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SUBMONTANE PARAMESEȘ DEPRESSIONS IN THE STRUCTURAL CONTEXT OF THE TRANSYLVANIAN BASIN

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ABSTRACT. – Submontane Paramesеș Depressions in the Structural Context of the Transylvanian Basin. The structure of the Alpine orogeny of the Silvania Mountains reveals fascinating and controversial Variscan remnants of the Hercynian orogeny. The Meseș hemi-anticline, incorporated into the alpine nappes structures of the Apusenides (Săndulescu, 1988) reflects the convulsions of the last thermo-tectonic Alpine cycle in a convergent geodynamic setting. The Meseș Mountains belong to an Alpine collisional chain of the Silvania Mountains, located in Northwestern Romania, as a wide V-shaped chain, detaching from the North Apuseni Mountains in the form of Variscan remnants.

Keywords: *hemi-anticline, mesozonal metamorphism, sedimentary basins, Neogene depressions, the Meseș Mountain.*

1. INTRODUCTION

The Meseș Mountains share a border with Ortelec Valley to the north, which separates them from Dumbrava Brebi Hill (557 m) and Someş Depression (Jibou-Ulmeni); Zalău Depression, Crasna Depression and Oșteana Piedmont to the west; Crişul Repede Valley separates them from Vlădeasa Massif and Gilău Massif to the south while the eastern border is represented by Almaș-Agrij Depression. The Meseș Mountains, as part of the Eastern Silvania Mountains, represent a hemi-anticline with the eastern flank oriented SW-NE, having a length of around 35 km and a width of 2-5 km.

The Meseș hemi-anticline separates the Șimleu Basin (as part of the Pannonian Basin) from the Transylvanian Basin (represented by its northwest sector, respectively the Almaș-Agrij Depression). The geodynamic evolution of the Meseș Mountains is linked to the Triassic back-arc basins in the South of the Meliata-Maliac domain, formed as a result of crustal shortening due to the

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opening of the Central Atlantic and to the rotation of Africa towards Europe. The roll-back processes in the Maliac-Meliata Ocean led to the opening of Vardar Ocean (Late Jurassic) and controlled the successive collision phenomena of the *arc-trench Vardar system* with the Meliata passive margin (Cavazza,W., 2004). The orogenic events *around Vardar* began in Late Jurassic and were completed in the Albian-Cenomanian through mollase-type sediments which constitute the tertiary fill of Șimleu and Transylvanian basins. The tectonic setting near the Meseș Mountains is relatively complex. East of the Meseș Mountains, the pre-collisional tectonic framework of the Transylvanides was that of *island arc* accompanied by a marginal basin subducted under the *Pre-Apulian Plate* (Nicolae et al.,1992). The Alpine orogen of the Sylvania Mountains to which the Meseș Mountains belong was formed in the Upper Cretaceous through the convergence of Tisia and Dacia microplates.

From a tectonic point of view, the Meseș Mountains belong to the Apusenides formed during the pre-Gosau tectogenesis. These are part of the Pre-Apulian or Tisia Block and represent nappes with north-northeast vergence from "Precambrian and Paleozoic" metamorphic rocks (granite rocks at local level) and their sedimentary cover. The oldest cooling ages indicate that during middle Cretaceous the location of the nappes was accompanied by a strong exhumation, which removed the configuration of the last Cretaceous sedimentary cycles (Dallmeyer et al., 1999; Sanders, 1999). The collision culminated during Middle Cretaceous (Săndulescu, 1988; Balintoni, 1994), but the local shortening would have continued at local level by the Cenomanian–Coniacian. Schuller (2004) interpreted these phenomena as a *hard collision* (lifting) during the early Cretaceous, followed by a *soft* Cretaceous collision during the late Cretaceous between the Tisia and Dacia microplates, as the subduction ceased and the local subsidence installed. The final suture probably took place during the Paleogene (Mațenco et al., 2005) and has been associated with an inversion at a smaller scale of the basin (De Broucker et al, 1998; Ciulavu et al., 2000). The last Cretaceous extension is linked to the post-orogenic collapse of the Cretaceous orogen (Sanders 1999;Ciulavu et al, 2000). The final location of *Pienidic nappes* induced flexures in the formation of the Transylvanian Basin.

The regional oligocenous compression in the eastern part of the Meseș Mountains may be linked to the beginning of the final closure of the Pienidic domain (Györfi et al, 1999). The northern Transylvanian Basin was affected by these flexures, indicated by a general thickening to the North of the oligocenous deposits (Săndulescu and Micu, 1989; Aroldi 2001), context in which the Transylvanian Basin was considered a reverse-rotation suction basin (Balintoni, 2003) and the basins on the eastern border of Meseș Mountains (the Almaș, Agrij Parameş basins) are *transformation and transcurrency sedimentary basins* located on continental crust.

Fig. 1. Ciumărna, Treznea and Stâna Depressions within the eastern part of the Meseș Mountains (source: the author)

The Meseș continental transform fault presents inflexions that can be relaxing curves (transtensive) and contracting (transpresive). The middle area of the Almaș-Agrij basin corresponds to a transversal inflexion on Meseș, which favoured the triggering of intense erosion processes especially in the upper basin of Agrij and Almaş. The western part of the Meseș Mountains belongs to the Pannonian Basin, respectively to one of its bays, the "Şimleu Basin", which was formed as a result of Badenian extensions of the Tisia Block. The system of "extensional-transtensional" Neogene depressions is associated with this bay. The North Transylvanian, Bogdan Vodă and Meseș faults control the tectonic evolution of the Transylvanian Depression (Almaș-Agrij Basin). In this respect, the elevation areas, in our case the Meseș hemi-anticline and descent areas (Agrij-Almaș Basin) are controlled by these faults. The first two faults belong to the category of left-lateral *strike slip* faults. Along the North Transylvanian fault, *strike-slip* tectonic movements took place on the basis of a transpresive tectonic regime that caused the strain of crystalline blocks and of sedimentary deposits within the Cenozoic cover of Meseș Mountains. They were generated on the peneplenized area of the Hercynian structures and took birth through their partial regeneration (Mutihac, V.,1990), reality confirmed by the presence of these Variscan remnants in Alpine nappe structures. The Meseş fault is a reverse fault, characterizing the eastern versant of the Meseș Mountains, from South of the Vlădeasa area, Crişul Repede Valley to the Moigrad fault area. It has a SW-NE direction and represents a longitudinal fracture towards the Meseş crystalline with a throw of 500 m as suggested by Clichici (1973). The eruptive rocks in the Vlădeasa area have a tectonic position, covering the Paleogene deposits from the Transylvanian Depression. It is a curved fault, an overthrust fault at surface and a gravity fault in depth, giving an asymmetrical aspect to the Meseş crystalline.

The evolution of the Meseș sedimentation area has been linked to the Permian-Mesozoic rifting and extensions which led to the individualization of the Pre-Apulian craton or Tisia. During the Mesozoic Era, it functioned as a *carbonate platform basin*. Between Upper Eocene and Lower Oligocene, major changes took place, induced by the pre-Pyrenean tectogenesis that led to the formation of thrust and fold systems as well as to a redistribution of emersed areas from the Meseș Mountains. The geological framework of the Meseș Mountains is given by the border formations and its basement. The basement is represented by the Bihor Autochthonous, characterized by the two crystalline series, *Someş and Arada*, and a sedimentary suite (*Permian, Triassic, Cretaceous*), divided into uplifts and grabens, as a result of diastrophisms, which took place from the Cretaceous until the Pliocene and which affected both the crystalline basement and sedimentary cover according to Clichici (1973). The Codru thrust line, the "main element subject to deformation processes" of meso-Cretaceous movements, was preceded by "a complicated system of faults", as noticed within The Meseș Mountains, that, in some sectors, gives a "clear ruptural character" and implicitly, the shear nappe character, to the tectonic relations between nappe and Autochthonous. As regards the post-tectonic cover, after the meso-Cretaceous folding, respectively the thrust of Codru nappe, the North Apuseni Mountains functioned as a more rigid unit, because the upper Cretaceous deposits have a distinctive facies and appear both on the Codru unit and on the Bihor Autochthonous, covering the main thrust and leading to the post-tectonic cover character of the respective deposits, predominantly detrital, being developed in Gosau-type facies. The Cretaceous evolution of the Apuseni Mountains and especially of the Meseș Mountains took place within Gosau-type basins. In the Meseș Mountains, as previously mentioned, shallow marine sediments laid down, the sedimentation processes started during the Turonian and ended during the Cretaceous. The "Gosau-type" sea entered in the form of large bays, one of them in the Șimleu Depression, separating the Preluca crystalline from that of the Prisaca, the latter, together with the Codru, Hăghișa, Măgura Șimleului and Plopiş crystalline, being during those days a large island with some bays, the Gilău-Preluca island, where both the detrital deposits of the shore area and the organogenic deposits were sedimented (Clichici, 1973). At the level of the Gilău sedimentation area, the pre-Pyrenean tectogenesis led to the emersion of large areas in north-western Transylvania which correspond to the Valea Nadăşului and Turbuţa formations specific to the Meseș Mountains. At local level, the invasive tendencies of the marine domain during the Priabonian are important, with the initial installation of evaporitic facies (the Foidaş Formation), followed by an extended carbonate platform (the Cluj Limestone Formation) which gradually passed to a basinal domain (the Brebi Formation, where is also the Eocene-Oligocene boundary). What we have to highlight is the advanced continentalization we can notice at the level of Moigrad Formation, dominated by red bed deposits. This continentalization, consisting of the installation of some fluvial system deposits in the sedimentation area of Gilău and Moigrad, continued during the Rupelian. The Moigrad Formation is characterized by the predominance of *red beds deposits* in fluviatile facies (Fărcaș, 2011). In other words, this marine-salmastrian alternation expresses nothing but the instability of the basins which developed having as basement the Apuseni orogen.

2. METHODOLOGY

The cartographic method (geological-morphological) and GIS analysis (Irimuș, I.A., 2005) allowed us to realize the geomorphologic and geologic profiles through which we underlined three subdivisions: The Meseș hemi-anticline alignment, separating the Pannonian Basin and the Transylvanian Basin within the Austroalpine system, intra-Meseș sedimentation area, the contact depressions from the external frame of the Meseș Mountains, a reflex of the integration of the internal and external geodynamics.

3. THE CONTACT DEPRESSIONS FROM THE EXTERNAL FRAME OF THE MESEŞ MOUNTAINS

The genesis of the Parameseş depressions, as contact depressions, from the external frame of the Meseş Mountains, is related to the Meseş fault, also known as Meseş overthrust line (the Paleogene strata are overthrown and overlapped by crystalline) the fault being active especially during the Miocene.

This overthrust occurred along with the Neo-Styrian paroxysm through the underthrusting of the Transylvanian Depression, which led to the folding of the Paleogene deposits from the proximity of the overthrust line. The Meseş Fault is a main overthurst fault, accompanied by numerous perpendicular or parallel secondary faults that affect the sedimentary deposits and the crystalline structures, under the form of a *transverse fractures system* oriented WSW - ENE to E - W, due to some displacements from west to east, with maximal intensity during the Badenian.

The morphodynamics in the Parameseş sedimentary area is characterized by piedmont glacis, by the piedmonts generated on the fault coasts and last but not least by the contact depressions (Irimuș, I.A., 2010) detached by fluvial erosion by the tributaries of Agrij and Almaș, a series of small depression basins, built-up of some old human settlements, with silvo-pastoral traits: Hodiș, Huta, Sângeorgiu de Meseș, Bogdana, Buciumi, Bodia, Bozna, Treznea, Ciumărna, Stâna. Towards east, these erosive contact depressions are confined by the Almaș-Agrij Basin, made of upper Oligocene - Aquitanian deposits. The Almaş Basin is considered a paralic basin, the coals being formed in a lagoonal environment with excess humidity.

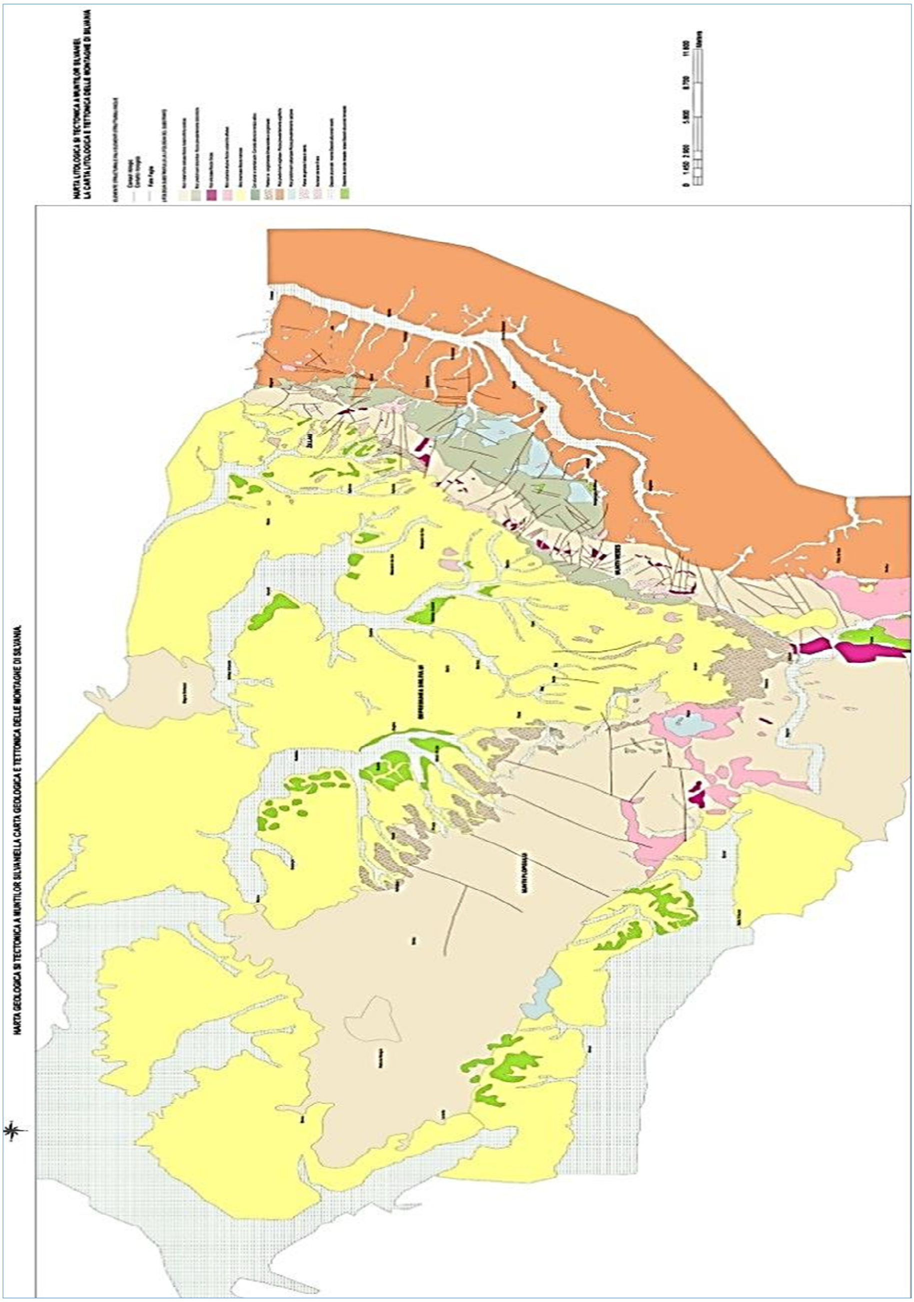

Fig. 2. The geological map of the Silvania Mountains, its legend and that of the geomorphological maps (source: the author)


HARTA GEOMORFOLOGICA A MUNTILOR SILVANIEI.
LA CARTA GEOMORFOLOGICA DELLE MONTAGNE DI SILVANIA.
AUTOR : CORINA BOGDAN.
I.ELEMENTE GEOLOGICE SI STRUCTURALE.
ELEMENTI GEOLOGICI E STRUTTURALI.
(I). 1.LITOLOGIA SUBSTRATULUI.
LITOLOGIA DEL SUBSTRATO.
Roci metamorfice sistoase.Rocce metamorfiche scistose.
Seria de Meses (Paleozoic Inferior- Precambrian).
Seria de Somes (Precambrian Superior).
Roci vulcanice efuzive.Rocce vulcaniche effusive.
Magmatite neogene-dacite si andezite.
Magmatite Senonian-Paleocene (dacite).
Roci silicioase.Rocce Silicee.
Camplian Inferior-Werfenian (gresii silicioase).
Roci predominant calcaroase.Rocce prevalentemente calcaree.
Priabonian.
Roci predominant dolomitice. Rocce prevalentemente dolomitiche.
Priabonian.
Roci predominant argiloase .Rocce prevalentemente argillitiche.
Oligocen-Miocen Inferior, Stratele de Moigrad (Chattian-Rupelian).
Roci marnoase.Rocce marnose.
Pannonian (Malvensian),Lutetian.Badenian.Sarmatian.Miocen.
Pietrisuri si conglomerate.Ghiaie sciolte e conglomerati.
Pleistocen Inferior.
Contact litologic.Contatto litlogico.
(I). 2.ELEMENTE TECTONICE.ELEMENTI TETTONICI.
Falie. Faglia
II.FORME STRUCTURALE SI VULCANICE.
FORME STRUTTURALI E VULCANICHE.
(II). 1. FORME STRUCTURALE. FORME STRUTTURALI.
Fronturi de cuesta. Orlo di cuesta.
Front de suprafata structurala. Orlo di scarpata strutturale.
Inseuare.Sella.
(II). 2.FORME VULCANICE. FORME VULCANICHE.
Neck vulcanic.Neck vulcanico.
Con polifazic. Cono poligenico.
Dyke. Dicco.
III. FORME, PROCESE SI DEPOZITE DE VERSANT DATORATE GRAVITATIEI.
FORME, PROCESSI E DEPOSITI DI VERSANTE DOVUTI ALLA GRAVITA.
(III). 1.FORME DE EROZIUNE.
FORME DI EROSIONE.
Alunecari de teren.Frane.
Fenomene de creep. Fenomeni di creep.
Suprafete cu forme de curgere concentrata (ravene si torenti).Superficie con forme di dilavamento concentrato (ravene e torenti).
(III).2.FORME DE ACUMULARE.
FORME DI DEPOSITO.
Con detritic activ. Cono detrittico attivo.
Con detritic inactiv. Cono detrittico inattivo.
Depozite eluviale.Depositi eluviali.
IV.FORME SI DEPOZITE FLUVIALE DE VERSANT DATORATE SCURGERII.
FORME E DEPOSITI FLUVIALI DI VERSANTE DOVUTI AL DILAVAMENTO.
(IV).1. FORME DE EROZIUNE.
FORME DI EROSIONE.
Curs de apa permanent.
Traccia di corso di acqua estinto.
Vai fluviale de tip V. Vallecola a V.
Vai cu fund concav.
Vallecola a fondo concavo.
Front de terasa aluvionala.
Orlo di terazzo alluvionale.
Suprafete cu forme de curgere difuze.
Superficie con forme di dilavamento diffuso.
(IV).2. FORME DE ACUMULARE.
FORME DI DEPOSITO.
Depozite aluvionale recente.Depositi alluvionali recenti.
Holocen.
Depozite aluvionale terasate, terase.Depositi alluvionali terrazzati.
Pleistocen.
Depozite coluviale. Depositi colluviali.
Cuaternar.
Curgeri noroioase. Depositi di debris flow.
Con aluvial si torential activ. Conoide alluvio torrentizio attivo.
Con aluvial si torential inactiv. Conoide alluvio-torrentizioinattivo.
V.FORME SI DEPOZITE DE ORIGINE CARSTICA
(V).1. FORME DE EROZIUNE.
FORME DI EROSIONE.
Dolina cartografiabila. Dolina.
VI.FORME SI DEPOZITE DE ORIGINE PERIGLACIARA.
FORME E DEPOSITI DI ORIGINE PERIGLACIALE.
Panza de grohotis.Falda di detrito.
VII. FORME RELICTE, SUPRAFETE DE NIVELARE SI FORME ASOCIATE CU O GENEZA COMPLEXA.
FORME RELITTE, SUPERFICI DI SPIANAMENTO E FORME ASSOCIATE TALORA DI GENESI COMPLESSA.
Suprafata de nivelare I Pria - Merisor(800-1000m).
La superficie di spianamento Pria- Merisor (800- 1000m).
Suprafata de nivelare II Talhareasa -Secatura (650-750m).
La superficie di spianamento II,Secatura- Talhareasa(650- 750m).
Martori de eroziune.Testimoni di erosione
VIII.FORME, DEPOZITE SI ACTIVITATI ANTROPICE.
FORME , DEPOSITI E ATTIVITA ANTROPICHE.
Mina, galerii de excavare antropica.
Cava, imbocco di galleria di scavo antropico.
Suprafete de excavare antropica.
Superficie di sbancamento.

3.1. The Hodiş Depression is situated east of the southern Meseş, in the sector of Grebeni - Coastei – Carelor peaks, being the result of the erosion of the rivers Hodișu (tributary of Crişul Repede) and Valea Peşterii (right tributary of Almaş) in the Oligocene structures of the Zimbor strata, mainly shaly, and the lower and upper Ticu strata. Towards west, the contact with the upper Senonian and Paleogene magmatites (Dacites) of the Meseş Mountains is made through the Meseş Fault and some secondary reverse faults. The Hodiş Basin is entirely overlapped to the mainly shaly Zimbor strata. In the Zimbor (Chattian) formation, there are coal strata. As the clay is less resistant to erosion, it determined a convergent drainage network which submitted the landscape to a strong hydrographic fragmentation, leading to hilly ridges (Rengheț Hill, Fârțe Peak, Prislopului Hill), where we can find erosion witnesses. The erosion processes were favoured by the presence of fault fronts, which, at the contact with the volcanic structures from Meseş, formed detached detritus. The clay landscape in the Hodiş Depression is characterized by pseudo-solifluxional processes and landslides, north of Valea Peşterii. These processes determined a progressive decrease of slopes and the presence of rounded forms. At the base of the main valleys' slopes or in the areas of inter-flow with the main reservoirs (Agrij, Almaş), there are numerous debris cones. The morphology of Poicu Valley and Ragu Valley draws the attention through the presence of the thalweg on a fault line and through the asymmetric transverse profile, as a result of the selective erosion. The formation of these valleys was favored by the tectonic displacements, which determined a process of mechanical fragmentation of the rock, according to the fault planes.

3.2. The Huta-Bogdana Depression is located in the area of Huta and Bogdana origin basins tributaries of Agrij Valley, under Măgura Priei (996 m). They are entirely on the Oligocene structures of the *lower Zimbor strata,* being confined by fault compartments. At the contact between the red clay characteristic of the Zimbor strata and the crystalline schists of *Meseș Series*, stands a strip of Priabonian limestones confined by reverse and strike-slip faults. Within these depressions, we can notice Brătinesei Hill (552 m), Albului Hill, Jurchii Hill (529 m), Gropii Hill (511 m) south of Agrijului Valley and Porcărețului Hill, Cucului Hill, Gorunel Peak (513 m) north of it. The general morphology is sustained by the mass displacement processes: landslides, mudflows (Porcărețului Hill) and rolling processes in the detritus nappes. The fluvial shaping of the landscape falls on Agrij Valley, which springs from the south-eastern slope of Măgura Priei (996 m). The mountain sector of the valley is narrow, with a high profile in "V", widening only downstream of the Bogdana village, from where the flow is parallel with Almaş Valley (Rus, M.I., Irimuș, I.A., 1992). Its left tributaries converge towards the spot of Românași (Sângeorgiu, Izvorul, Pârâul Pe Vale, Treznea, Ciumărna, Chichișa, Prunetului Valley, Lunca

Brazilor Valley, Ortelec), being situated in *the rain shadow* of Meseş, which mirrors in the flow regime and fluctuations. The landslides in the proximity of Gorunel Peak, the pseudo-solifluxional processes, the creep and the torrential regime of the versant and riverbed drainage lead to risk phenomena in these origin basins. The accumulation forms are the active alluvial-fans from the Agrij Valley, the colluvium at the base of the morphodinamically unstable slopes and the numerous Quaternary eluvial deposits on the interfluves.

3.3. The Sângeorgiu de Meseș Depression spreads east of the central compartment of Meseş (Meseșul Central - Poiana Tâlhăresa and Gorunul Păstăești), being confined by the Sângeorgiu valley at south and Valea Izvodul at north. The basin is formed of post-tectonic covers of the Occidental Dacides (Apusenides), respectively of the Paleogene epicontinental formations. The basin is filled with highly faulted Priabonian strata (Brebi Marls, Cluj Limestone, Turbuța Strata and Hoia Strata) and Lutetian strata (Mortănușa Marls, Căpuș Strata and Jibou Strata). In the immediate proximity of the Meseş Mountains, under the local subsidence of Jibou, the rivers Agrij and Almaş submitted to strong erosion the post-tectonic cover of the Apusenides. Thus, a strip of Priabonian limestones (mainly limestone, dolomite and marlstone), sloped south-east, under the form of a 200-400 m uneven step above the crystalline, but tightly linked to it, through a strong tectonic and morphologic contact, was detached through daily erosion. Through regressive erosion, the stream flow of the Sângeorgiu and Izvodul valleys detach important stretches of the fault front which remain islanded in the geomorphologic landscape as outliers, extremely numerous in the general morphology. North of Gorunel Peak (513 m), the Moigrad strata are inconsistent above the lower Zimbor strata, the contact between them being marked through a structural surface. The landscape is mainly structural, namely structural surfaces maintained by limestone and dolomite (suggestive is the one of Gorunul Păstăești, Panului Hill, Păltiniș, 687 m), which spreads west - east. We can see remnants of the old piedmont surfaces under the form of the outliers, inconsistent over the sedimentary formations: Leardora (550 m), Pietri Hill, Pietriș Hill (456 m), Dumbrava (473 m). The tectonic complexity becomes more prominent towards north, where we can find Ragului Valley, developed as a result of the selective erosion on strike-slip faults which cross-cut a consistent stratum of plaster and Priabonian dolomicrite, deposing active clastic cones and colluvial deposits. Towards the mountain frame, at the contact between the crystalline schists of the Someş series and the Brebi marl, there are landslides, and east of Prislop Hill there are detritus nappes which materialize the lithological contact between the crystalline (metamorphic rock) and clay (sedimentary rocks), the latter being poorly cohesive rocks prone to physical and chemical disintegration. The accumulation forms in the Păltiniș Hill (687 m) are large colluvial deposits, while the erosion processes are the flows and creep processes.

3.4. Buciumi Depression spreads north of Izvodul Valley. Lupulețului Valley detaches north-west structural outliers, a proof of the past large piedmont covers: Flămând Hill (424 m) towards south, Măgura Buciumi (590 m) and Ursului Hill (540 m), the last one north of Valea Ragului, towards west. In this sector the strata present a normal polarity, as a result of the formation of the area of plaster, (Priabonian) dolomite and marl, marlstone, respectively the *Strata with Numulites Perforatus*. The main characteristic of this sector's structural landscape (on dolomite deposits) is the presence of structural areas and a horizontal fragmentation which affects the entire eastern slope of the Meseş, generating the erosion basins. These structural attributes are completed by a diversified lithology, given by the presence of marl, loamy horizons subject to linear and areal erosion.

The anticlinal structure (the anticline Ursu-Cățelu, with the axis oriented SW - NE, from Ursului Hill to N-W of Cățelului Hill), sustained by Priabonian - Lutetian marl, marlstone, plaster and dolomite, was submitted to dismantling through erosion. This resulted in erosion basins, confined by fault lines (the cross-cut profile SW - NE in the sector Ciucea – Buciumi, fig 3). As for the sector Sîngeorgiu de Meseș - Stâna - Moigrad, the transition from marine to continental is made gradually, in a continuous succession which does not imply sedimentation lacunae (Fărcaș, 2011). The sedimentation lacunae are present on a limited area. The continental formations - Valea Nadăşului, Turbuţa, Moigrad alternate with marine or marine-salmastrian formations. The upper Eocene (Priabonian) continental sequence has a base structure according to the sedimentation area, respectively the carbonate platform of the Viștea limestone Formation (in the areas of Gilău and partially Meseş) or the siliciclastic rocks of the Rakoczy Sandstone Formation (the areas of Meseș and especially Preluca).

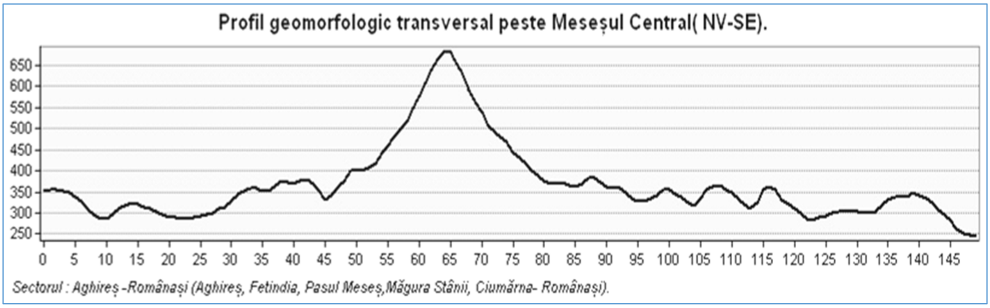

Fig. 3. Transversal geomorphological profile across the Meseş Mountains

At the base, on a reduced area in Gilău and Preluca, but extended in Meseş, we can find the anhydrites of the Jebuc Formation, which include paralic coaly deposits. Consequently, these determine the Priabonian age for the upper Eocene continental sequence from Transylvania. Turbuţa Formation (Lower Priabonian) is the lateral correspondent of Valea Nadăşului Formation, being similar to it, as a result of the depositional environments in which they formed. Both are deposits of flood plains, except that Turbuţa has a more flooded aspect (Fărcaş, 2011).

3.5. Bodia Depression spreads asymmetrically, on the right side of the creek Pe Vale, under the Obârșia peak (868 m). The basin is filled with Oligocene deposits (the Zimbor strata - the horizon of red clay and the Moigrad strata) and Priabonian deposits (Brebi Marl, Cluj limestone, plaster, dolomite, marl, marlstone and sandstone - the *Strata with Numulites Perforatus*). The general morphology detaches Măgura Bodiei (625 m) and Cățelului Hill (621 m) as imposing limy promontories, sustained by the Cluj limestone and detached through transverse faults. The processes of linear erosion (the formation of gullies) and areal erosion (landslides, pseudo-solifluxion) generated colluvial and proluvio-colluvial deposits, which dims the contact with the depressionnary area through a series of anthropically exploited glacises (Vâtca, A.M., Irimuș, I.A., Roșca, S., 2014).

3.6. Bozna Depression, north of Bodia Depression, between the Pe Vale creek at south and Treznea at north, on sedimentary deposits, is similar to Bodia (Oligocene and Priabonian deposits), except that Brebi Marl is better represented here and is strongly faulted, thus, we can find transversal, longitudinal and strike-slip faults. In the general geomorphology, Măgura Bozna (635 m), Corbului Hill (479 m) and Făgetului Hill stand out.

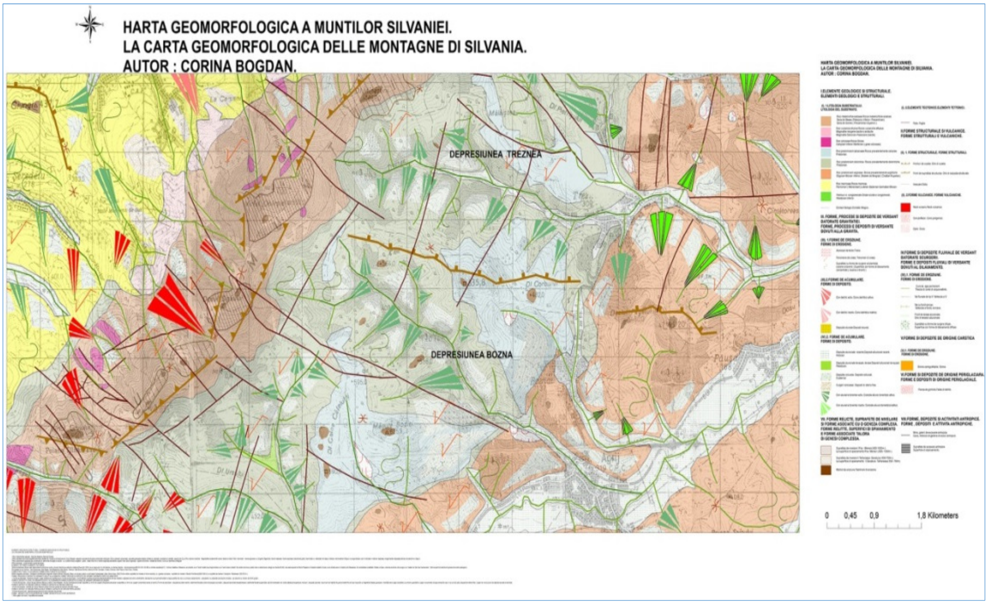

Fig. 4. Bozna and Treznea Depressions, geomorphological map (source: the author)

The first two are maintained by structural surfaces with structural outliers on the marlstone with Numulites Perforatus. Along Pârâul Pe Vale and Treznea we can see active alluvial fans, landslides in Corbului Hill and colluvial deposits affected by scattered flow phenomena.

3.7. Treznea Depression spreads north of Bozna Depression to Valea Ciumărna, being situated east of Mânăstirii Hill (658 m). The geological conditions of formation are the faults' systems and the lithological constitution, respectively the large development of *Cluj Limestone* and *Brebi Marl* (significantly extended, and proves the unstable character of the sedimentation conditions of the Paratethys, at the level of the sedimentation area of Gilău), the Oligocene Creaca (limy sandstones) and Curtuiuş (marl, clay) Beds. The general geomorphological landscape is dominated by fluviodenudational processes, marked by the interfluves Mălăiștea Hill (459 m), Pietrișului Hill (424 m), Dosu Crucii Hill (436 m) and La Măgură Hill (420 m). They are confined by vertical and sub-vertical faults which enabled a strong fracturing of the *Cluj limestone*, over which is disposed the *Brebi marl*. On the slopes, we can find colluvial deposits. Treznea Valley led to active alluvial fans. North of Treznea we can observe the presence of nest-like landslides, favored by the mostly loamy lithology of *Moigrad strata. Treznea fossiliferous point* coincides with the short episode of the formation of a freshwater marsh (Fărcaș, 2011).

3.8. Ciumărna Depression spreads between the valleys of Ciumărna, at south, respectively Chichișa, at north. The basin's fill is relatively similar to that of Treznea basin, except that, here, the *Curtuiuș and Moigrad Oligocene strata* are better represented, with a marly-loamy lithology. The lithology and strong faulting of deposits enabled a depressionary basin. The Meseş Mountains' slopes present large detritus nappes. La Arini Hill (416 m) and Țifla Peak (478 m) stand out in the general morphology, Țifla Peak being a structural outlier incorporated into a structural area maintained by the limy sandstones of the *Creaca strata.* The sandstones horizon is more conspicuous for the landscape, with headland caps and structural outliers. West of Țifla Peak (478 m), on Ciumărna Valley, an obvious anticline stands out, with adjacent slopes affected by linear erosion processes (rills, gullies) and areal erosion (landslides). Along its tributaries, we can also find numerous inactive alluvial fans.

3.9. Stâna Depression spreads north of Ciumărna Depression and east of Măgura Stânii (716 m) on Chichișa Valley.

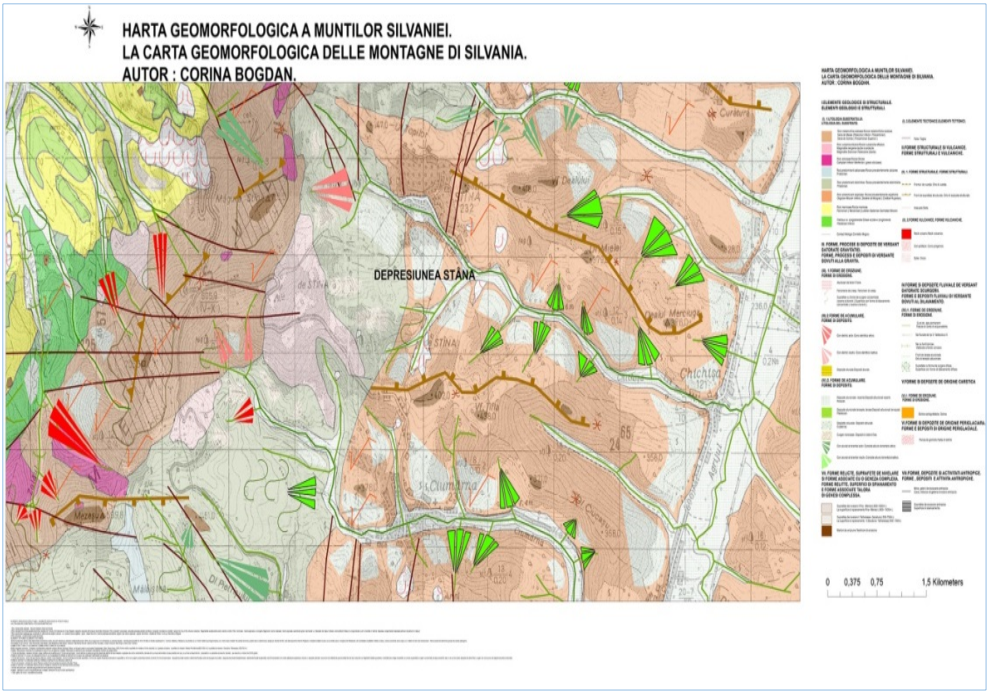

Fig. 5. Stâna Depression, geomorphological map (source: the author)

The fill of the basin is different from the others' fill. *The Cluj Limestone* is intensely folded and Brebi marls cover it as discontinuous and discordant strips. *The Turbuța Strata* and the plaster horizon are well represented in comparison with the other basins. From West to East, the Piatra Albă Hill, Topilor Hill (441 m), Pleșița (380 m), Vârful Dealului (414 m) detach from a morphological point of view as structural witnesses. The Chechișa Valley versants receive colluvial deposits and its tributaries laid down alluvial fans, at present inactive, to which is added the insular presence of the landslides on the structural fronts from the Topilor Hill (470 m) and Vârfului Dealului (414 m). At the base of the crystalline coast, detritus fields (the land of the Stâna locality) were accumulated, transformed by the torrential erosion. The sequence of Eocene deposits, where the platers (Stâna) are interbedded, indicate the gradual retreat of marine waters, and the result was the uplift of a littoral piedmontan platform, covered by the formations of the Romanian accumulation piedmont.

4. CONCLUSIONS

The submontane depressions on the external border of Meseș Mountains, due to the complexity of the geological and tectonic context in which they evolved, offer a wide range of natural resources belonging to the tertiary deposits: limestone, sandstone, dacitic tuffs, clays, clays, marble, sands and coal. Some of these resources, as the caolinic sand (Jac, Var), siliceous sand (Jac, Creaca), quartz sand (Var), kaolin (Ruginoasa), river aggregates (Almaşu, Românaşi), Eocene plasters (Stâna și Jibou), crystalline and eruptive rocks (andesites exploited at Moigrad) with important reserves, can be a solid base for the argumentation of regional recovery programs and the reduction of unemployment rate in Sălaj. The geomorphological subdivision of these depressions was made in the context of the Morpho-climatic Miocene-Pleocene and Quaternary matrix, which is reflected by the pedogenetic profile of these depressions. The soil resources (cambosoils, luvosoils and preluvosoils), affected by numerous processes of degradation (geomorphological, water, anthropic), which determines whether the loss of the (rich) soil horizon from the surface, the deformation of the terrain, the sedimentation and clogging, the compaction, the salinization; the acidification or pollution. The soil erosion remains the most important degradation factor, having serious consequences for agriculture, by withdrawing from the agricultural circuit some areas of land. In terms of landscape, all these depressions from the external frame of the Meseș Mountains are suitable for recreational activities.

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