişurilor/ (*Debris fall*)	Prăbuşiri ale solului/(*Earth fall*)
Răsturnări *(Topples)*	Răsturnări de blocuri/ (*Rock topple*)	-	Răsturnări de blocuri/(*Earth topple*)

	Roci/Bedrock	*Grohotişuri/Debris<80% nisip sau materiale mai fine)*	*Pământ/Earth* *(>80% nisip sau materiale mai fine)*
	Răsturnări flexurale/ (*Flexural topple*)		
Alunecări *(Slides)*	Alunecări de roci lente/ (Rock slump) Alunecări rapide/ (*Rock slide*)	Alunecări ale grohotişurilor/(*Debris slide*)	Earth slump *Earth slide*
Împrăştieri *(Spreads)*	Împrăştieri ale rocilor/*Rock spread*	-	Împrăştieri de sol/(*Earth spread*)
Curgeri *(Flows)*	Creep/(*Rock creep*) Curgeri de pantă/(*Slope sagging*)	Curgeri ale materialelor slab consolidate/(Debris flow) Avalanşe/(*Debris avalanche*) Creep al solului/(*Soil creep*) Solifluxiune/(*Solifluction*)	Curgeri de nisipuri şi mâluri umede/(*Wet sand and silt flow*) Curgeri de sol rapide/(*Rapid earth flow*) Curgere de loess/(*Loess flow*) Curgeri de nisipuri uscate/(*Dry sand flow*) Curgeri de sol /(*Earth flow*)
Complexe *(Complex)*	Avalanşe de rocă/(Rock avalanche) Curgeri pe distanțe scurte-Curgeri noroioase/(*Earth slump-Earthflow*)		

After a general presentation of the processes that affect the slopes is necessary to detail how they have shaped and enabled in case of the slopes of the Transylvanian Basin.

The massive land slides and glimee category was treated in particular, aiming the assumptions about the genesis of these forms and their development. Special attention was given to massive “glimee” landslide types due to their high frequency in the Transylvanian Basin and their specific morphology.

Along with the massive landslides we have tried to present the pseudovolcanic phenomena, considering that, together with massive monticular formations generated by the massive landslides, they are a distinctive feature of the Transylvanian Basin (SPULBER ET AL., 2010).

An important part of this chapter is dedicated to the massive land slip at Cămăraşu. In order to achieve a comprehensive study, using GIS techniques has been made a block diagram of the sliding, further used to implement an USLE (Universal Soil Loss Equation) model. Model results show a maximum erosion rate of 3.194 tons / ha / year while the median for the area studied is 0.014 tons / ha / year.

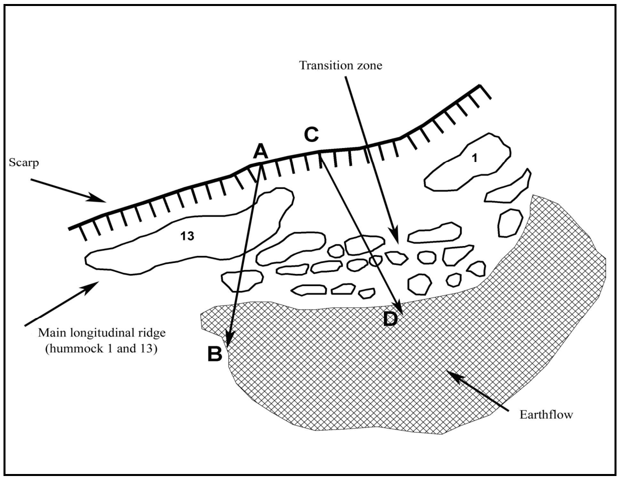

Figure 2.10. Cămăraşu landslide scheme, sliding sectors delimitation by analogy with Mam Tor landslide and the definition of the two sectors by sliding surface (AB and CD)

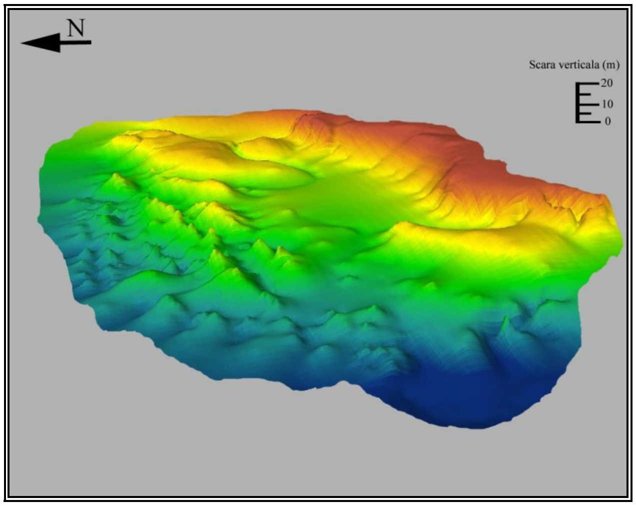

Figure 2.17. Block diagram of the Cămăraşu glimee type landslide (variable perspective scale, vertical exageration 1.5)

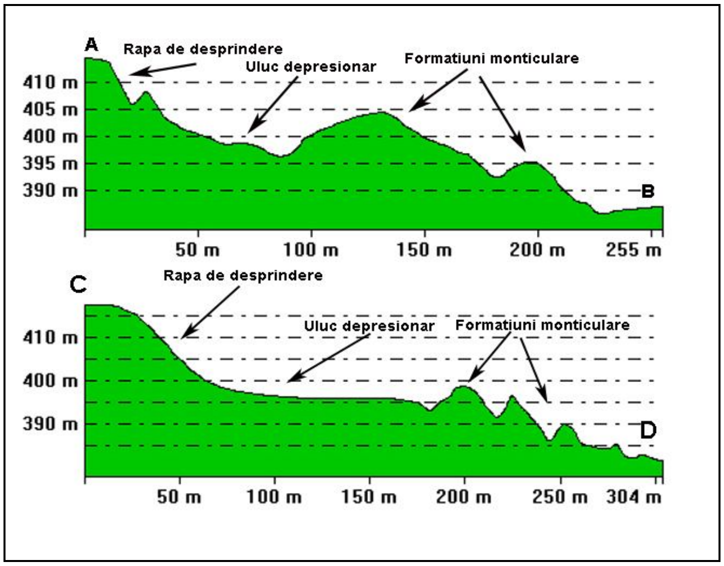

Figure 2.21. Transversal profiles through Cămăraşu landslide

CHAPTER III CLIMATE, SOIL AND SUBSTRATE AS PREDISPOSING FACTORS OF VEGETATION DEVELOPMENT IN THE TRANSYLVANIAN BASIN

Current topoclimate diversity, created by the orographic conditions determines xeroterme conditions, which are common in the Transylvanian Basin. Therefore appear larger or smaller areas of land, characterized by a low level of ecological factors, to which adapt plants and structural different phytocenoses. Slope effect overlaps the one of the aspect and in this way controls the ecological factors flow that determine the quantity and quality of the phytocenosis biomass. In the Transylvanian Basin, the low slope to steep slope terrain influences the biomass by slope, indirectly of course, by changing the climatic and ecologic factors as light, heat and humidity. Composition and structure of vegetation cover recorded more or less faithful slope changes (RESMERIȚĂ ET AL., 1968).

Among the first theories that make reference to the factors influencing the vegetation in the Transylvanian Basin, is the theory advanced by ENCULESCU (1929). He believes that the genesis of forest-steppe vegetation of the Transylvanian Basin is due to geological substratum, the presence of marl. This hypothesis has been taken even by VANCEA (1960), one of the greatest scientists of the Neogene deposits in the basin.

Below are the types of soils and their distribution, including cernisoils, luvisoils, hidorsoils, protisoils and so on.

The chapter ends with the concept of the chain, given the importance of the concept in the theoretical approach of the study.

Thus, the chain is a group/association of soils despite the fact that in a natural classification system they are different at a fundamental level and morphological manifestation are linked by their relationship to topographic conditions and their relationship is repetitive if the conditions are similar. The similarity of the conditions for manifestion of this relationship is in fact the key concept (MILNE, 1935; SELBY, 1993).

The concept is strongly related to the one of the relationship/correlation because such a model implies the existence of a relational complex between factors that determine soil evolution, mainly climate (including the slope determined topoclimate and Aspect), relief and geological structure.

The most explicit expression of this relationship is given by the model “nine-unit landsurface model” of DALRYMPLE ET AL. (1968) in which the relationship soil topography is called “landsurface catena”.

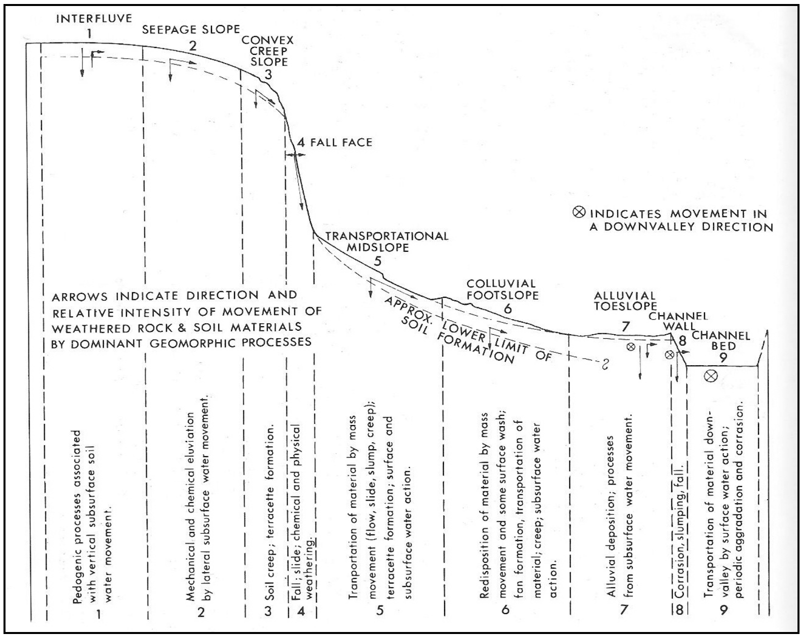

Figure 3.2. The "nine landsurface” model (after Dalrymple et al., 1968)

CHAPTER IV ANALYSIS OF PLANT SPECIES ASSOCIATIONS IN THE TRANSYLVANIAN BASIN

The chapter begins with the presentation of vegetation and plant associations representative of the Transylvanian Basin and goes on to present the results of mapping the species of interest in the context of the study, respectively the species populations *Astragalus exscapus* L., *Nepeta ucranica* L., *Centaurea trinervia* Stephan, *Goniolimon tataricum* Boiss. and *Serratula wolffii* Andrae.

Grassland associations include:

Festuceto rupicolae – Caricetum humilis association (A)
Jurineo mollis - Stipetum lessingianae association (B)
Salvio nutantis - Stipetum pulcherrimae association (C)
Thymio pannonici - Stipetum stenophyllae association (D)
Carici humilis - Brachypodietum pinnati association (E)
Salvio austriacae - Festucetum rupicolae association (F)

It is the most extensive chapter of the work including numerous figures and tables in which there are presented few phytocoenotic indices such as the number (abundance) and density of individuals as well as the limit of the populations and their location within the form of geographical coOrderates.

Also this chapter includes an overview of the ecology and importance of the mapped species.

From a practical perspective mapping results have been integrated into a GIS database and is available in both ESRI shapefile and geodatabase format. In addition species resorts were analyzed in terms of geology, geomorphological processes and human impact. The data sheet included in the characterization of each station was used in statistical analysis section of the species.

Mapping of Astragalus exscapus species included four newly discovered resorts during field investigations. Ucrania Nepeta species was mapped in a number of six resorts, Centaurea trinervia and Goniolimon tataricum also in six resorts while Serratula Wolff has been identified and mapped in four resorts.

As an example we quote a standard form completed for each resort:

Urmeniş Astragalus excapus resort

Description and notes: Astragalus exscapus individuals vegetate at the top of the first row of monticular formations belonging to the landslide located just outside the locality of Urmeniş.

Location: in the locality of Urmeniş going to Reghin on the left side of the road in the area of glimee type massive landslide.

Figure 4.16. Urmeniş landslide with the *A. exscapus* population (Urmeniş)

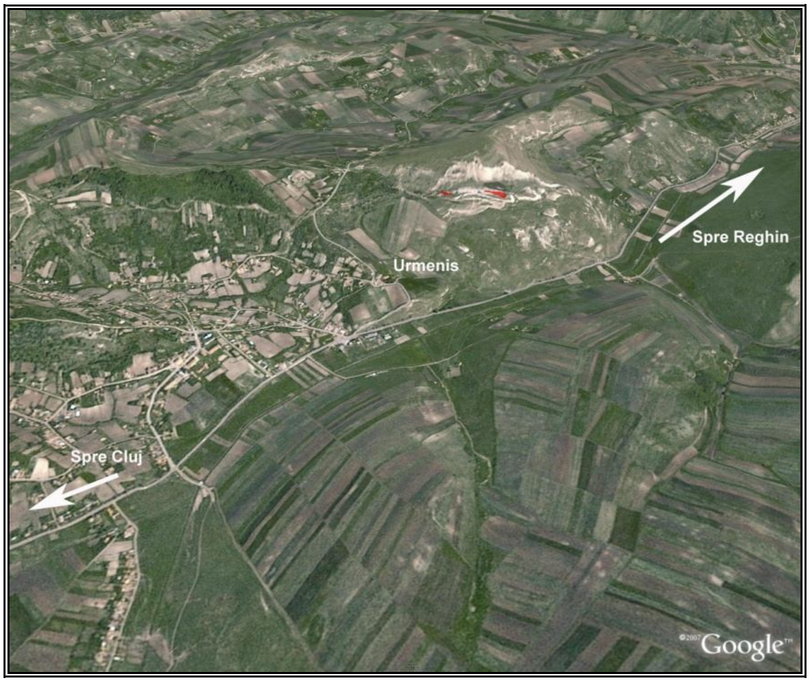

Figure 4.17. Urmeniş A. exscapus population

Table 4.12 Statistical data regarding *A. exscapus* resort from Urmeniş

No.	***New Code***	***Old Code***	***Density(ind/m2)***	***Individuals***	***Surface (m2)***	***X***	***Y***
1	Ex_urm_1	Urmenis1	0.2	277	1386.31	24° 22' 56.68" E	46° 45' 57.52" N
2	Ex_urm_2	Urmenis2	0.2	105	524.19	24° 22' 51.15" E	46° 46' 4.02" N
Total				382	1910.49		

Altitude: A. exscapus specim ens are found at an altitude of 400-410 m.

Slope: 6-20 °; catenary unit - glimee

Aspect: South-west, west.

In the end of the chapter there are presented methods of statistical analysis of phytosociological rises (surveys) conducted in the filed as well as the results of these interpretations .There have been used clustering and ordination types of analysis. There are presented the results of the statistical analysis of field surveys.

Among indirect ordination methods there are mentioned the following:

Correspondence analysis (CA and DCA)

Non-metric multidimensional scaling (NMDS)

A particular type of computation is direct canonical one which allows direct analysis of ecocenotic variables. The most common type used of this computation is CCA (canonical correspondence analysis).

Multivariate clustering and Orderative type totally confirmed the accuracy of flora rises, but also the employment of phytocenosis in the cenosystem. In all cases the phytocenosis of the associations differ depending on the degree of anthropogenic intervention.

These tests were performed using the software package PAST.

For each species was conducted an phytotaxonomic list.

Such species have been classified in the following associations:

ASTRAGALUS EXSCAPUS*:*

Class FESTUCO – BROMETEA Br.-Bl. et R.Tx. ex Klika et Hadač 1944

Order *Festucetalia valesiacae* Br.-Bl. et Tx. 1931. (incl. *Brometalia erecti* auct rom. et hung. non (Koch 1926 n.n.) Br.-Bl. 1936, *Brachypodio-Chrysopogonetalia* (Horvatić 1958) Boşcaiu 1972, *Stipio pulcherrimae-Festucetalia pallentis* I. Pop 1968).

Alliance *Festucion valesiacae* Klika 1931 (syn. *Festucion rupicolae* Soó (1939n.n.) 1940 corr. Soó 1964 and incl. *Stipion lessingianae* Soó 1942).

A Association *Festuceto rupicolae – Caricetum humilis* Polgár 1933

B Association *Jurineo mollis - Stipetum lessingianae* (Soó 1947)

C Association *Salvio nutantis - Stipetum pulcherrimae* (Soó 1942) Boşcaiu et Răulea 1984 (= *Stipetum pulcherrimae* Soó 1942)

D Association *Thymio pannonici - Stipetum stenophyllae* (Soó 1946, 1947) Sanda et al. 1997 (= *Stipetum stenophyllae transsylvanicum* Soó 1946, 1947, *Danthonio alpinae – Stipetum stenophyllae* Ghişa 1941, *Stipetum stenophyllae austro-transsilvanicum* Borza 1959).

E Association *Carici humilis - Brachypodietum pinnati* (Schneider-Binder 1971) nom. novum (= *Carici humilis – Brachypodietum pinnati transsylvanicum typicum* Schneider-Binder 1976)

Alliance *Cirsio-Brachypodion* Hadač et Klika 1944 emend. Krausch 1961 (incl. *Bromion erecti* (Koch 1926) Br.-Bl. 1936 s.str., *Danthonio-Stipion* Soó 1957).

F Association *Salvio austriacae - Festucetum rupicolae* (Burduja et al. 1956 corr. Burduja et al. 1972) (= *Festucetum rupicolae* Burduja et al. 1956, *Festucetum rupicolae – Onobrychietum* Ciocârlan (1968) 1969, *Festucetum sulcatae mesophilum* Csűrös et al.1961, ass. *Festuca sulcata – Vicia cracca* Csűrös 1963, *Cytiso – Festucetum rupicolae* Peia 1981).

Alliance *Prunion fruticosae* Tx. 1952.

G Association *Melico transsilvanicae - Amygdaletum nanae* (Soó 1951)

NEPETA UCRANICA:

Class FESTUCO – BROMETEA Br.-Bl. et R.Tx. ex Klika et Hadač 1944

Order *Festucetalia valesiacae* Br.-Bl. et Tx. 1931. (incl. *Brometalia erecti* auct rom. et hung. non (Koch 1926 n.n.) Br.-Bl. 1936, *Brachypodio-Chrysopogonetalia* (Horvatić 1958) Boşcaiu 1972, *Stipio pulcherrimae-Festucetalia pallentis* I. Pop 1968).

Alliance *Festucion valesiacae* Klika 1931 (syn. *Festucion rupicolae* Soó (1939n.n.) 1940 corr. Soó 1964 and incl. *Stipion lessingianae* Soó 1942).

A Association *Festuceto rupicolae – Caricetum humilis* Polgár 1933

B Association *Jurineo mollis - Stipetum lessingianae* (Soó 1947)

C Association *Salvio nutantis - Stipetum pulcherrimae* (Soó 1942) Boşcaiu et Răulea 1984 (= *Stipetum pulcherrimae* Soó 1942)

Alliance *Prunion fruticosae* Tx. 1952.

G Association*Melico transsilvanicae - Amygdaletum nanae* (Soó 1951)

CENTAUREA TRINERVIA:

Class FESTUCO – BROMETEA Br.-Bl. et R.Tx. ex Klika et Hadač 1944

Order *Festucetalia valesiacae* Br.-Bl. et Tx. 1931. (incl. *Brometalia erecti* auct rom. et hung. non (Koch 1926 n.n.) Br.-Bl. 1936, *Brachypodio-Chrysopogonetalia* (Horvatić 1958) Boşcaiu 1972, *Stipio pulcherrimae-Festucetalia pallentis* I. Pop 1968).

Alliance *Festucion valesiacae* Klika 1931 (syn. *Festucion rupicolae* Soó (1939n.n.) 1940 corr. Soó 1964 and incl. *Stipion lessingianae* Soó 1942).

A Association *Festuceto rupicolae – Caricetum humilis* Polgár 1933

B Association *Jurineo mollis - Stipetum lessingianae* (Soó 1947)

C Association *Salvio nutantis - Stipetum pulcherrimae* (Soó 1942) Boşcaiu et Răulea 1984 (= *Stipetum pulcherrimae* Soó 1942)

GONIOLIMON TATARICUM* (H,A) ŞI *SERRATULA WOLFFII* (J,I)*:

Class ARTEMISIETEA VULGARIS Lohm. et al. in R. Tx. 1950

Order Artemisietalia Lohm. et Tx. 1947

Alliance *Arction lappae* Tx. 1937 emend. Siss. 1946

H Association *Artemisio campestris – Agropyretum intermedii* Schneider-Binder mscr. 1974 cf. Schneider-Binder 1976.

Class FESTUCO – BROMETEA Br.-Bl. et R.Tx. ex Klika et Hadač 1944

Order *Festucetalia valesiacae* Br.-Bl. et Tx. 1931. (incl. *Brometalia erecti* auct rom. et hung. non (Koch 1926 n.n.) Br.-Bl. 1936, *Brachypodio-Chrysopogonetalia* (Horvatić 1958) Boşcaiu 1972, *Stipio pulcherrimae-Festucetalia pallentis* I. Pop 1968).

Alliance *Festucion valesiacae* Klika 1931 (syn. *Festucion rupicolae* Soó (1939n.n.) 1940 corr. Soó 1964 and incl. *Stipion lessingianae* Soó 1942).

A Association *Festuceto rupicolae – Caricetum humilis* Polgár 1933

Alliance *Cirsio-Brachypodion* Hadač et Klika 1944 emend. Krausch 1961 (incl. *Bromion erecti* (Koch 1926) Br.-Bl. 1936 s.str., *Danthonio-Stipion* Soó 1957).

J, I Association *Festuca rupicola – Vicia cracca* Csűrös 1968 presented in Resmeriţă et al. 1968 p.55 tab. 2)

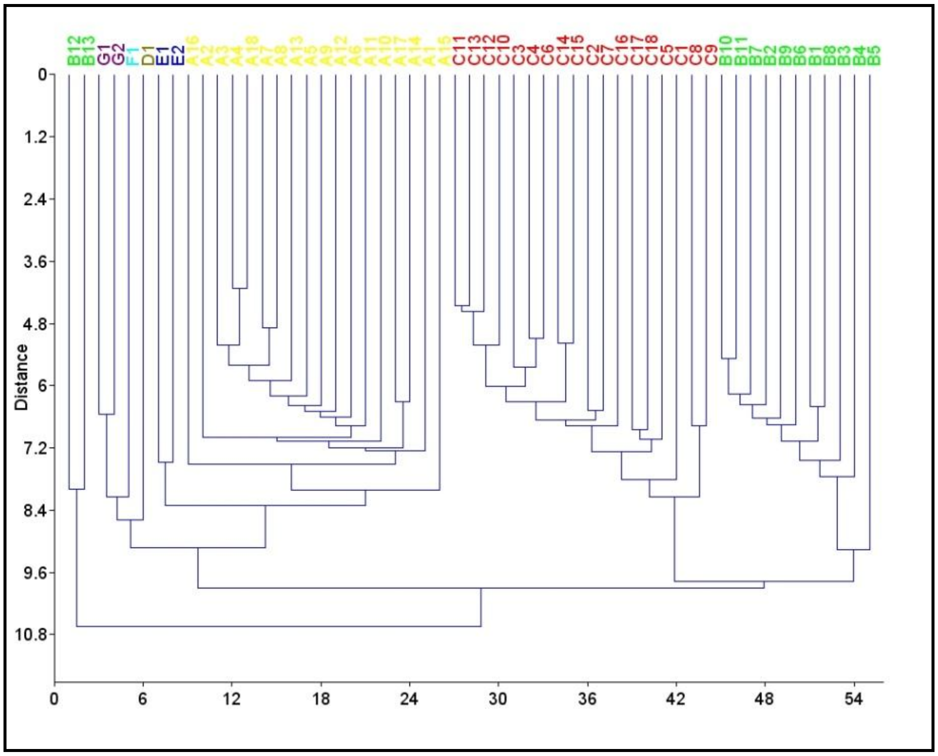

Figura 4. 51. Clustering UPGMA based on quantitative data concerning As*tragalus exscapus*

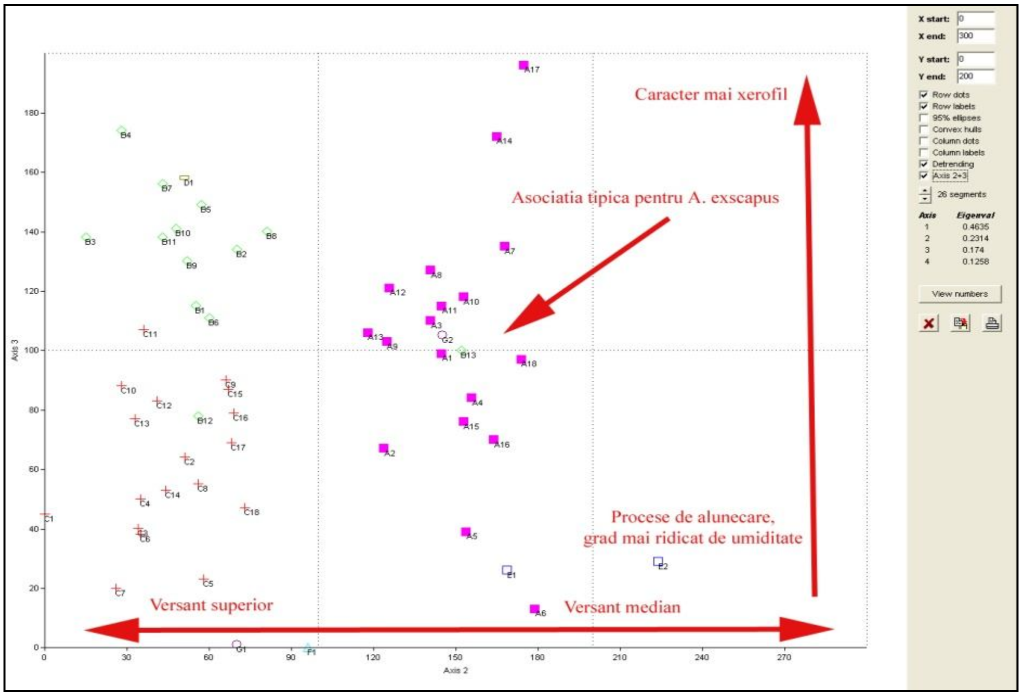

Figura 4.54. DCA ordination with quantitative data (*Astragalus exscapus*)

CHAPTER V CORRELATIONS BETWEEN GEOLOGY, GEOMORPHOLOGICAL PROCESSES AND STUDIED THE STATUS OF STUDIED SPECIES

To capture the meaning of the term correlation, we begin by presenting the general relationship term. Thus, the term relationship (Fr. Relation, Lat. Lit. relation, -onis) refers, in most cases, at a link between objects, processes, ideas, phenomena, beings, but also between their properties.

In the same order by correlations, or mutual existence relationships we mean those relationships in which components can not exist outside the other and between which there is some relationship of dependency, support and cooperation.

Following this theoretical aspects we present the main correlations between geological, geomorphologic processes and vegetation of the Transylvanian Basin.

This category includes the geologic determined steppe in accordance with the theory formulated by ENCULESCU (1929).

Briefly, this theory claims that levels of marl, in fact quite common, are leading to a delay of the development of forest soils (Luvisoils). Thus the dominant soil types are the chernozem ones, which favor the steppe species.

This theory can be regarded as applicable in the north western sector, ehere the basin margins are in contact with the Western Carpathians.

Next we present the correlations between cuesta morphology and their associated vegetation, and also the correlation between the geological substrate, landslides, soil and specific vegetation.

As mentioned in the previous chapters, cuesta genesis is linked to two key factors, both geological: monocline structure and lithological alternation of rock layers with a different resistance to erosion. The result of modeling such structures and alternating lithologies is a “cuesta”, an asymmetric form of relief with a steep slope (front) and a lower slope (reverse).

Asymmetric “cuesta” interfluves from the Transylvanian Basin, with steep and sunny front and shaded reverse are the most common repetitive fractal pattern in the region. Potential vegetation is differentiated depending on climate and landform, thus leading to varied landscapes.

Where the slope is affected by actual smaller landslides, vegetation structure changes. *Brachypodium pinnatum* (a commune species in the basin) is clearly preferring the habitats and sites affected by landslide processes.

This preference for such sites was analyzed from a geologic point of view, the correlation between vegetation and geology being studied according with the theory that

Brachypodium pinnatum, is present on the landslide mass due to the fact that the soils have a higher calcium carbonate content (GERGELY 1957; BĂDĂRĂU, 2005).

For this we analyzed 12 soil samples (see Table 5.1), on a landslide near Cojocna, Botosul Mic Hill, in a small temporary valley, tributary of Mărăloiu, tributary at his own to Somesul Mic river.

For the land sliding mass we collected six samples, in three different points. The first two (0-15 cm one and 15-25 cm the second) were located near the scarp of the landslide, the next two at the same depth intervals, in the middle of the landslide and the last two ones at the bottom of the sliding mass. At the correspondent height we took another 6 samples (same depths) near the landslide on the unaffected slope.

Table 5.1. Sampling coding and location

Code location	**Code sample**	**Altitude**	**Longitude**	**Latitude**
PCT1	A.1.S	381	23° 48' 24.79" E	46° 44' 23.43" N
	A.1.B			
PCT2	V.1.S	387	23° 48' 25.06" E	46° 44' 21.98" N
	V.1.B			
PCT3	V.2.S	382	23° 48' 23.77" E	46° 44' 21.99" N
	V.2.B			
PCT4	A.2.S	370	23° 48' 23.42" E	46° 44' 23.29" N
	A.2.B			
PCT5	A.3.S	355	23° 48' 21.23" E	46° 44' 23.24" N
	A.3.B			
PCT6	V.3.S	360	23° 48' 21.26" E	46° 44' 21.94" N
	V.3.B			

Figure 5.6. Soil sampling (sampleV.3.B)

Tabelul 5.2. Sample analyzes results

Sample code	***pH***	***Oxido-reduction potential (mV)***	***Conductivity (µS/cm)***	***TDS (mg/l)***	***Salinity***	***Humidity***	***Carbonate***	***Humus***
A.1.S	8.32	69.8	124.1	62.05	0	27.39	7	2
A.1.B	8.39	73.7	126.7	63.35	0	24.76	4	1
A.2.S	8.09	56.2	117.1	58.55	0	28.76	2	2
A.2.B	8.13	56.9	126.1	63.05	0	28.22	1	2
A.3.S	8.19	62.1	128.9	64.45	0	36.28	2	3
A.3.B	8.3	65.2	156.7	78.35	0	17.63	4	2
V.1.S	8.12	63.3	135.5	67.75	0	26.21	7	2
V.1.B	8.25	66.4	142.7	71.35	0	24.22	7	2
V.2.S	8.37	74.4	122.8	61.4	0	21.05	4	3
V.2.B	8.31	73	125.5	62.75	0	22.73	10	2
V.3.S	8.37	72.9	166.5	83.25	0	24.47	10	2
V.3.B	8.54	83	158.6	79.3	0	21.64	7	2

These results show the difference between soil characteristics on the landsliding mass and unaffected slope. Although the variation is not significant; the difference is big enough to play a role in the development and distribution of plant species. As a result the distribution is determined by the geomorphologic process, in the presence or absence of landsliding.

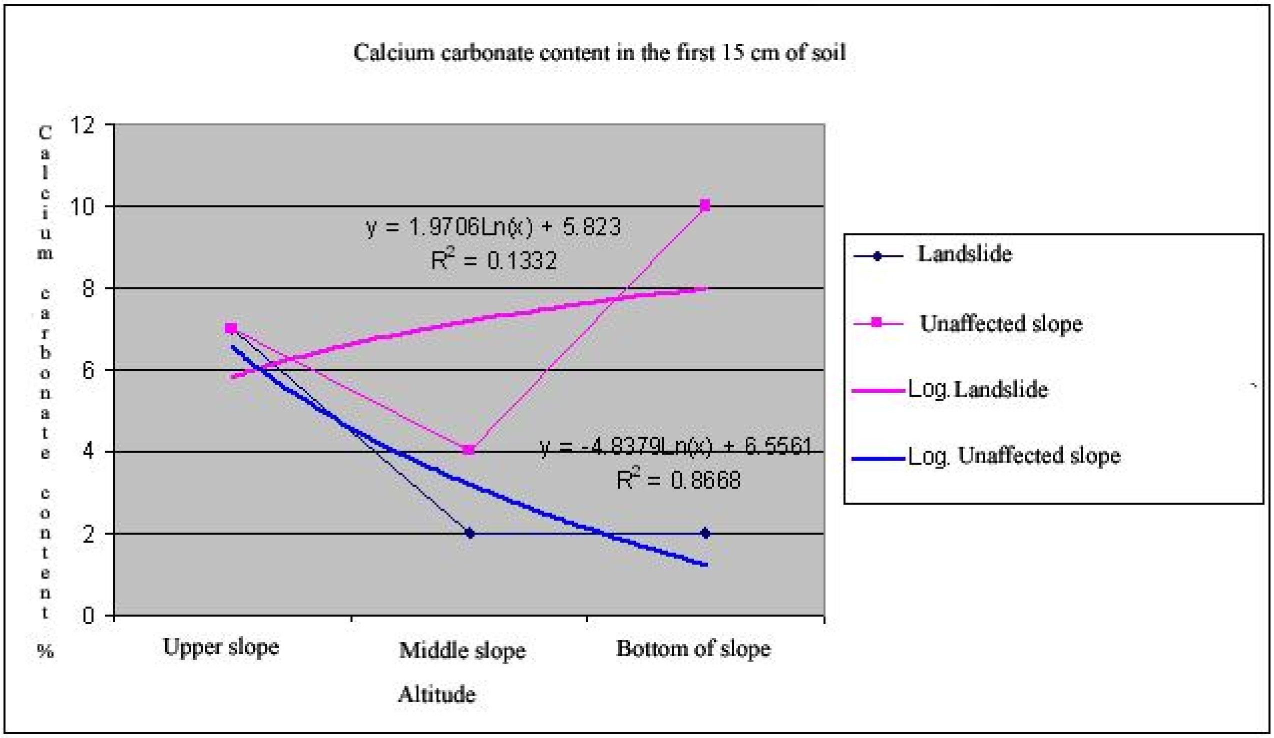

Figure 5.8. $CaCO_3$ content in the soil cover (0-15 cm)

CHAPTER VI CONCLUSIONS

The general geological settings, but especially the Neogene sediments, which in fact cover almost entirely the Transylvanian Basin, play a key role in the process of landform genesis and also about vegetation distribution.

Generally these sediments are represented by clastic - pelitic alternations, sometimes of considerable width. Deposits of Badenian age, the most extensive ones, include two key elements, the evaporitic and volcanic tuffs horizons , the later one being continued also in Sarmatian. The salt deposits are very important in the context of domes and diapirs, which influenced both the general landforms and vegetation structure and distribution especially where the salt managed to reach surface. Intercalations of tuffs, sometimes very thick, have a very specific role from a morphogenetic view, because of the diagenetic processes which lead to chemical, physical and mechanical alterations. The main processes include bentonitisation, zeolitisation, calcification and silicification, on the basis of volcanic glass. Bentonitisation and zeolitisation affect most of the tuffs layers (BEDELEAN ŞI STOICI, 1984), silicification and dolomitisation only the Dej Tuff as the Borşa-Apahida Tuff is only affected by calcification (GHERGARI ET AL., 1964).

Between the most important factors which influence the vegetation distribution we have to mention: geology, climate, microclimate, geomorphologic processes and anthropic factors. As a result of this dependence, sustenance and cooperation relationship between the main factors, derivate factors emerge. One of these is the soil which in fact represents an interface between geology and vegetation.

The complexity of these relationships is difficult to asses, especially having in mind the large territory needed to be covered. As a result the study was focalized mainly on the correlations established between the main factors which influence the status and distribution of plant species and associations, like geology and geomorphologic processes, regarded as a manifestation of the general relationship substratum – climate and also the status of some vulnerable species of national and international conservative importance.

As an example, the species *Astragalus exscapus* is presented in the annex of O.U.G 57/2007 as a species which requires strict protection.

Of course, together with the detailed study of the plant species, the field studies were also focused on determining some aspect regarding the correlation established between geology – geomorphology – landforms – phytocenoses.

One can conclude saying that the tectonic units that compose the fundament of the Transylvanian Basin were a key factor in the later sedimentation process, thus contributing to the genesis of folds and domes which at their turn influenced the river network in its development process. As a result the river network was developed in concordance with the information offered by the substratum, the outcome being the specific land form which is the cuesta.

A cuesta is a specific landform, which in fact represents a fractal model for the entire basin, being developed from secondary river valleys (2^{nd} order in Horton – Strahler system) to the main river.

As to the mass movement processes and especially land sliding processes in the Transylvanian Basin and the correlation with the vegetation cover we analyzed the genesis of landslides and the “preference” of some association (*Carici humilis - Brachypodietum pinnati)* for these areas.

Landslides are a category of mass movements characterized by a downward and later movement. In this process a very important role plays the geology, in fact the presence of clay or marl layers.

In the Transylvanian Basin, the week rock layer of Sarmatian age, are the domain of the creep and mass land sliding. The tuff layers associated with those marls and clays tend to favor the development of such processes. So the geologic structure and lithology are important factors in the morphogenetic process.

In our specific case, *Carici humilis - Brachypodietum pinnati* vegetation development in landslide affected areas is considered to be determined by the high calcium carbonate content (from marls) in the first soil horizon.

Our investigations show the following:

- the soil developed on the landsliding mass do not have a higher calcium carbonate content in the first 25 cm ;
- the calcium carbonate content is actually higher on the slope not affected by landsliding;
- the *Carici humilis - Brachypodietum pinnati association* clearly prefers landslide habitats;
- on the slope without landslides the dominant association is *Festuceto rupicolae – Caricetum humilis,* developed on soil with higher calcium carbonate content;
- in the 15-25 centimeters of soil the trend in the calcium carbonate seems to be conservative and constant;
- the calcium carbonate content varies a lot more in the first 15 cm of soils, the content is increasing from top to bottom in the case of the unaffected slope and decreasing in the case of the landsliding mass;
- humidity is a key factor in the pedogenesis process
- pH values are normal, there are differences between the landslide and the unaffected slope;

Considering that the calcium carbonate content and pH values seem to be the closely related we can say that they represent, together with humidity important and principal factors in vegetation distributions on landslides and normal slopes. The vegetation patter is as follows, *Carici humilis - Brachypodietum pinnati* on the landsliding mass (with lower calcium carbonate content) and *Festuceto rupicolae – Caricetum humilis* on the unaffected slope which may suggest that the last association actually prefers higher calcium carbonate content. Very interesting is also the fact that *Stipa* association seem to prefer also a higher content of calcium carbonate.

As of the geomorphologic processes, particular morphologies as „ glimee” present in the Transilvanan Basin, our investigations regarding the Cămăraşu landslide offered some very interesting elements for our study.

It is generally considered that mass movement morphologies development is associated with:

- material characteristics

- speed and direction of movement
- rock mass geometry
- substratum.

The "glimee" relief is developed based on common characteristics such as geology (alternation of permeable and impermeable sedimentary rock with clay marl, sand or sandstone).

The landslide from Cămăraşu was analyzed by a digital elevation model developed using GIS and GPS technology. Model error ±3m elevation range has no influence on the further development of the model.

Analysis of the distribution of *Astragalus exscapus* on Cămăraşu landslide indicated the species preference for accentuated slopes on hammock formations.

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