Geogr. Fis. Dinam. Quat.
25 (2002), 95-100, 2 figg.

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PLIOCENE-QUATERNARY EVOLUTION IN THE CONTACT AREA BETWEEN BRAŞOV DEPRESSION AND THE SURROUNDING MOUNTAINS (ROMANIA)

ABSTRACT: CIOACĂ A. & DINU M., *Pliocene-Quaternary evolution in the contact area between Braşov Depression and the surrounding mountains (Romania).* (IT ISSN 0391-9838, 2002).

Braşov Depression is the largest intramountainous depression in the Romanian Carpathians. Its surface-area of 2,004 km^2 represents 10.8% of the Eastern Carpathians and 0.84% of Romania. Being situated in the inner Bend of the Carpathian Arch, the Depression appears as a discontinuity between the southern summits of the Eastern Carpathians and the eastern summits of the Southern Carpathians. Its formation is traceable to the Carpathian geosyncline, in the wake of collapse in the Dacian followed by subsidence associated with sedimentation, a continuous process up to the Quaternary when lacustrine accumulation became dominant.

The margins of the Depression show several types of morphological contact with the surrounding mountains, the result of a distinctively different Pliocene/Quaternary evolution. In the south, there is the large northern escarpment of the Piatra Craiului, Bucegi, Postăvaru and Piatra Mare massifs, sliding down into the milder slopes of the Clăbucetele Intorsurii. Lots of piedmonts gradually sliding into the plain, and very much fragmented, recall the amplitude of recent crustal movements in these places with mountain upliftings by over +2 mm/year on the one hand, and sinkings of –4mm/year at the Olt/Râul Negru junction, on the other.

These continuous movements, developing in opposite direction, went on throughout the Upper Pliocene/Quaternary interval, generating escarpments festooned only by short, yet very deep valleys, a major supply source of materials for the piedmonts extending at the base of the escarpment which, in this way, acquired appreciable dimensions. Eastwards and northwards, at the contact with the Breţcu, Nemira, Bodoc and Baraolt mountains, movements had lower amplitudes, which accounts for the different aspect of the contact area sloping stepwise towards the depressionary plain. Although the system of pre-Hercinian horsts and grabens has not been recently reactivated, yet the northern margin aquired a sinuous outline through the penetration of depressional gulfs.

On the western side, the Perşani Mts overlie the basement horst of the Zărnesti – Hoghiz – Ocland gravimetric axis, a zone of medium uplifts (+1.0 - +1.5 mm/year) adjoining a relatively balanced depressional area (0 mm/year). So, the boundary of the Depression is formed from the narrow glacis of the Perşani Mts, extending gulf-like inside them in front of the Vlădeni Pass.

The Pliocene-Quaternary evolution of the piedmonts and the glacis gave rise to a combination of genetic types of morphological contact that had contributed to the compartmentation of Braşov Depression. The best developed piedmonts occur on the southern and south-western margin, outstanding being Sohodol, Râsnov, Braşov and Sacele. On the northern margin are Turia, Dalnic, and Câmpul Frumos; on the eastern margin is Ojdula and Poian. On the western margin, the morphological contact is marked by some narrow glacis: Tohan, Vulcan, Codlea, Crizbav, Măierus, Apata, Ormenis and Augustin.

KEY WORDS: Morphoevolution, Contact area, Braşov Depression, Romania.

REZUMAT: CIOACĂ A. & DINU M., *Evoluţia pliocen - cuaternară a ariei de contact a Depresiunii Braşovului cu munţii din jur.* (IT ISSN 0391-9838, 2002).

Cea mai întinsă depresiune intramontană din Carpaţii Româneşti, Depresiunea Braşovului, are o suprafaţă de 2 004 km^2, ceea ce reprezintă 10,8% din cea a Carpaţilor Orientali şi 0,84% din suprafaţa ţării. Situată în Curbura internă a arcului carpatic, depresiunea apare ca o arie de discontinuitate între culmile sudice ale Carpaţilor Orientali şi cele estice ale Carpaţilor Meridionali. Depresiunea s-a format în geosinclinalul carpatic, prin prăbuşirea din dacian continuată cu o scufundare subsidentă însoţită de sedimentare, până în cuaternar când a predominat acumularea lacustră.

Marginile depresiunii sunt marcate prin mai multe tipuri de contact morfologic faţă de munţii din jur, rezultat al unei evoluţii pliocen-cuaternare diferenţiate. Astfel, în *sud*, depresiunea este dominată de abrupturile nordice ample ale munţilor Pietrei Craiului, Bucegi, Postăvarul şi Piatra Mare, continuate cu versanţii mai domoli ai Clăbucetelor Intorsurii. O mulţime de piemonturi, larg efilate dar puternic fragmentate, evocă amplitudinea mare a mişcărilor crustale recente de aici: mişcări de înălţare a munţilor cu valori de peste + 2 mm/an în contrast cu mişcări de scufundare ce ating –4 mm/an la confluenţa Oltului cu Râul Negru. Aceste mişcări continui şi de sens contrar, ce s-au menţinut în tot intervalul Pliocen Superior-Cuaternar, au generat abrupturile acestor munţi, festonate doar de văi scurte dar puternic adâncite. În aceste condiţii, ele au alimentat cu cantităţi importante de materiale piemonturile de la baza abrupturilor, care au căpătat dimensiuni apreciabile. Spre *est*, ca şi spre *nord*, la contactul cu munţii Breţcului, Nemirei, Bodocului şi Baraoltului, mişcările au avut o amplitudine mai mică, astfel că şi aspectul ariei de contact este altul: piemonturi restrânse aflate în prelungirea culmilor ce coboară treptat spre şesul depresiunii. În plus, faliile sistemului de horsturi şi grabene prehercinice, deşi nu au fost reactivate recent, au impri-

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mat marginii nordice, un contur sinuos prin pătrunderea golfurilor depresionare. Pe latura *vestică*, Munţii Perşani se suprapun horstului de fundament al axului gravimetric Zărnşti – Hoghiz – Ocland, o arie de înălţare medie (+1,0 +1,5 mm/an) ce se învecinează cu o parte relativ echilibrată a depresiunii (0 mm/an). În aceste condiţii, limita depresiunii o formează contactul cu glacisul îngust al Munţilor Perşani, ce se prelungeşte ca un golf in interiorul acestora în dreptul pasului Vlădeni.

Evoluţia pliocen-cuaternară a piemonturilor şi glacisurilor a dat naştere la o asociere de mai multe tipuri genetice de contact morfologic, care au contribuit la compartimentarea Depresiunii Braşovului. Piemonturile cele mai dezvoltate se află pe marginea sudică şi sud-vestică, mai importante fiind piemonturile Sohodolului, Râşnovului, Braşovului şi Săcelelor. Pe latura nordică sunt piemonturile Turiei, Dalnicului şi Câmpul Frumos, iar pe cea estică piemonturile Ojdulei şi Poian. Spre vest însă, contactul morfologic cu Munţii Perşani este format de glacisurile înguste ale Tohanului, Vulcanului, Codlei, apoi glacisul mai larg din golful Vlădeni şi se continuă cu cele ale Crizbavului, Măieruşului, Ormenişului, Apaţei şi Augustinului.

CUVINTE CHEIE: Morfologic evoluţie, Arie de contact, Depresiunea Braşov.

GENERALITIES

Braşov Depression is the largest intramountainous depression in the Romanian Carpathians, more than 2,000 km^2, representing 10.8% of the Eastern Carpathian area and 0.84% of Romania's territory. It lies in the inner Bend of the Carpathian Arch, being surrounded by the southern ranges of the Eastern Carpathians (the Bend Group) and of the Southern Carpathians (Făgăraş-Bucegi massifs). This location turns it into an area of discontinuity between mountain boundaries, through which the River Olt enters this depression, attracted by the subsidence area from Lunca Câlnicului. The river Olt thus becomes the only draining channel of the depression, collecting all other draining basins from the East and South East of the Râul Negru, from the South West the basins of Timiş, Bârsa, and Hamaradia, and from the Northern part-the Cormoş.

The bounds of the Depression feature by appreciable levelling compared to the mountains surrounding it. The southern part is dominated by the northern escarpments of the Piatra Craiului, Bucegi, Postăvaru and Piatra Mare mountains, continued into the Întorsura Mountains which link the Depression to the northern extremity of the Bran-Dragoslavele Corridor and the Timiş Valley. Eastwards it comes into contact with the Vrancea (Breţcu) and Trotuşul (Nemira) Mts., separated by the Oituz Valley and the Oituz Pass. In the north it shows the isolated penetration of the Bodoc and the Baraolt mountains (fig. 1). The valleys of the Olt and of its tributary the Râul Negru lend the

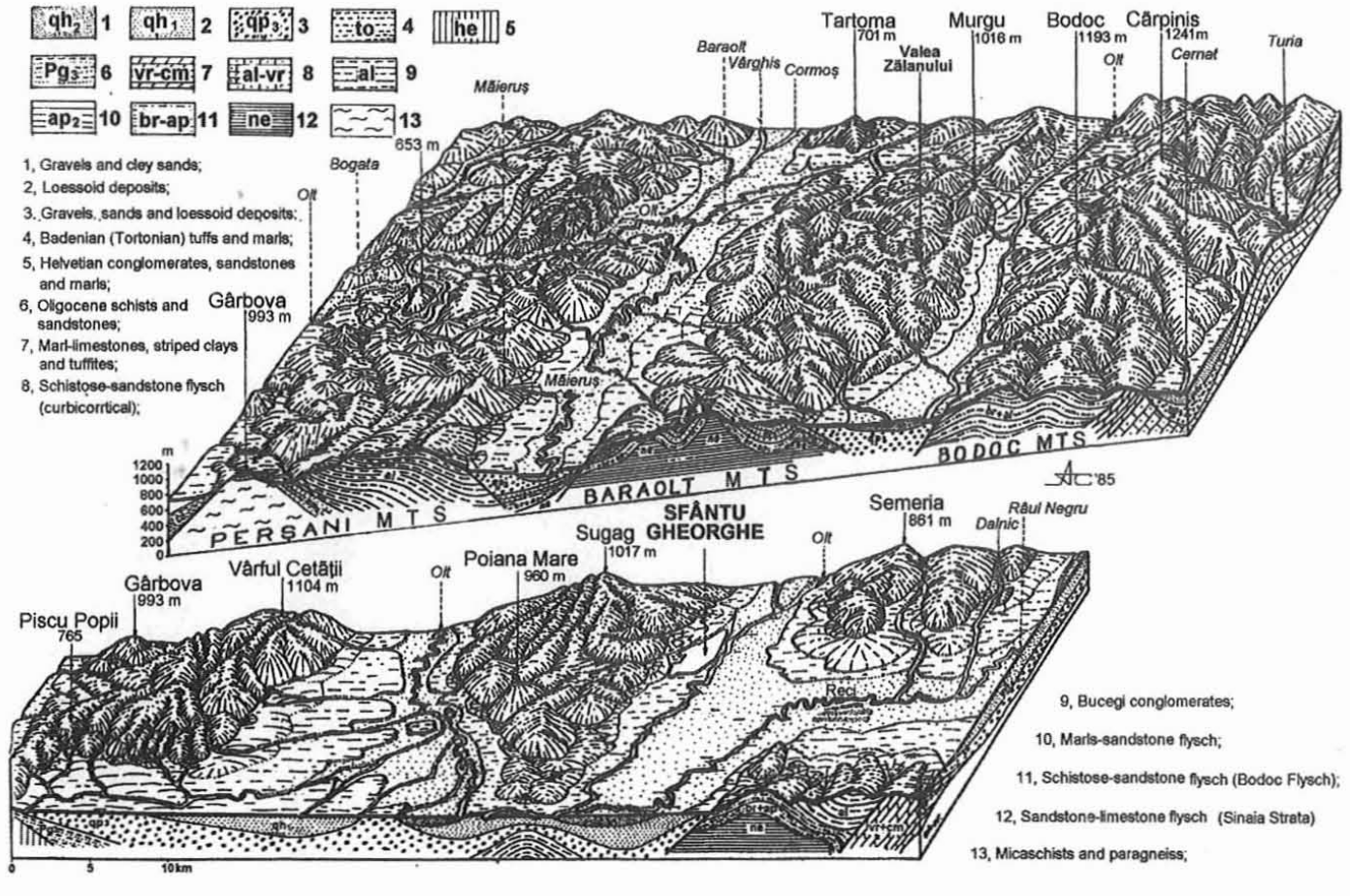

FIG. 1 - Contact area between Braşov Depression and Perşani, Baraolt and Bodoc Mountains.

northern line a sinuous contour through the penetration of depressionary gulfs. To the west, the depression is closed in by the Perşani Mts, extending gulf-like inside them in the Vlădeni Pass area.

The relief features by a relatively concentrical stepwise display with piedmonts, glacis and alluvial fans at the contact with the mountain. The absolute altitude varies from under 500 m in the Olt floodplain (498 m at the junction with the Râul Negru and 461 m at Augustin), to 850 m in the Sohodol Piedmont.

The dominant aspect of the Depression is that of a higher extended and flat plain (over 80% of the area), widely inclined towards the central part, more precisely towards the valleys of the Olt and of its tributary the Râul Negru. It appears as an association of several genetic types: plains of accumulation (fluvio-lacustrine), piedmontal fields (520-550 m), river plains, terrace plains, subsidence and divagation plains. Piedmonts and accumulation glacis occupy the higher ridges of the Depression (850 m in the Sohodol Piedmont and 550 m at the contact with the alluvial plain), the contact area itself being marked by lines of springs. The best developed piedmonts lie on the southern and south-western edge, outstanding being the Sohodol, Râşnov, Braşov (Timiş) and Săcele. The piedmonts of Turia, Dalnic and Câmpul Frumos occupy the northern side.

There is little depth fragmentation, comparable with the plain zones (50 to 150 m). The density of fragmentation (0.5-0.8 km/km^2) is the result of a host of rivers and brooks flowing down from the mountains towards the lower base level of the Olt (530 m at Sfântu Gheorghe, 498 m at the junction with the Râul Negru River, 484 m downstream Feldioara, 461 m at Augustin). There are several areas of hydrographic convergence, eg. at Lunca Câlnicului, Feldioara-Bod, Târgu Secuiesc-Lunca-Imeni. Density and depth of fragmentation in the piedmont zone are 0.8-0.9 km/km^2 and 150-200 m, respectively.

THE PLIOCENE-QUATERNARY EVOLUTION OF THE BEND AREA AND OF BRAŞOV DEPRESSION

The Depression emerged within the Carpathian geosyncline through a sinking begun presumably in the Dacian era, followed by subsidence associated with sedimentation, a process that lasted up to the Quaternary. There are some low alluvial plain sectors along the Olt Valley which still undergo subsidence of −2 and −3 mm/year (Ozun, Halchiu and Augustin settlements).

The geological built-up is fairly complex: sedimentary deposits originating from the Cretaceous flysch (sandstones, limestone) and volcanic formations (andesites-not sectioned in the profiles from fig. 1) overlain by Quaternary deposits (sands, gravels and clays). The Pliocene deposits (weakly-bound sandstones, marls, and gravels), occurring on the orogen rim surrounding the depression, led to the assumption the sinking took place during the Pliocene and that «tectonic and magmatic extrusions from the northern volcanic chain» had been considerably inolved in its formation (Iancu, 1957).

UPLIFTING - The Bend Mountain space had been subjected to uplifting movements that culminated in the Savic orogenesis (Oligocene-Aquitanian), continued in the Miocene-Pliocene, with rhythmical uplifts that engendered the Râu Şes and Gornoviţa complex sculptural surfaces. The almost synchronous sinkings in the central axis produced the Depression of Braşov. The map of recent vertical crustal movements in Romania (*Harta mişcărilor crustale verticale din România*, 1987) provides a clear-cut image of local disparities in the direction and rate of vertical movements. So, no wonder that low and moderate intensity uplifting areas (0.0-2.0 mm/year and 2.0-4.0 mm/year respectively) have built the mountainous relief, while the subsidence area of medium and great intensity (0.1-2.0 mm/year and 2.0-4.0 mm/year, respectively) resulted in the formation of the Depression. The set of high massifs (Piatra Craiului 2,238 m, Bucegi 2,505 m, and Ciucaş 1,954 m) overlap the area of moderate uplifting intensity (top values of the Bend), while the Perşani, Baraolt, Bodoc, Nemira, Vrancea and Clăbucetele Intorsurii Mts., correspond to the low- intensity area (fig. 2 A). The emergence, development and lasting preservation of a lake was a hypothesis advanced by Orghidan, 1929, Mrazec, 1932, Iancu, 1957; Mihăilescu, 1963. The formation of a lacustrine cuvette in the wake of sinking in the Dacian, later drained towards the Transylvanian Depression, would explain the upfill of Braşov Depression with Quaternary alluvia (over 800 m thick) brought by the rivers from the neighbouring mountain regions (Mihăilescu, 1963).

Lately, however, as new sedimentological and palinological evidence has kept piling up, most geomorphologists are inclined to consider this area as marshland at the most (Posea, 1981; Mihăilă & Popescu, 1977).

The mountain summits around Braşov Depression were already in place when the Cretaceous deposits, forming mainly the southern and western massifs, started being eroded in the conditions of an arid climate. As a matter of fact, upliftings begun in the Senonian, led to the expansion of the weathered areas obvious in the Paleogene. The Paleogene erosion removed much of the mountain land developed on Aptian-Albian conglomerates, generating a host of terrigenous materials.

The modelling of a vast border surface, begun in the Pliocene on either side of the Bend Carpathians, went on until the Middle Pliocene Rhodanic phase. The subtropical Mediterranean climate of the Pliocene was marked by extreme periodical fluctuations, from arid to pluvial, as revealed by lithological and sporopollinic analyses. The strong iron-hydroxide pigmentations of the Perşani microconglomerates are suggestive of this subtropical climate that weathered continental deposits. So, piedmont depositions on the edge of the mountain space indicate not only the higher intensity of uplifting movements, but also the beginning of the first subsidence, ending up in the formation of the first erosion glacis (Cioacă & Dinu, 1996).

THE SEDIMENTATION OF THE DEPRESSION - While geology and geomorphology specialists have agreed in the

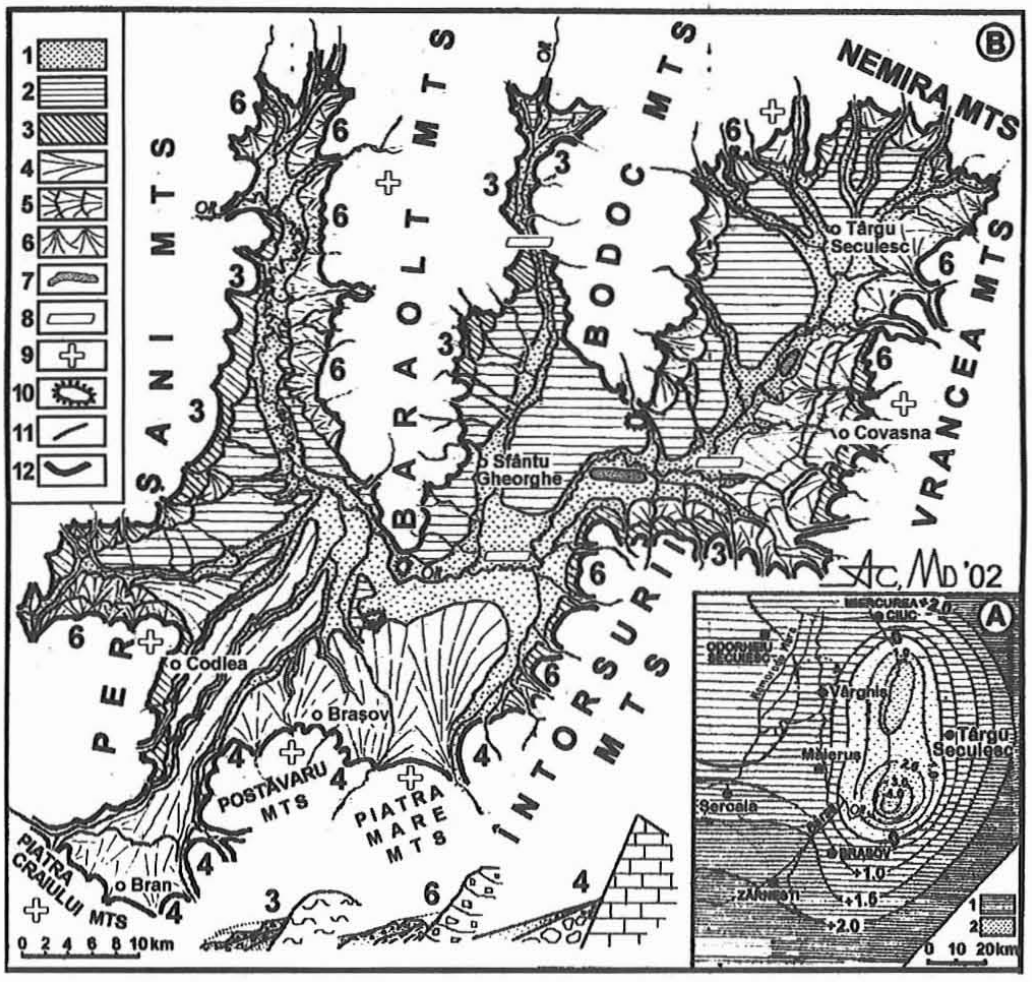

FIG. 2 - Brașov Deppression. The map of recent crustal movements (A): 1, Uplifting areas; 2, subsidence areas and the types of morphological contact with the surrounding mountains (B); 1, floodplains and lower terraces; 2, terraced plains; 3, accumulations, glacis; 4, large marginal piedmonts; 5, terraced piedmonts with erosion outliers; 6, narrow marginal piedmonts, step-like display; 7, dunes; 8, active subsidence areas (gravimetric minima –2 and –4 mm/year); 9, areas subjected to recent positive crustal movements (average uplifting: +1.0 up to +1.5 mm/year, maximal 2.0 mm/year); 10, erosion outliners; 11, relief units bounds; 12, depression bounds.

course of time on the uendeniable tectonic origin of the Depression, when it came to its age and to the presence of a lake in the area, numerous disputes arose. We shall not dwell on this aspect, because the latest evidence entitles us to affirming that recent sinking crustal movements did generate subsidence in the Upper Pliocene continued with various intensities to this day. The presence of a lake is confirmed only for the early stage of depressionary formation, the lake being subsequently silted by the huge amounts of sediment yielded by the strong erosion of the surrounding mountains. What was left of the lake in the aftermath of tectonic sinking and rich alluviation were a few pools spread within the marshland. This argumentation is sustaind by specific deposits, together with lots of overmoist areas and the weakly outlined banks of the watercourses crossing them in their way to the Olt River. Sedimentation intensified and continued throughout that period, turning the initially lacustrine domain into dominant marshland. This aspect of the Depression was by no means a permanent one, because there were certain stages, especially during the Pleistocene, when some pools would form, drained by the course of the Olt and its tributaries. Such lenses with lacustrine sediments were evidenced by several drillings made to study the consistency of the cover layers of Liassic coal accumulation at Codlea and Vulcan, to assess the thickness of sands at Iaras, or to capture some mineral waters in Târgu Secuiesc Depression.

The climatic background against which modelling processes had taken place at the beginning of the Quaternary, was moderate Mediterranean as revealed by the intense weathering of the mountainous territory that engendering glacis and floodplains. This proves the dominance of sideways erosion here (Posea & Popescu, 1974, p. 99), with important fluvio-torrential formations accumulating in the Depression. The Quaternary featured by frequent climatic variations which, associated to the neotectonic movements, often led to oscillations of the base levels, in other words, to permanent modifications of the morpho-sculptural system.

The present-day relief modellig processes were strongly influenced by the Quaternary evolution of the drainage net thoroughly tributary to the Olt River. The processes developing in the alluvial plains and small catchments reflecting clear-cut differences between the up-and-downstream sectors, are of great intensity.

The geomorphic processes in the Olt floodplain have recorded space and time changes through man-induced intervention, most often in the sense of bank erosion. Sedi-

mentation within the channel, or in the aftermath of extreme flood events with specific effects, has led to the formation of new holms, or to the reshaping of existing ones. In the areas of hydrographic convergence flooding was a frequent phenomenon (every one or two-three years) with negative impact on the floodplain. As from 1975, a program of hydrotechnical works has been initiated through which the meanders of the River Olt have been cut, correcting its course. These works have resulted in the speeding up of the river flow, whereas abandoned creeks have been turned into leisure areas. Works being halted (in 1983), the ground waters started infiltrating into the embanked areas. The new, lower base level of the Olt, has brought about a fresh phase of tributary deepening, affecting secondary dams through sideways erosion.

TYPES OF GEOMORPHIC CONTACT BORDERING BRAŞOV DEPRESSION

The key to understanding the Braşov Depression's relief was to look into the Pliocene-Quaternary environmental factors, and moreover to study the contact area between the Depression and the mountains around it, an area of great morpho-structural diversity. Since the margin of the Depression is largely overlapping the line separating areas subjected to opposite vertical movements and since climatic conditions were and still are rather homogeneous, one would expect the contact relief to be fairly monotonous. But that is not so, because geomorphic processes are not the same everywhere in this area, they reflecting both the variable uplift and sinking amplitude and the different intensity of erosion in relation to rock complex, relief step and the distance between local base levels and the surrounding escarpments. These are sufficient reasons to justify a distinct approach to each situation, the morpho-structural complexes and their forms of manifestation making the contact area geomorphic landscape hugely diverse.

PIEDMONTS - As a contact area between mountain and the low neighbouring zone, piedmonts are typical of the young and massive mountain chains. Altrough the Bend Carphatians are of recent age, they lack massiveness, so that the accumulation contact surface between mountain and Depression meets only incidentally piedmont criteria.

An extended marginal piedmont, emerged in the Pleistocene, is seen on the southern side of Braşov Depression. Its appreciable dimensions should be understood in terms of two basic factors: the height of the mountain front (here are the tallest massifs around the Ddepression: Piatra Craiului, Bucegi, Postăvaru, and Piatra Mare), and the great density and expansion of drainage basins which had sculptured these massifs. Zărneşti Piedmont depressionary gulf appears to be a normal extension of the Dragoslavele-Bran tectonic corridor spanning the Iezer and the Piatra Craiului Mts in the west and the Leota and the Bucegi Mts in the east (Cioacă, 1974). The piedmont is as narrow as the tectonic corridor, having filled up the narrow gulf of Braşov Depression imposed by the Perşani and the Postavaru mountains. The robust morpho-structural systems acting during the Villafranchian and the Pleistocene in the over 2,000 m-high mountains on either side of the tectonic corridor, showed up in the correlative deposits of the piedmont. Thus, the effect of the two sculptural cycles was the formation of two piedmonts in one and the same area: an older piedmont containing coarse materials, frequently uplifted at the contact with the mountain rim, and a younger piedmont, stretching as far as Tara Bârsei, and containing finer grain-sized materials, often resulting from the refashioning of the highest part of the older piedmont. As a matter of fact, this sector of Braşov Depression, namely Sohodol Piedmont (over 850 m alt), is the highest and most fragmented one. The deepening of the drainage net that would form later, led to piedmont outcrops of great granulomentry, largely in the depression-to-mountain contact.

The Timiş Piedmont (between the Ghimbăşel and the Timiş valleys) and the Târlung Piedmont (between the Timiş and the Târlung valleys) cover a wider area. Beside, the turn taken by the Târlung Valley towards the area of maximum active subsidence at the junction with the Râul Negru, is associated with a fan-like opening of the Târlung Piedmont in the same direction.

All in all, the geomorphic landscape of extended marginal piedmonts features smooth or slightly cumbered interfluves, especially towards their axial part. It is only in the Sohodol Piedmont that a hilly landscape, transitional to the mountain zone, is seen on the margin edging the Bran-Dragoslavele tectonic corridor or the neighbouring massifs.

GLACIS represent another type of morphological contact between the mountains and Braşov Depression, widely spread out under the massive conglomarate escarpments of the Perşani, Baraolt, Întorsurii and Breţcu mountains (fig. 2, B, 3). They had emerged during the Pleistocene either in the Riss-Wurm interglacial period, when they had a wide extension, or in the colder Pleistocene climate, when solifluxion processes were particularly active. A special role in the process of glacis formation was played by the short torrential valleys developed on the rim of the massifs that used to uplift at a slower pace. On the eastern side of the Perşani Mts., they penetrate into the mountain space along the Cepei, Nadeş, Bozon and Hotarul valleys; in the Baraolt Mts., along the Malnaş, Zălan, Arcuş and other valleys. On the northern side of the Intorsurii Mts, the glacises penetrate up the valleys (Dobârlau, Lisnău, Beldi, Saciova, Boroşneu), ending up in the Depression, form together a narrow hill-like marginal step.

Recent and present-day alluvial fans overlap functional piedmonts, alluvial glacis respectively, even though piedmonts are no longer forming today. Because of the relatively closed local base level on which subsidence is going on, the alluvial plain alongside the Olt and the Râul Negru valleys, the piedmont terraces and plains surrounding them, have imposed upon the rivers flowing down from the surrounding mountain zone that is relatively stable or mildly uplifting (0.5 mm/year), a tendency to continue building some alluvial fans.

This type of geomorphic contact was evidenced at the periphery of Vlădeni gulf in the Perşani Mts., on the west-

ern margin of the Baraolt Mts. between Iaraş and Brăduţ, on the eastern rim of the Bodoc Mts. between Dalnic and Caşinu Mic (Cioacă, 1981), at the foot of the Nemira Mts between Estelnic and Lomnia and at the mouths of the valleys emerging from the Vrancea Mts. between Breţcu and Ghelinţa.

CONCLUSIONS

The largest of Romania's intramountainous depressions, but also the best known geologically and geomorphologically, Braşov Depression appears like a concentrical succession of relief steps (Geografia Romaniei, vol. III, 1987). The transition from the alluvial plain in the centre to the surrounding piedmont terraces and fields is very smooth, without any traces in the landscape. On the other hand, the passage from the smooth step of the Depression centre to the surrounding mountains runs through a contact area of great landscape diversity, which reflects the correlation of the morphogenetic phases of Pliocene-Quaternary deposits. The complexity of the contact area depends on the lithology of the massifs, the proximity or distance between areas undergoing opposite vertical crustal movements of different intensities, and the compartmentation of the Depression through some spurs penetrating inside it.

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(ms. received 15 May 2002; accepted 31 October 2002)