Hydrogeography of the Szamos/Someş-Kraszna/Crasna[1] river system

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Introduction

The catchment area of the Szamos/Someş-Kraszna/Crasna is mostly in Transylvania, where we can see various distinct natural geographical formations. This natural feature required us to make a survey and a geographical evaluation with interdisciplinary theme-study method for an area bigger than the drainage basin in question, similarly to the studies of the „Tiscia monograph series" published so far. Therefore in certain sections of chapters in our study our survey and analysis include the whole Transylvanian Basin and its surrounding mountainous region.

Keywords: hydrogeography, River Szamos/Someş, River Kraszna/Crasna

II Geological structure of the Transylvanian Basin and its surrounding mountainous region

The mountain system of the Carpathians is broadly the youngest orogenic mountains in Europe. Its components formed via recurring crustal movements, folds, emersions, volcanic eruptions, marine and lacustrine deposit accumulation, from the end of the Palaeozoic era through the Mesozoic era to the end of the Tertiary.

In the region of the Carpathians and the basins surrounded by them, the range of the Variscan mountain system was situated in West and Central Europe in the Palaeozoic era. This mountain system broke in the Mesozoic era, and it partly emerged, partly subsided deep, and crumbled into pieces. The crystalline pieces emerged in the shape of horsts and inselbergs from the sea. The subsided parts were covered by the water of the Tethys Sea and deposited by a thick set of alluvial layers.

These deposits tightened on the crystalline pieces in the process of the recurring crustal movements and folds. These pieces played the role of a „last" in the orogenic movements, according to Gyula Prinz.

The Tethys Sea was transformed into an enclosed mediterranean sea when a powerful W-E movement of the eastern plate of the Atlantic Ocean began. So the Tethys Sea was wedged between the European (northern) and the African (southern) plates.

From the surface of the surrounding dried regions great amounts of alluvium and deposit moved in the basin of the sea during abrasion.

[1] The first name is Hungarian, and the second Romanian

During orogenic movements the sea gradually narrowed and shallowed from the end of the Cretaceous to the middle of the Tertiary. The deposits filling the basin folded during orogenic movements at the beginning of the Miocene, and the rim range, risen in the form of a wide flis belt, composed mainly of sandstone, enclosed the Carpathians into a uniform framework (Figure 1.).

I.

Figure 1. The eastern half of the Carpathian Basin at the beginning of the Pliocene (I) the Pannonian approximately 10 million years ago, and at the end of that (II) 1-1.5 million years ago (after J. Fink)

a. = Pannonian
b. = Upper Pleistocene
c = present beds

II.

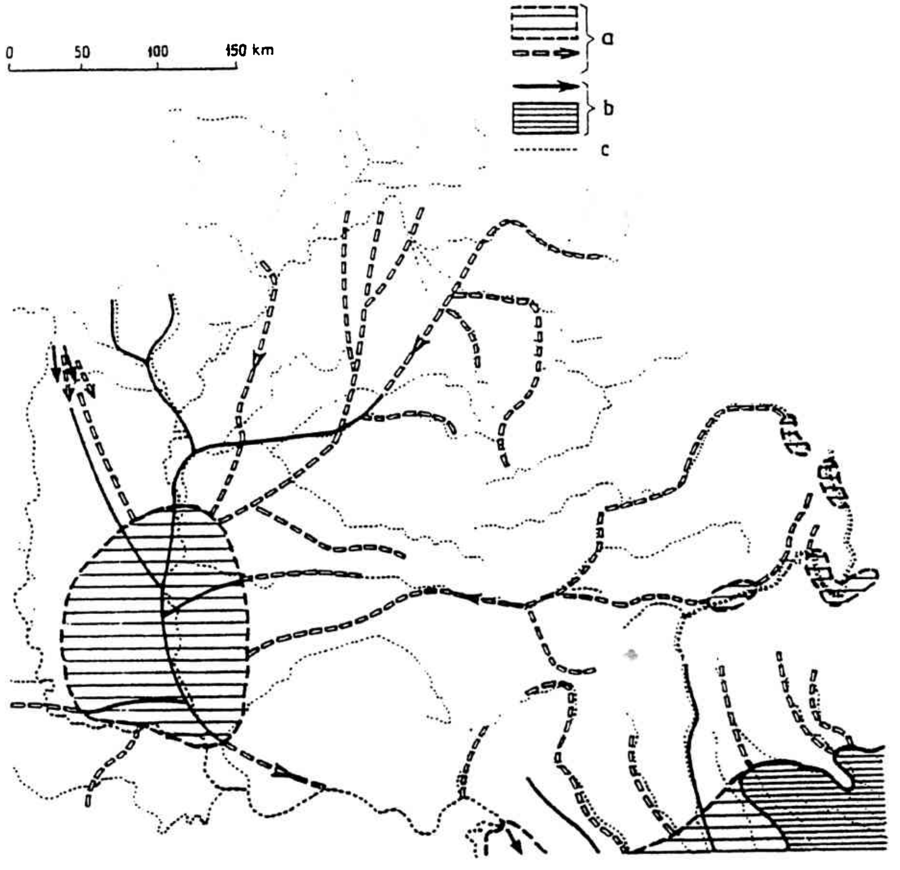

Figure 1. The eastern half of the Carpathian Basin at the beginning of the Pliocene (I) the Pannonian approximately 10 million years ago, and at the end of that (II) 1-1.5 million years ago (after J. Fink)

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The mass of the Carpathians is in places dissected by emersions, in other places by depressions lengthwise and transversely. All along the mountain range, thus, mountains higher than 2000 m and the low ranges of 1000-1200 m can be traced. In the eastern areas intramountainous, or intra-Carpathian basins of great importance, as well as the most significant and biggest basin along the Carpathians, the Transylvanian Basin, were created.

The river system of the Szamos/Someş-Kraszna/Crasna is situated in the northern system of the Transylvanian Basin. The basin came into existence at the time of the upward folding of the outer zone of the Carpathians and the surface effusion of volcanic lava zones.

The edge of the basin is enclosed by mountain masses of great size: the Eastern Carpathians, the Southern Carpathians and members of the eastern mountainous area.

The independent basin in Transylvania was created as a result of the division of the eastern range of the Carpathians into two branches. While the eastern branch runs as a continuation of the Maramuresh Carpathians through the Lápos/Lăpuş and the Radna/Rodna Mountains into the Mountains of the Székelyföld (Călimani, Gurghiu, Harghita, Perşani), the other, the western branch begins at the Lápos/Lăpuş Mts. and through the Preluca, Czikó/Ţicăn and Szilágyság/Sălaj crystalline shale enclaves, all along the range of the Meszes/Meseş Mountains it stretches into the huge mountain mass of the Királyhágó/Pădurea-Craiului, the Vigyázó/Vlădeasa, the Bihar/Bihor Mountains and the Transylvanian Ore Mountains (Erdélyi Érchegység/Munţii Metaliferi). The subsidence flanked by these two branches constitutes the Transylvanian inland, or basin, which is closed from south by the enormous central range of the Carpathian system bending back westward (Figure 2.)

Volcanic effusive rocks formed in the Tertiary and the mountains created by them can be found spread all along the above-mentioned Eastern Carpathians' inner concave sides facing west. For example the inner volcanic mountains of the eastern branch: the Lápos/Lăpuş Mountains, the eruptive masses of the Radna/Rodna Mts., which have their continuation in the gigantic range of the Hargita/Harghita, and farther away in the Persány/Perşani Mountains.

At the inner side (the more or less western or south-western turn) of the branch of the western mountain ranges the continuation is the isolated tiny volcanic points of eruption of the Meszes/Meseş mountain range as well as the sprawling volcanic mass of the Vigyázó/Vlădeasa.

The flowing volcanic lava mass of the latter was injected in, and filled up the radially faulted fissures of the crystalline mass of the Bihar/Bihor mountains. A similar phenomenon took place in the Transylvanian ore mountain system too, where the significant folds can be found on the fault lines of the eruptions lying in a southwestern direction, as well as in the Bánát/Banat region south of the River Maros/Mureş. Isolated from the 2 main eruptive lines mentioned above minor lava effusions can also be detected in the small range of the Cicsó/Culmea Brezei Mountains.

Only mainly at the edges of the Tertiary basin can we detect with few interruptions mountains built up with crystalline shales and Mesozoic strata, while from the Palaeozoic strata the Devonian layers, occurring in patches, play an inferior role.

Generally speaking, the Tertiary deposits are regular and simple in the northern part of the basin. All along the northern and western edge the older Tertiary layers, reclining with few exceptions on the edge mountains with a slight dip (5-20°) and surpassing it only at few points, slope facing the middle of the basin. As a result of this, ever younger Tertiary sediments follow one another closely from the edge towards the middle part.

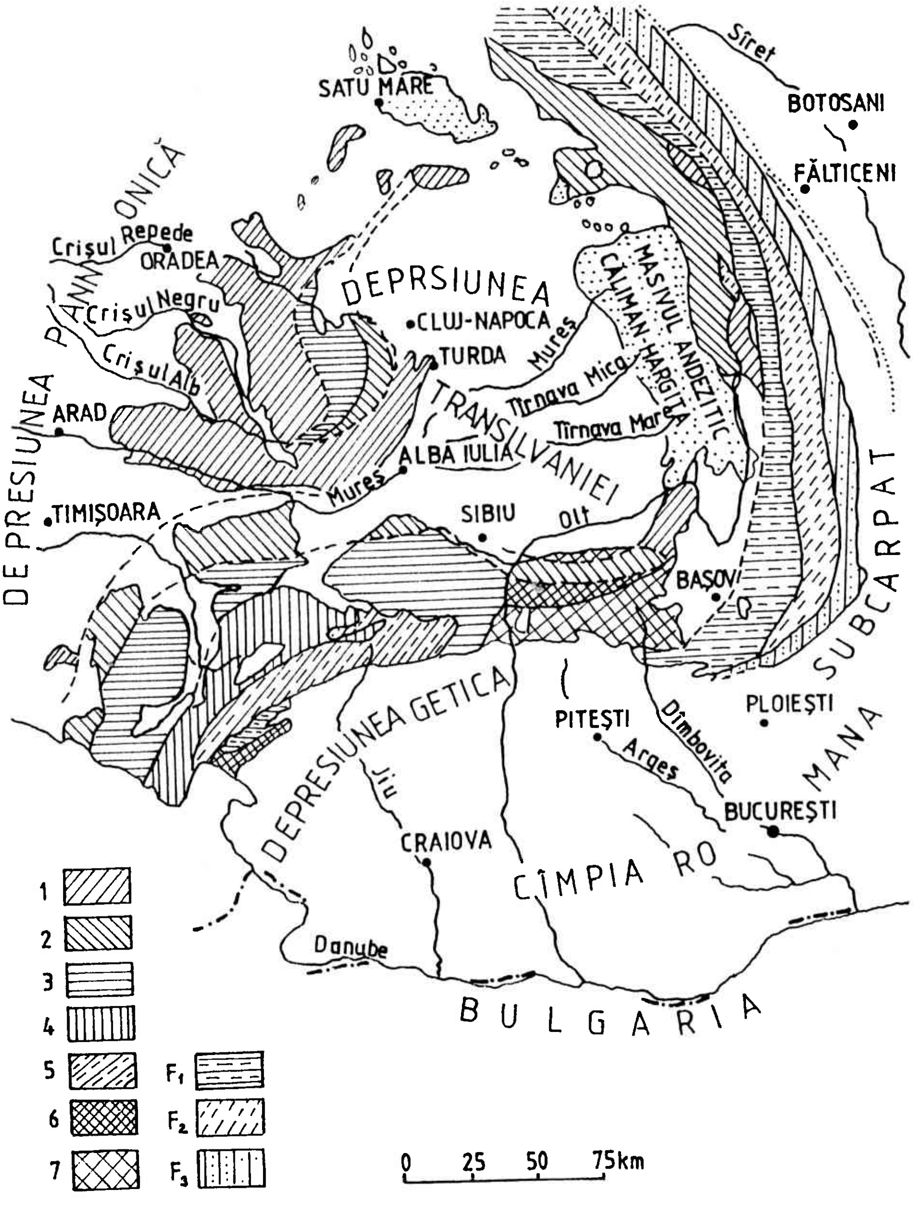

Figure 2. Structure of the Carpathians

1. Transylvanian cover
2. Bukovina/Bucovina cover
3 Geta cover
4. Retyezát/Retezat-Sivinila cover
5 Kazán-Cserna/Cazan-Cerna cover
6. Vaskapu/Porţile de Fier cover
7 Bucsecs/Bucegi conglomerate
F1 = Sirius sandstone
F2 = Fusaru cover
F3 = rim cover

We can find certain traces of considerable layer disorder, fold-faults, faults and folds in the northwestern quarter of the basin, along the edge mountains. There the fault lines and the fold axes run parallel with the edge mountains or with the line of strike of the nearest crystalline shale islands.

In the south of the Transylvanian Basin, especially at the eastern and southern edges we find most of the older Tertiary layers subsided and covered by younger Tertiary layers. Some broken off pieces of older deposits, however, have emerged or are stuck up here and there.

Lower Tertiary layers at the western and southern edges overlay unconformably the Mesozoic and Palaeozoic strata or directly the crystalline shales too.

This undoubtedly suggests that the emergence of the contiguous dry land did not only commence towards the end of the Mesozoic era in the southern and western quarters of the Transylvanian Basin, but it might have been in such an advanced stage before the Tertiary that a solid frame of the future basin was formed on this land. On the northern and eastern rim there could be only a few individual island masses of various size emerging from the embrace of the open sea, and therefore the Transylvanian Basin, which was to be enclosed later, could be an open sea gulf to the north and the east, forming a parallel strip with the eastern volcanic range.

Similarly, a second eruptive core formed inside the basin constituting the cones of the Avas/Oaş Mountains in Szatmár/Satu-Mare County. All the other Tertiary eruptive rocks, without exception, are situated within the above mentioned main eruptive line.

Structural and morphological evaluation of the mountain frame surrounding the Transylvanian Basin

1 Eastern Carpathians

It is the crystalline range of the Eastern Carpathians that the valley of Aranyos/Arieş-Beszterce/Bistriţa closing the Northeastern Highlands etched into beyond the Radna/Rodna Mts.. From there down south as far as the 1240 m high Törcsvár/Bran Saddle along the eastern border of Transylvania lies the significantly upfolded Eastern Carpathian mountain system. It is built up by a heavily upfolded sandstone (flis) belt, a very well-developed cliff belt with sporadic shreds of a puny border-Mesozoic cover, a crystalline belt covered on the outer side and a volcanic belt with excellent facies. The sandstone belt, poor in fossils, consists of Mesozoic and Tertiary sandstone, shale, marl and conglomerate. The period of its intense upfolding came connected to, but only after the upfolding of the same belt in the Northwestern and the Northeastern Carpathians in the Tertiary. Therefore orogeny in the Carpathians gradually spread and faded in space and time from north to east and later to south, which is also proven by the folding of the foreground of the Eastern Carpathians (the sub-Carpathian belt) at the end of the Tertiary (Pliocene). The formation of the volcanic range took place at the same time as the folding of the sandstone belt. Volcanism is of the Sarmatian and the Pliocene, but it extended even into the Pleistocene. Orostructural studies would formerly ascribe the creation of the central crystalline zone and the cliff belt to the development of one single large cover fold. Later research, however, discards the assumption of this cover fold and considers the crystalline range one single large Upper-Cretaceous anticline. The formation of the cliff belt is of the Tertiary.

Parallel to the upfolding of the mountain both its erosion and structural division were in process. Block surfaces, and among the blocks, basins formed. Tertiary orogenesis later caused the great elevation of the sandstone-belt blocks. Revived river activity, erosion etched deep valleys into the surface. The erosive activity of the rivers was not disturbed even by the ice age because the mountain masses with the exception of the Kelemen/Căliman Mountains did not rise above the Pleistocene ice-age snow line (Figure 3.).

The Tertiary volcanic range run parallel to the crystalline range. Andesite eruptions begin at the southern foot of the Radna/Rodna Mts. already, but extruded to form high mountains only in the Kelemen/Căliman Mts. The mountains are a series of volcanos, the highest point is a 2102 m high brim fragment of a large caldera (a collapsed volcanic cone), the formerly glaciated Pietros. The very rarely inhabited mountainous region is covered by vast forests. Around its foot there are a number of locations of volcanic tuff accumulation. It is these andesite tuffs that the Maros/Mureş etched its valleys through, and to the south of it comes the second member of the volcanic range, the mass of the Görgény/Gurghiu Mts. It consists, in fact, of two huge volcanos - the Fancsal/Fîncel and the Mezőhavas/Saca -, of the lava flows covering the slopes, and of the tuff accumulations. The heavily intersected, 1684 m high Fancsal/ Fîncel Peak is a steep ridge, which is separated from the exceptionally beautiful and regular, 1777 m high cone of the Mezőhavas/Saca by the deep valley of the Görgény/Gurghiu Stream. It is an enormous caldera with steep walls, which has been crosscut by the Székely/Secuiu Stream. The unbroken, fresh forms of the cone, an initial stage of erosion, the presence of the volcanic tuff that fell on the gravel field on the Upper Pleistocene terrace of the Maros/Mureş running at the foot of the volcano at Gyergyóremete/Remetea, and other proofs all testify that the volcanism of the Görgény/Gurghiu Mts. and the Hargita/Harghita did not end in the Tertiary, on the contrary, even ancient man might have witnessed the gradually weakening volcanic activity.

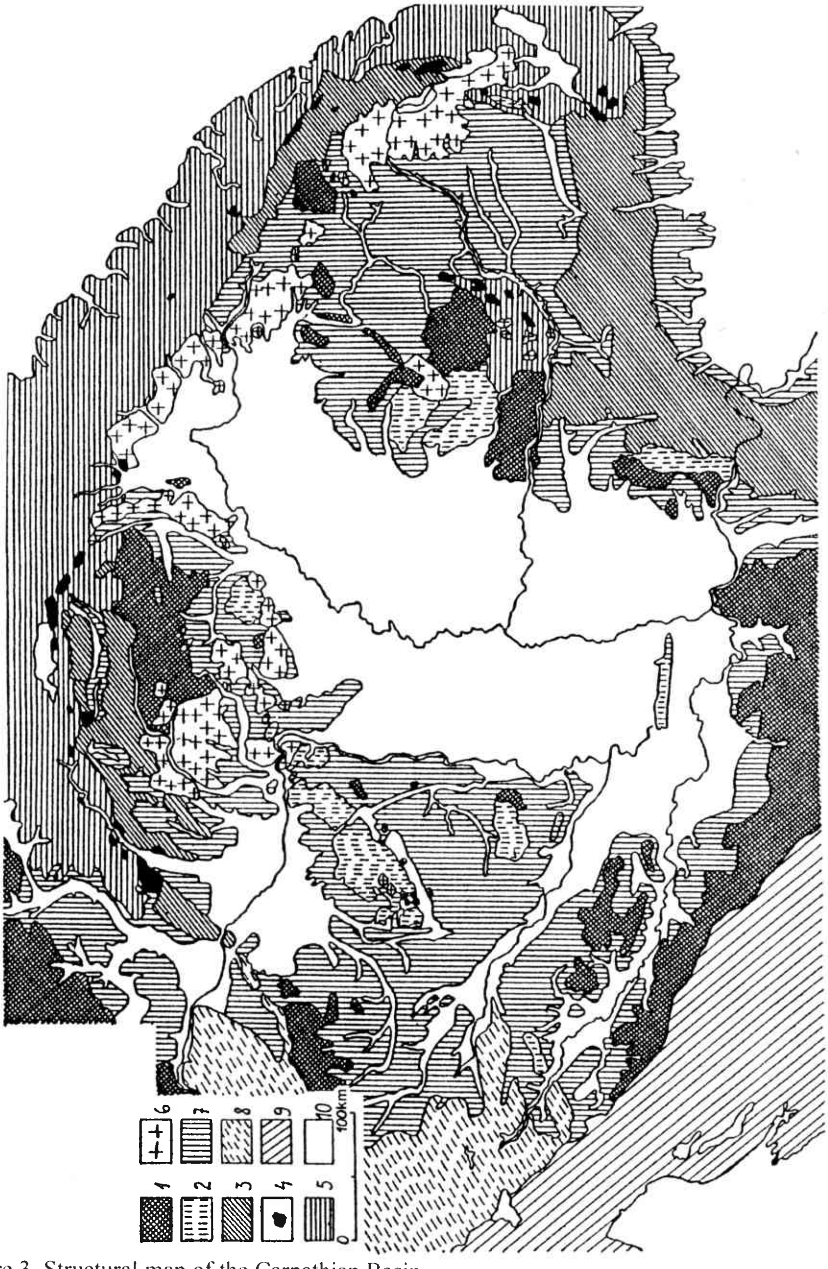

Figure 3. Structural map of the Carpathian Basin

1 Palaeozoic blocks, 2. Blocks covered by Mesozoic deposits,
3. The crystalline ranges of the Carpathians and the Southern Carpathians,
4. Carpathian limestone range, 5 Carpathian sandstone (flis) belt, 6. Tertiary volcanic mountain masses,
7. Tertiary hillocky and hilly areas, 8 the Alps, 9. the Dinaric Alps, 10. Plains, basins and flood plains

2 The Eastern Island Mountains

Lying between the valleys of the Maros/Mureş and the Visó/Vişeu, closing the Transylvanian Basin in the west, the indented Eastern Island Mountains, laid out in depth, are not, by far, a solid mountain wall like the one we encounter in the Eastern and Southern Carpathians. It is a block range of various height, history and fate, a group of the parts of the Variscan Magyar massif that remained on the surface, through which wide passages and gates lead from the Great Plain to the Transylvanian Basin between the individual blocks. In its eastern and northern parts, elevated high and without cover, it is the base mountain range that is on the surface represented by the Gyalu/Gilău and the Radna/Rodna Mts. In the Gyalu/Gilău Mts. it is in the form of wide block surfaces, in the Radna/Rodna Mts. it is intersected by ice-age glacial erosion, and characterized by bold shapes; in its western part in the Bihar/Bihor and the Bél/Codru Mountains as well as in Királyerdő/Pădurea-Craiului the subsided crystalline massif hardly surfaces. By contrast, large areas are covered by Mesozoic limestone layers and by the karstic, platform limestone mountains carved from them. Yet another type can be seen in the Hegyes/Highiş, the Drócsa/Drocea and the Szilágyság/Sălaj mountainous area. Low crystalline blocks and lumps resembling those of the island mountains between the rivers Dráva and Száva surface, from which the Mesozoic alluvial cover eroded long ago.

With regards to the creation of the Carpathians the Island Mountains underwent an especially significant change. At the time of the Cretaceous orogenesis not only its southern edge piled up and scales and covers formed in the southern part of the Bél/Codru and the Bihar/Bihor Mountains, but also a Carpathian-type mountain range, the Transylvanian ore mountains, lying in the same direction as the Eastern and Southern Carpathian ranges, folded up on the southeastern edge.

At the time of the Miocene orogeny it broke into many pieces, and the pieces settled at various levels. Along the fault lines the glowing, flowing rock dough, the lava broke up to the surface at a number of locations. It occupies an especially large area in the north of the Bihar/Bihor with the huge dacite cover of the Vigyázó/Vlădeasa (Figure 4.).

The first member of the range is the Transylvanian ore mountains between the valleys of the Maros/Mureş, the Fehér-Körös/Crişul Alb and the Aranyos/Arieş. Its northern part is even cut off by the Aranyos/Arieş. It is separated from the crystalline mass of the Zaránd/Zarand Mts. by the structural line that can be drawn from Körösbánya/Baia de Criş through Brád/Brad to the Maros/Mureş. East of the line rocks of Tertiary volcanism (andesite lava, tuff) cover the relief. This part is a wooded, gentle mountainous area, inside its mountains reefs, formed by a post-volcanic impact, hide the richest gold ores of Europe in the regions of Zalatna/Zlatna, Nagyág/Scărîmb, Brád/Brad, Abrudbánya/Abrud and Verespatak/Roşia Montană. Volcanism reoccurred in the Pliocene bringing basaltic lava to the surface. The two Detonata mountains were built up from this, with their great basalt of columnar jointing.

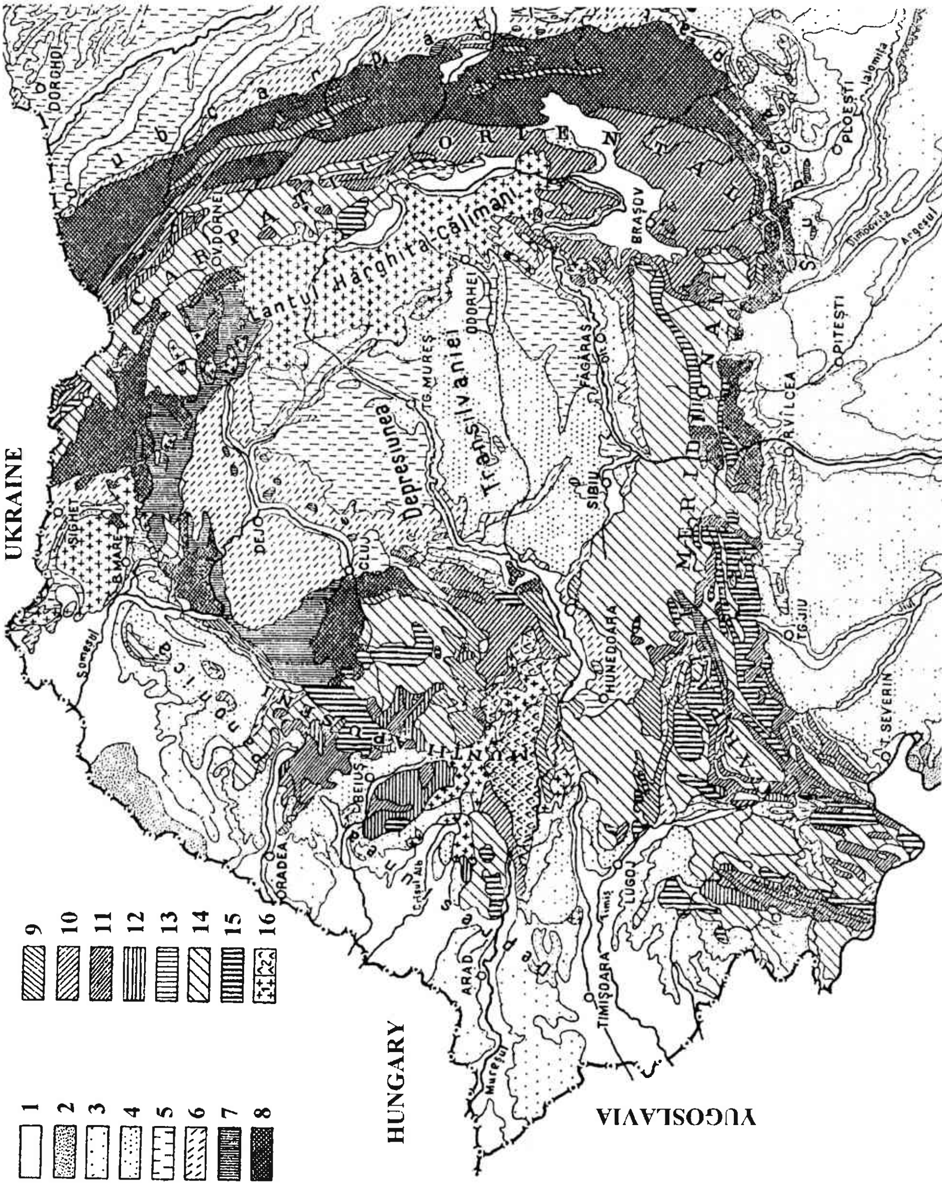

Figure 4. Simplified geological map of Transylvania by Harta geologica a RPR (Grigoraş 1961)

1. Alluvium, 2. Dune sand, 3. Pleistocene, 4. Upper Miocene-Pliocene, sandy and marls, 5. Sarmatian, sandy and marls, 6. Badenian, marls, limestones and tuffs, 7. Oligocene and Egerien, marls, limestones and, 8. Paleogene, marls, limestones and sandy, 9. Middle and Upper Cretaceous, limestoness, sandstons and marls, 10. Lower Cretaceous, predominantely limestones, 11. Triasic-Jurasic, predominantely limestones, 12. Carboniferous-Permian, conglomerats, sandstons, 13. Silurian-Devonian, 14. Crystalline rock, 15. Intrusive magmatic rocks, 16. Extrusive magmatic rocks (1) Terciary, (2) older

Northeast of the line from Körösbánya/Baia de Criş to Szászváros/Orăştie the Cretaceous sandstone folds interspersed by Jurassic limestone cliffs surface from under the volcanic rocks. Among the limestone cliffs the biggest and most beautiful are the Vulkán (1266 m), the Csáklya/Cetii (1233 m) and the Székelykő/Piatra Secuiului (1130 m). The composition of the mountain range is varied, so its shapes are picturesque, especially in its northern part, where the mountain range is broken through in the form of epigenetic limestone ravines, by the Aranyos/Arieş (the scenic Borév/Buru Pass), by the Hesdát/Haşdate (Torda/Turzii Gorge) and by the Túr/Tur (Túr/Tur Gorge). Beyond the Túr/Tur Gorge Tertiary deposits of the Transylvanian Basin cover the mountain range.

In the western continuation of the Transylvanian Ore Mountains we can find the low, wooded, sideways elevated crystalline block mountains of the Zaránd/Zărand. The northern and western slopes of the 600-800 m high mountains are overlain by andesite tuff. These gently undulating hills are the famous wine producing Aradi Hegyalja. On one of the broken-off pieces of the mountains that end with a fault in the west are the ruins of Világos/Şiria Castle, while in the southern part the Maros/Mureş etched an epigenetic valley cutting off Lippa/Lipova Castle from its area.

The wide, tectonic valley basin of the Aranyos/Arieş separates the Gyalu/Gilău Mts. from the Transylvanian Ore Mountains. This is a quite considerably folded, wide block-type mountain range consisting of crystalline shale. Its middle part is occupied by a large granite stock. The Kalotaszegi Basin/Depresiunea Huedin, part of the Transylvanian Basin, runs deep into its northern quarter. The formations of the flat block surface are determined by the rock composition, by the different qualities of soft crystalline shale and hard granite, which are manifested by erosion. Streams etch terraced valleys of slight dip into soft shales, and narrow gorges into hard granite. On the wonderfully even alpine pastures of the wooded mountains - with an average height of 1200-1600 m, and with the highest point, Nagy Havas/Muntele Mare, 1827 m - livestock is grazed. Concerning the landscape, what is nice here is the deep valleys of the Hideg-Szamos/Someşul Rece and the Meleg-Szamos/Someşul Cald and the Jára/Iara Stream.

The northwestern part of the Gyalu/Gilău Mts. and partly the neighbouring area of Bihar/Bihor are covered by Tertiary dacite lava. The hard dacite lava (hence the term „dacogranite" for the rock of the dacite mine at Kissebes/Poieni) covers all kinds of rocks. It is the Jád/Iad, Dragán/Drăgan and the Sebes/Sebeş streams that etched deep valleys into it. Wooded tablelands alternate with alpine pastures. The highest point of the area is the 1838 m high Vigyázó/Vlădeasa with faint marks of Pleistocene glaciation.

The Belényes/Beiuş Basin, the Gyalu/Gilău Mts. and the Transylvanian Ore Mountains surround the Bihar/Bihor Mountains proper. Its base is a heavily folded and abraded crystalline shale massif; a huge cover of Permian and Mesozoic alluvial deposits (mainly limestone) lie on its surface. The limestone layers of the overthrust cover are rich in karstic phenomena (Szkerisóra/Scărişoara ice-grotto), but are barely surveyed yet. The Meleg-Szamos/Someşul Cald ravine is outstanding with its romantic beauty, with a number of caves and the famous Oncsásza/Onceasa bone cave, with a great many of dolinas and sinkholes on the top. The highest peak of the wooded, rarely inhabited mountain range is the 1849 m high Nagy-Bihar/Bihor with faint marks of glaciation. Its southern neighbour, the wide Gajnatető/Găina (1486 m) is famous for the variegated Romanian „maiden fairs".

The Belényes/Beiuş Basin, filled with Tertiary strata and covered by loess, separates Bihar/Bihor and the 1114 m high Bél/Codru Mountains (Moma-Codru Mts.). Inside it the subsided Variscan crystalline shale base mountains are covered by a Permian and Mesozoic (Triassic and Jurassic limestone) layer, which is heavily folded in the southern edge. The Permian sandstone settled in the north and west, the limestone in the northeast and south. The southwestern corner of the range is also covered by andesite tuff. The limestone cover is considerably karstic. The periodic karst spring, the Izbuk at Kalugyer/Izbucul de la Călugări is notable.

In the western foreground of the Bél/Codru Mountains there is a mild, loess-covered hillocky area built up with Pannonian layers, and it connects in the north to the Tertiary hillocky region of Nagyvárad and environs, and the Érmellék/Câmpia Erului. From it emerges the 500-550 m high limestone plateau of the wooded, rarely inhabited Királyerdő/Pădurea-Craiului, which is rich in karstic phenomena (some limestone cave, formerly a cave, of the Sebes/Sebeț).

From the valley of the Sebes Körös/Crişul Repede to the Radna/Rodna Mts., the region of the Szatmár/Satu-Mare and the Szilágyság/Sălaj hillocky and hilly areas are covered by Tertiary layers. They are Eocene limestone tables, Oligocene deposits, which were nearly transformed into a mountainous area by uneven elevation and the creation of valleys. At the western side of the hilly area they are loess-covered, sandy, argillaceous Pannonian deposits from the region of Nagyvárad/Oradea, through the wine producing downs of Érmellék/Câmpia Erului to the Nagybánya/Baia Mare Basin. The landscape, especially between the Meszes/Meseş, Réz/Plopişului and Avas/Oaş Mountains, reminds us approximately of the Transdanubian hillocky areas of Zala and Somogy. It is the „rough, old Szilágyság“ with the wide valley basin of the Kraszna/Crasna, the Szamos/Someş and the Berettyó/Barcău; a wide gate area towards the Transylvanian Basin. The Tertiary hillocky area slopes along the fault line towards the Câmpia Tisei/Great Plain. The rich spas of Püspökfürdő/Baile 1 Mai and Félixfürdő/Băile Felix bubble up beside the fault.

From the Tertiary hillocky area three wooded blocks, the 758 m high Réz/Plopisului, the 990 m high Meszes/Meseş and the 575 m high Avas/Oaş Mountains emerge. The base of all three is crystalline shale with a Tertiary cover on it. The Réz/Plopişu is almost uncovered, in the Meszes/Meseş and the Avas/Oaş there is Eocene limestone lying on the block of the crystalline shales. The nearly 1000 m high Meszes/Meseş emerges steeply from the Szamos/Someş valley along the fault. The fault line is indicated by volcanism. Beside the regular, cone-shaped Várhegy of Mojgrád/Moigrad are the relics of the Roman Porolissum.

In the continuation of the Meszes/Meseş, crystalline rocks surface even beyond the Szamos/Someş valley, in the western and eastern part of the Eocene and Oligocene tableland between the Szamos/Someş and the Lápos/Lăpuş, at the bend of the Lápos/Lăpuş. This small crystalline rock is indicated as the Preluka/Preluca Mountains by certain maps, while the tableland itself between the Transylvanian Basin and the Kővár/Chioar Basin is indicated as the Ilosva/Dealurile Suplai Mountains. This is a 600-800 m high table intersected by valleys. It is densely scattered with villages, but on the ridges there are a lot of forests, too. The Ilosva/Dealurile Suplai Mountains slope onto the Lápos/Lăpuş Basin in the north. At its northeastern edge, between the Gutin/Gutâi and the Cibles/Ţibleş, the watershed tableland, which is built up by the Lower Tertiary deposits of the Tisza/Tisa and the Szamos/Someş, emerge like a mountain range. This is the Lápos/Lăpuş Mountains. The peacefully lying Eocene and Oligocene strata rise up to 1000 m, there are separate volcanic cones (Gutin/Gutâi, Priszlop/Prislop, Cibles/Ţibleş) sitting on them.

Between the Ilosva/ Dealurile Suplai Mountains and the Meszes/Meseş Mountains lies the Zsibó/Jibou Basin, and between the Ilosvai Mountains, the Lápos/Lăpuş, the Gutin/Gutâi and the Avas/Oaş lies the nice Kővár/Chioar Basin. The two are connected together by the Szamos/Someş valley in the Cikó/Ţicău Pass (Figure 5.).

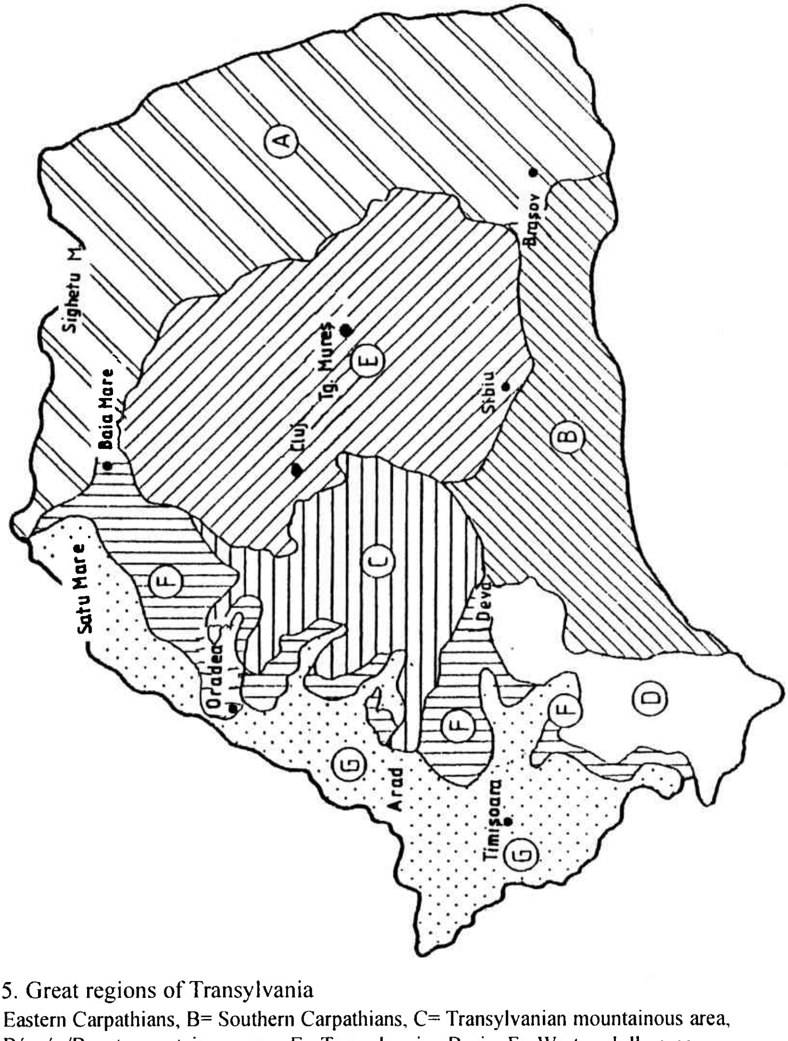

Figure 5. Great regions of Transylvania

A= Eastern Carpathians, B= Southern Carpathians, C= Transylvanian mountainous area, D= Bánság/Banat mountainous area, E= Transylvanian Basin, F= Western hilly area, G= Great Plain (after the monograph Geografia României, vol I)

The last, easternmost and highest member of the Eastern Island Mountains is the Radna/Rodna Mts.. It is built up predominantly by crystalline shale. Its sharp watershed ridge spreading E-W, surpassing 2000 m (Nagy Pietrosz/Pietros 2305 m, Ünő-kő/Ineu 2280 m) was significantly glaciated in the Pleistocene ice age. There are large trough valleys, tarns, firn fields and moraine mounds here. The lower regions are covered by vast forests. At the eastern end of the mountains the 1257 m high Radna/Rodna Saddle lead over to the valley of the Aranyos-Beszterce/Bistrița-Aurie.

The Transylvanian Basin

In the mountain framework described previously the Transylvanian Basin occupies more or less a middle position, whose northern half bears the River Szamos/Someş and its river system.

The basin narrowing from south to north is surrounded by mountainous border areas all around. With the uneven subsidence of the Tisia massif, among the Carpathian basins it was the Transylvanian Basin that subsided the least and whose subsidence stopped first. That is why the height of its surface is greater than the others'. Average height of the basin is 500-600 m, and because the low surface of the Great Plain is the erosion base of its rivers, the surface of its basin-filling layers was broken into pieces by the river valleys, and an erosive hilly region with deep valleys formed.

The basin was in wide and open contact in the northwest with the basin and the sea of the Great Plain until the Lower Tertiary. In the Miocene this contact was very narrow, and was probably confined to the narrow strait which stretched from the Déva/Deva region to the present upper valley of the Fehér Körös/Crişul Alb. In the Lower Miocene, therefore, the inland sea of the basin came into such conditions that it received less fresh water than the amount that evaporated from it. The water loss was replaced by salt water flowing in through the strait, so the sea water of the basin slowly became saturated salt solution, the salt even precipitated and quite thick rock-salt beds came into existence at the bottom of the basin in the argillaceous sea sediments.

The basin and its environs went through a considerable surface development in the Tertiary. The recurring regional subsidence and elevation resulted in a deposit fill of quite heterogeneous composition. One significant change of these occurred along the northwestern rim at the end of the Cretaceous and the beginning of the Tertiary. It was then that the varied unit strata, already containing sandy, gravelly deposits from dry land, came into being and was present in significant thickness at the western coast of the Transylvanian Eocene bay. This considerable accumulation shows the activity of the rivers as well, which cooccurred with the redistribution of the deposit.

Huge mud drifts formed, behind which lagoons and sea swamps came into existence filled partly with semi-salt water and partly with fresh water swamp deposit.

The other important change in the relief took place about the middle of the Middle Eocene, again at the northwestern coastal area. It was the result of rather the filling up of the coastal belt by sea deposits in the course of time than the elevation of this area.

The water from precipitation flowing in from the land carried a great deal of alluvium again, containing large pieces as well, into the shallow coastal belt, and through creating drifts lagoons and coastal swamp areas were formed again. Because of the continued subsidence of the coastal area, towards the end of the Middle Eocene it was the salt water of the sea again that flooded the former coastal swamps. It was from this sea that the upper coarse lime layers deposited along the coast.

A slow emergence of the coastal line of the Transylvanian sea bay began to manifest itself in the Oligocene, which cooccurred with the change of the semi-salt and freshwater fauna. Similarly, the commencement of the Tertiary volcanic activity falls on the beginning of the Middle Oligocene because it was then that quartz trachytoid and probably trachytoid volcanic lava broke to the surface.

Consequently, the Transylvanian Basin closed to the east as well in the Upper Oligocene, lost its direct contact with the mediterranean open sea, but might have been connected with the northeastern European sea to some extent. In the first stage of the Miocene, namely the Aquitanian stage, the same conditions of deposition continued in the now Transylvanian inland sea, and as a result, deposits still containing carbon settled at the eastern foot of the Meszes/Meseş range.

From the beginning of this stage, however, intense mountain elevation restarted, which resulted in the termination of the contact with the northeastern open sea as well. After that the Transylvanian inland sea retained its communication with the mediterranean sea only through the Hungarian mediterranean sea bay.

The Lower Mediterranean Nádaskóród/Coruş sand and the Hídalmás/Hida layers deposited in the already completely enclosed Transylvanian inland sea, which could only communicate with the mediterranean inland sea of the Hungarian Basin through some fissures of the Meszes/Meseş Mountains and in the southern part of the ore mountains, and which was perfectly closed off in the north and east from the open sea situated in the northeast.

At the beginning of the Upper Mediterranean stage the lateral thrust operating from the south reached its peak in the old mountain ranges of the Transylvanian Basin, which brought about the commencement of the intense activity of the andesite volcanos on the fault lines. Volcanic activity was started by the enormous dacite eruptions of the Vlădeasa in the northwest, continued with the eruptions of the dacite and biotite andesite of the Radna/Rodna Mts.. The dacites settled on the bottom of the inland sea with a tremendous amount of ash and volcanic substance, forming a sequence of Upper Mediterranean deposits. Apart from the volcanic substance argillaceous marl silt and argillaceous sand, washed in from the dry land surrounding the basin, deposited abundantly on the bottom of the inland sea, interspersing time and again the thin interbedded layers of the ash of the future dacite eruptions.

The Transylvanian inland sea had to be closed off for a long time from the ocean for the thick rock-salt and gypsum beds to form. The salt water of the completely enclosed inland sea slowly evaporated under the influence of the then tropical climate, and after the salt solution reached saturation the gypsum and later the rock-salt had to precipitate from it in the deepest regions of the basin, and blended together in the deepest part of the basin because of the leaching effect of rainwater, and thus formed substantial beds.

This era was followed by the incursion of the ocean again, and the basin was filled with salt water again even in the Upper Mediterranean. The incursion of the sea may probably have taken place from the Hungarian inland sea, along the line of the Maros/Mureş. The sea covering the already settled salt beds with its silt now started slowly to freshen together with the enclosed Hungarian inland sea, and, according to the quite unique mixed organic remains held in the silt deposits above the salt beds, it deposited layers resembling very much the abyssal sediments of the present Black Sea.

At the same time, dacite lava eruptions may have happened again and again, followed by eruptions especially rich in ash, which settled in the upper layers, too, as tuff. The activity of the small volcano of the Csicsó/Ciceu Mountain and the formation of the dacite mountains of the Transylvanian Ore Mountains, especially of the Csetrás range, fall approximately on the end of this era.

With the coming of the Sarmatian the Transylvanian inland sea maintained a contact with the Hungarian inland sea only along the line of the Maros/Mureş, and was freshened more and more by the increasing amount of precipitation of the dry land.

Most of the Pontic freshwater inland lake, however, drained along the line of the Maros/Mureş towards the end of this era, but at the eastern and western bases of the Persány/Perşani Mountains some freshwater lakes of considerable size remained longer, and from them an abundance of sediments settled again in the first half of the following stage, the Levantian. Among these sediments there are not only lacustrine marl, clay silt and lignite, but also a great amount of basalt detritus from the Olt and andesite detritus of Hargita/Harghita, partly separately and partly mixed together. This indicates that the volcanic activity of the prevailing pyroxene andesites of the southernmost peak of Hargita/Harghita and the basalts along the Olt falls on this last stage of the Tertiary, and it must have lasted until the end of the Tertiary, if not extending even perhaps into the Quaternary.

The catchment area of the Szamos/Someş-Kraszna/Crasna

The wide alluvial valley of the Maros/Mureş divides the Transylvanian Basin into two, which are physiographically different. North of the Maros/Mureş sprawls the Mezőség/Câmpia Transilvaniei; in the west as far as the dacite tuff hill range from Torda/Turda through Kolozsvár/Cluj to Dés/Dej, in the north as far as the foot of the Ilosva/ Dealurile Suplai Mountains, and in the east as far as the eruptive range of tuff hills of the Kelemen/Căliman-Hargita/Harghita. The Mezőség/Câmpia Transilvaniei is a hillocky area with an average height of 400 m. There is no sign of regularity in the relief. The hillocks are situated irregularly among the valleys, in a way that the watercourses divided them. The often soggy valleys are meadows, the hillsides are plough-lands, the flat hill ridges, on the other hand, are barren, scattered pasture areas, hence the term Mezőség/Câmpia Transilvaniei.

The Almás/Almaş Basin lying surrounded by the Meszes/Meseş Mountains and the dacite tuff hills of Kolozsvár-Dés/Cluj-Dej also belong to the Mezőség/Câmpia Transilvaniei proper. In it Oligocene and Eocene deposits come to the surface all around from under the Miocene sediments. It is for the most part the drainage basin of the Almás/Almaş Stream.

A characteristic feature of the relief of the Mezőség/Câmpia Transilvaniei is that the valleys meander capriciously, without any regularity between the randomly situated hill ridges of Miocene salt substances, marl, sandy layers and tuff. The hill ridges are arid, the flora on it is scanty because of the infertility of the soil. In the valleys with impermeable argillaceous soil small ponds and puddles stagnate.

The Transylvanian Basin lacks the substance so characteristic of the interior of the Carpathian Basin in the cold and dry ice age, loess. There are, though, loess-like substances here and there at the foot of the slopes and on the river terraces, but they are not typical: they are stratified, polluted and mainly flood-plain deposits (Figure 6.).

These clays, including the Pannonian ones, but especially the mediterranean salt clay and the Oligocene clay are impervious rocks. If they get wet they will become plastic, mouldable, and the great phenomena creep and landslide take place.

Solifluction was an important factor in the ice age concerning the transportation of mass and the decrease of the difference in levels. The dust that fell on the clayey slopes could not become loess because the impervious soggy clay, which was frozen in winter and thawed in summer, slowly moved like a mud slide on the slopes under gravitational force, and because of the alternation of freeze and thaw with a vermicular motion, down to the foot of the slopes together with the dust mass that fell on the surface, and from there the watercourses transported them off.

The large-scale movement of substance under gravitational force, landslip can at various places be detected. This phenomenon occurs especially in the northern quarter of the basin, where the „Mezőség/Câmpia Transilvaiei substances“ are situated on the surface or under the thin Sarmatian-stage cover.

Layers at the edge of the basin lie peacefully, in the interior parts, however, folds of NW-SE direction formed (so-called domes) which contain rock-salt and a valuable hydrocarbon compound (natural gas).

Ice ages occurring in the Pleistocene forced the rivers of the Transylvanian Basin to change tract. They filled up the bottom of their valleys with gravel. Then in the interglacial periods the rivers etched into the sedimented bottom of the valleys, and transformed them into terraces. Within the basin terraces 3 (Middle Pleistocene) and 4 (Lower Pleistocene) can be found in 15-23 and 43-60 m high relief facies in the river valleys.

Distinctively well-formed terraces can be detected in the Nagyág/Săcărâmb Basin, situated in the northern border area of the basin. We can also find the Cikói crystalline shale block in the Lapos Mountains consisting of crystalline shale, which our geological maps and several descriptions designate as the Preluka/Preluca Mountains, and the Cretaceous-Eocene-Oligocene watershed tableland, indicated in turn as the Lápos/Lăpuş Mountains by geological maps, separating the Transylvanian Basin from the Maramuresh Basin, and including the adjoining Oligocene (Chattian-stage) erosive hilly area and the Lápos/Lăpuş valley basin.

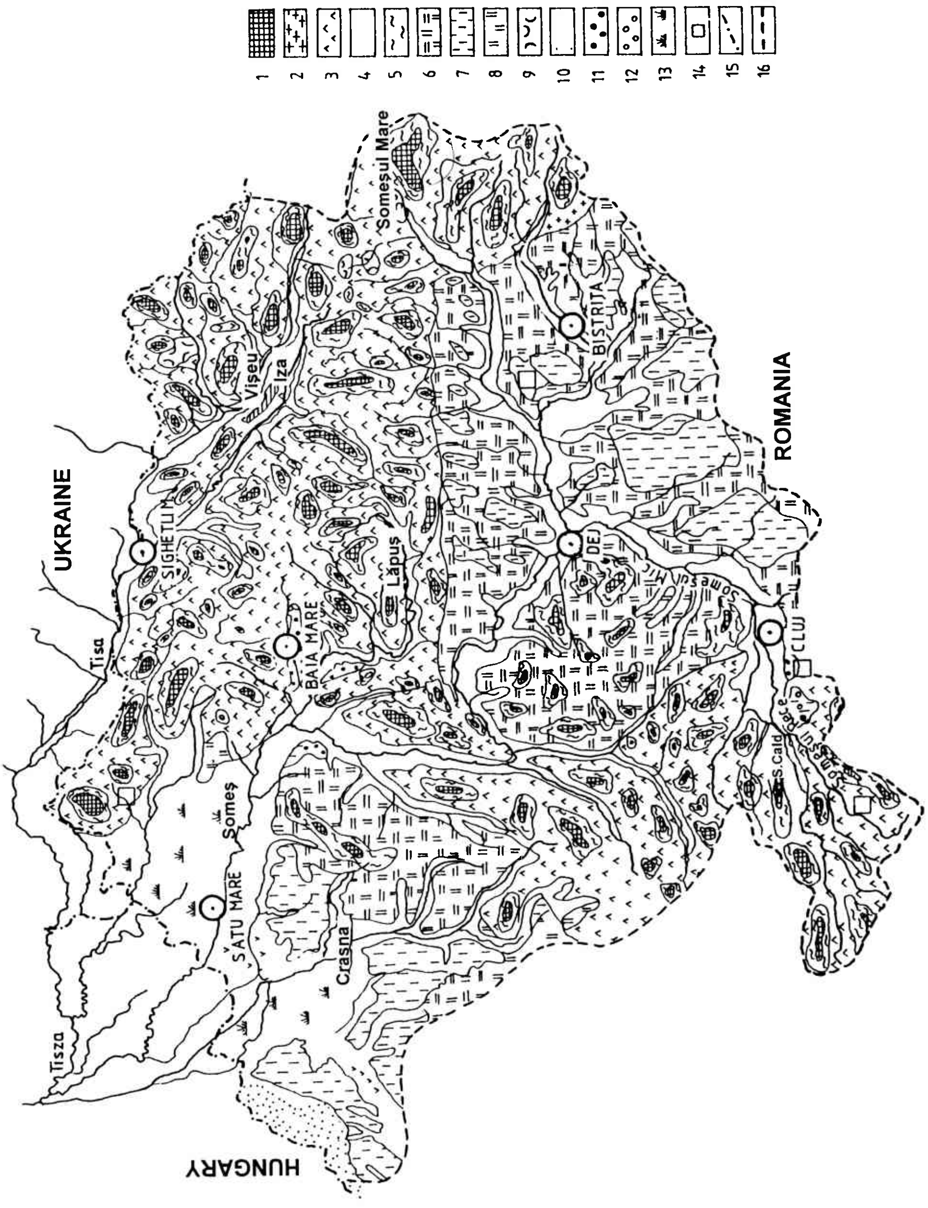

Figure 6. Genetic features of the Quaternary sediments in the catchment area of the Szamos/Someş-Kraszna/Crasna

1 marine sedimentary formations, 2. volcanic complexes, 3 delluvial formations, 4. alluvial formations, 5. colluvial formations, 6. elluvial and delluvial formations, 7. delluvial and prolluvial formations, 8. prolluvial formations, 9 glacial deposits, 10. lolic deposits, 11. deposits formed on lower terrace, 12 deposits formed on upper terrace level, 13. swamp deposits, 14 Palaeolithic deposit, 15 Mezőség/Câmpia Transilvaniei measures, 16. depth of ground water

From now on, we are going to give an account of the terraced valley formation as standard, which holds for the whole region of the basin as well! Where the basins and the slopes of the mountain ranges are surrounded by argillaceous marly deposits (deep-sea Upper and Middle Oligocene deposits) there are erosive hilly regions that have sliding slopes, and Tertiary and Quaternary terraces formed in the river valleys. For example while the tops of the Oligocene erosive hilly region north and south of the Lápos/Lăpuş Basin are 500-600 m high above sea level, the height of the middle of the basin is only 300-350 m. The terrace gravel of the river overlay the eroded surface of the subsided Oligocene (and partly - in the southwest and west - Eocene) deposits in the interior of the basin. So the basin is the same type as the Tertiary terraced basins of the Carpathian Basin, like the Gömöri, the Nógrádi etc. terraced basins; even the Nagybánya/Baia Mare terraced basin situated in the northwestern vicinity of the Lápos/Lăpuş Mountains belongs to this group. It is precisely the terraces of the basin that testify that the relief did not subside any more at the end of the Pliocene, on its surface an accumulative plain did not form, but sedimentation was replaced by the erosive activity of the rivers.

The river created six terraces in the Lápos/Lăpuş Basin. All the terraces are typical, transitory terraces abundant in gravel. (Figure 7.).

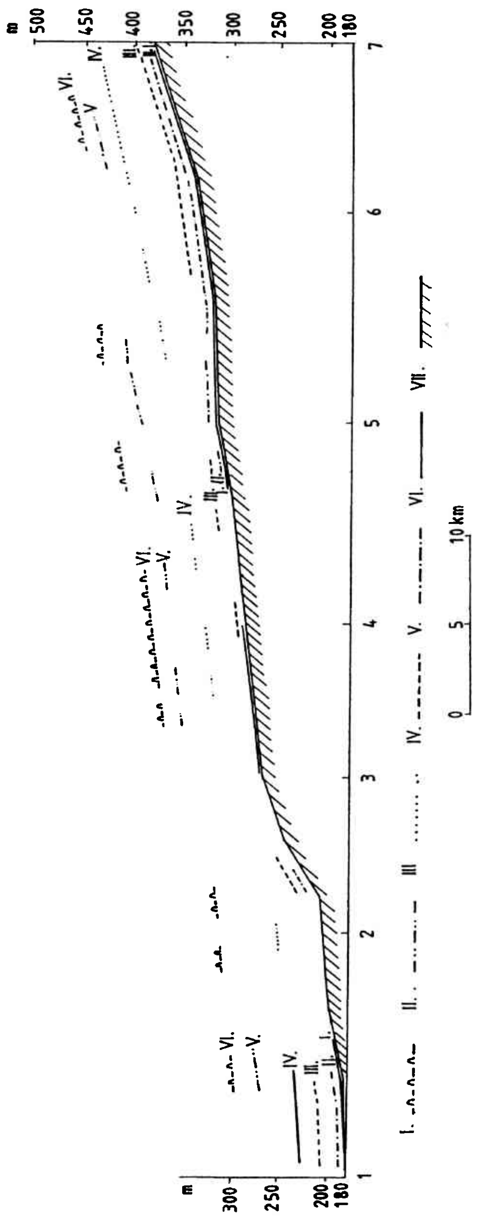

Figure 7. Longitudinal profile of the terraces of the Lápos/Lăpuş Between Oláhlápos/Lăpuş and Kovás/Coaş, and the present water level at certain locations

1. Kovás/Coaş 180 m, 2. The ruins of Kővár/Igniş 211 m, 3. Buny/Bunı Valley 271 m,
4. Ferry at Erdőszállás/Sălniţa 287 m, 5. Domokos/Dămăcuşeni 338 m, Oláhlápos/Lăpuş 384 m,
Terrace types· I. Holocene, II Upper Pleistocene III. Middle Pleistocene, IV. Lower Pleistocene, V. at the beginning of the Pleıstocene VI. at the end of the Pleistocene, VII. present water level of the Lápos/Lăpuş

Terrace 1

Both this erosion and accumulation characterize it on the present flood-plain (accumulation at high water mark, erosion at low and middle water mark). The terrace is an amphibious formation, indeed. Part of it is cultivated, and because its height above the surface of the river is 1-1.5 m, it can be called a terrace in the morphological sense, too. On the left bank of the river there is a wider strip, more than 1 km wide. Its substance is very similar in size and composition to the present deposit of the river. It is mainly much-rolled andesite gravel of various size, but quartz gravel and local gravel were also mixed in it, especially from the marly, gravelly Eocene and Oligocene strata of the southwestern stretch of the basin. Apart from gravel quicksand and silt play only an inferior role in the terrace composition.

Terrace 2, or Upper Pleistocene terrace

The valley bottom of the last ice age formed into a terrace only after the Wurmian ice age, in the postglacial period. The terrace constitutes an almost uniform surface that remains in both narrow and wide zones. Only the valleys of the affluents coming from the south intersect it on the left of the Lápos/Lăpuş. The Upper Pleistocene terrace is 4-5 m above the 1-1.5 m high alluvial terrace, so above the river a 6-7 m high bench, covered by a thick layer of adobe, rises, and behind it we reach another adobe-covered bench, which is 6 m higher and has an energetic rim. Its height, therefore, is 12 m above the river. The right-bank realizations of terrace 2 may be considered absolutely unimportant because of the powerful landslides, while on the left bank an 8-10 m high ice-age terrace surface with a steep edge rises above the river.

Terrace 3

Terrace 3 is most probably one gravelled up in the Riss ice age and etched in the last interglacial period. Its remnants in characteristic facies rise 12-14 m high above the river level on both the right and the left banks. The composition of the terrace is completely andesite gravel; only ice-age adobe overlay the top of it, which at places reaches 5 m thickness. The adobe contains mainly decayed andesite gravel.

Terrace 4

The terrace, retaining traces of sedimentation in all ice ages and the interglacial etching of the Mindelian-Riss, in typical facies with dominating features that gives the basin almost its character, characterize the beautiful terrace peninsula between the valleys of the Lápos/Lăpuş and the Szőcs/Suciu Stream on the left bank of the Lápos/Lăpuş. The more than 6 km long and at places nearly 1 km wide terrace field interspersed by branch ravines has an energetic rim. Its dip is even, the edge of its plain surface is 50 m above terrace 2, so 59 m above the river. Its exposure is scant; what it has is feeble. In the walls of the dry valleys splitting its edges we can see that its composition is heavily decayed andesite gravel. What is also evidence of the terrace's great age is that it is abundant in quartz gravel, too. The gravels are somewhat smaller and softer than those of terrace 3. The ice-age adobe formed from the falling dust overlay the gravel in a 3 m-thick layer. Absolute height of the terrace surface is 400-410 m above sea level. For that matter, terrace 4 rises from the alluvium of the Lápos/Lăpuş with a quite slight slopingness, first to 45 m, but its height further increases inward, and reaches 50-55 m above the river. On its slope the decayed andesite gravel of the Lápos/Lăpuş, mixed together with the slope detritus of solifluction, can be found at many places.

Terrace 5

It presents itself in various spots in the Lápos/Lăpuş Basin as a Lower Pleistocene formation. It rises onto a 23 m wide adobe-covered slope above the plateau of terrace 4. The composition of the terrace is heavily decayed andesite, its gravelly surface is 80-85 m high above the water surface of the Lápos/Lăpuş.

Terrace 6

It exists in a lower number, mostly as a gently sloping narrow edge at the bottom of the 500 m high Oligocene tops. It is 23-30 m further above terrace 5, so 105-110 m high above the river. In the Lápos/Lăpuş valley and basin we have not found river terraces older than terrace 6 from the end of the Pliocene, neither have we found any on the etched, meandering valley section or in the Nagybánya/Baia Mare Basin. Its either because they have eroded or, what is much more probable, because the Lápos/Lăpuş valley is not older than the Middle Pliocene or the last third of the Pliocene.

All the 6 terraces follow the present dip-line of the river regularly. There is no trace of subsequent fragmentation or possible arching that can be derived back to tectonic movements.

The disappearance of the Tertiary sea, the Pliocene subsidence of the Great Plain and the activity commencing parallel to these processes provided an opportunity to the formation of all the terraces.

Climatic features

1 Macro-synoptic conditions

The Atlantic and Mediterranean climatic effects making the climate milder exert their influence to the least degree in the catchment area of the Szamos/Someş, even in the entire territory of Transylvania. The continental features of its climate are sharp and distinctive. When giving a brief characterization of its climate we must, in any case, take into account the circumstance that its middle is an enclosed dry basin, in which the winds arrive as eddy-winds from every direction, and its borders are high mountains richer in precipitation than the basin, but having a severe climate. The continental character is most powerful in the Transylvanian Basin and in the high enclosed basins of the mountains. The winter in Transylvania is colder than in the Câmpia Tisei/Great Plain, but the summer is cooler (Dfbx- and Dfbxc climate).

So climatically the region is a border area, a meeting point of temperate western, oceanic and extreme eastern, Eastern European continental climates. Intermediate temperate continental climatic features prevail.

In this area air masses streaming from various climatic centres of impact exert their influence. The most frequent one is the Atlantic influence, called western, oceanic cyclones, which is present all year, and lasts for several days alternating. It provides 45% of all the influences. In winter it makes the severe, freezing weather milder, and brings ample precipitation. In summer it makes the climate changeable, brings abundant precipitation especially to the northern quarter of Transylvania.

The direction of the polar influence is NW-SE, and it provides 30% of all the influences. Mixed with the wet north-Atlantic air masses it causes considerable decrease in temperature, clouding and showers. One of its northern variants sometimes stretch over Transylvania in spring, summer and autumn.

Hot tropical air currents amount to 15% of all the influences. It causes great warming up. Its south-southwestern variant is an air mass streaming from the Mediterranean Sea bearing humid „mediterranean“ cyclones, while the southeastern one is an anticyclone causing the broiling weather of dry summers. The mediterranean cyclone is more frequent in winter, but it sometimes appears at the end of summer and the beginning of autumn in the southwest. Its influence manifesting itself in abundant precipitation can mainly be felt in Temesköz.

In winter, the air passing over the Mediterranean Sea makes the weather milder, and it often causes ample snowfall in Transylvania.

Air masses streaming from any centre of impact may have several variants, such as the Azorean anticyclone, the Greenland anticyclone, the Iceland cyclone, the Scandinavian anticyclone, the North African anticyclone and the Arabian cyclone. The Azorean high and the Iceland low often move combined both in summer and winter, which causes a powerful weather front activity in Transylvania, too.

The Siberian anticyclone is a winter phenomenon. It causes a great fall in temperature all over Transylvania.

The relief of Transylvania characterized by distinctive units greatly influences and changes the characteristics and effects of the air currents. The influence of the relief is dual here, too. On the one hand, local vertical temperature-based climatic zones form, caused by the differences in height, at levels between 100 m and 2544 m. These differences in climate and relief are reflected by the vegetation levels of different composition in the Southeastern Carpathians. On the other hand, the mountains and mountain ranges rise like dykes and block the air currents. This relief effect manifests itself especially in the oceanic air currents. Air currents rising on the western slopes of the Transylvanian mountainous area cause clouding and orographic precipitation, whereas on the eastern slopes of the mountain range, on the slopes facing the Transylvanian Basin, the föhn effect, characterized by dry descending air currents occurs.

Similarly, the Eastern and Southern Carpathians block the air currents as well. The western side of the Eastern Carpathians is wetter than the eastern side, and its northern part receives much more precipitation than the middle or the southern part. It is because of the „Szilágyság/Sălaj Gate“, where above the low relief humid air masses are able to advance east almost undisturbed.

On the mountain and high-hill relief characterized by distinctive units the valleys and basins alter the direction and effect of the air currents. Temperature inversion and the föhn effect are frequent, and insolation is different on the side slopes of the valleys lying in an E-W direction.

Conditions of temperature

On a relief laid out in depth, like the area of Transylvania, the distribution and manifestation of meteorological and climatic factors like solar radiation, temperature, winds, atmospheric pressure, humidity and precipitation show a different, changing picture. Annual solar radiation is 120-122 kcal/sq. cm on the plain area of the Körös/Crişul and in Temesköz/Câmpia Timişului, an average of 115-117 kcal/sq. cm on the hilly region of the Transylvanian Basin, and it is lower on average in the mountainous area, because the effects of the relief laid out in great depth and the orientation of the slopes play a more powerful role.

Depending on the degree to which the relief is laid out in depth, differences appear in the distribution of temperature as well. The air is coldest at the alpine level of high mountains. Above 2000 m annual mean temperature is 2 °C (Figure 8.).

Annual mean temperature reduced to sea level is 8-10 °C, in reality it is, of course, lower, because with every 100 m of elevation there is a temperature drop of 0.5 °C. The Eastern and the Southern Carpathians are very cold regions. Mean temperature of the hottest month does not reach 20 °C and it is about -3 °C of the coldest one.

Mean annual fluctuation is therefore similar to that of the Câmpia Tisei/Great Plain, it is even less in the western quarters of the Southern Carpathians and in the region of the Lower Danube, 22-23 °C (mediterranean impact). It is highest in the Gyergyó/Giurgeu Basin: 25.8 °C. Annual absolute fluctuation is similar to that of the Câmpia Tisei/Great Plain, too. In Nagyszeben/Sibiu 36 °C was the highest and -35 °C the lowest temperature ever measured. So the difference is 71 °C. The course of monthly fluctuation is not so uniform as in the Great Plain. The maximum of March and the minimum in June still exist, but the maximum of October (Indian summer) disappears. Daily fluctuation is usually lower than in the Câmpia Tisei/Great Plain. In winter it is 3.1-6.4 °C on average, depending on the location in question: a mountain top or a basin. Late frosts may occur even in June, early ones even in September. The number of days with frost exceeds 100.

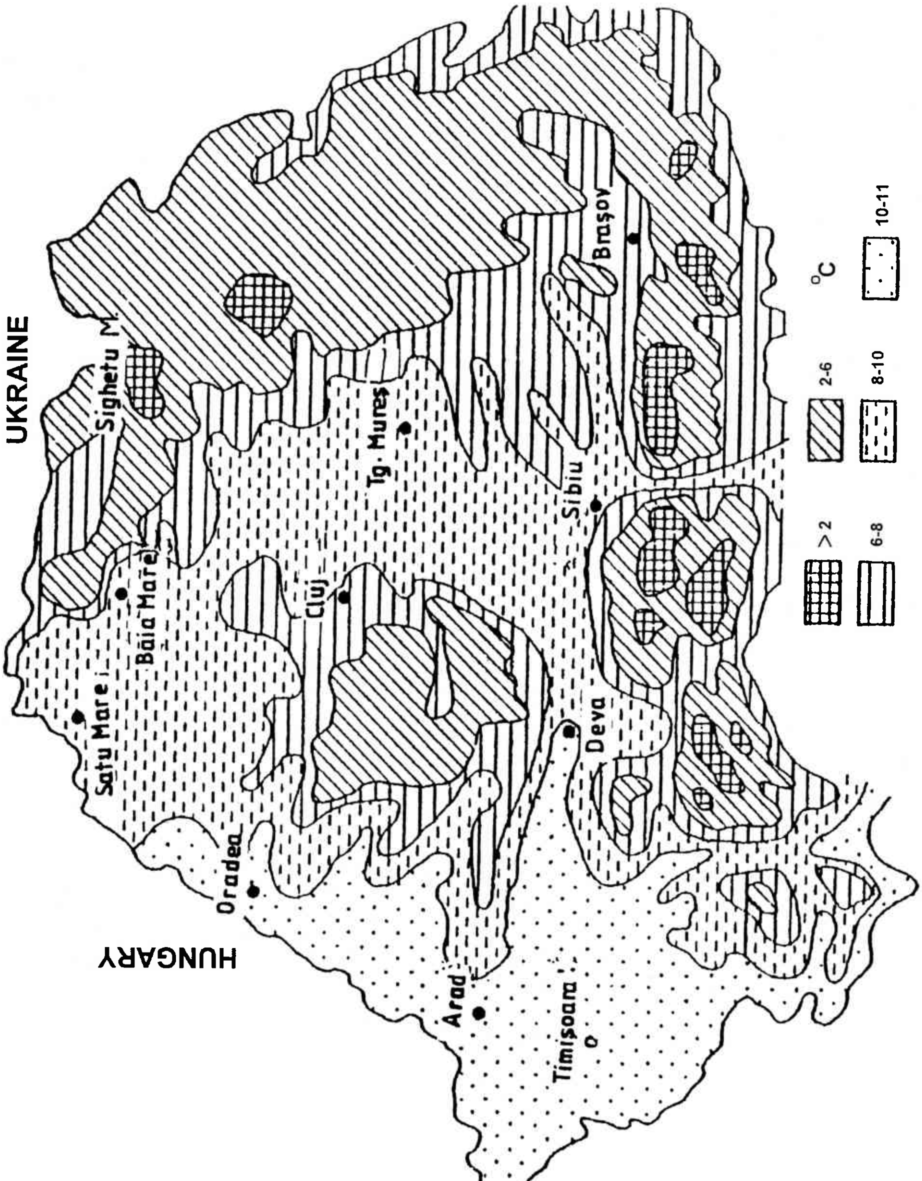

Figure 8. Regional distribution of annual mean temperature in Transylvania (after the study book Geografia României for form XII)

Regional distribution of precipitation

The amount and the spatial distribution of precipitation reflect the relief of Transylvania accurately. The interior of the Transylvanian Basin, the Csík/Ciuc and the Gyergyó/Giurgeu enclosed basins are driest, and the mountainous areas, especially the Southern Carpathians are wettest. The outer slopes of the Eastern Carpathians receive more water (mediterranean impact) than the inner ones. Average annual precipitation is 600-1200 mm; the same figure is 550-600 mm in the Transylvanian Basin, in the Mezőség/Câmpia Transilvaniei, 600-700 in Csík/Ciuc and Gyergyó/Giurgeu, 650-750-800 mm in the Brassó/Braşov basins as well as in Szilágyság, 800-850 mm in the Eastern Carpathians, in Bihar/Bihor and in the Szilágyság/Sălaj-Crasna hills, 900 mm in Hargita/Harghita, in the Radna/Rodna Mts. and on the western side of the middle of Bihar/Bihor, and 1000-1200 mm in the Southern Carpathians (Figure 9.).

The early-summer rainfall maximum presents itself quite intensely. 40% of the annual precipitation falls in summer, the secondary maximum of October is absolutely insignificant because of the powerful continentality. On average half the number of days with precipitation are snowy.

A distinctive local wind is the eddy-wind-like, dry cold eastern wind passing over the Eastern Carpathians and arriving in the Transylvanian Basin with great vehemence, called 'nemere'.

Certain regions of the centre of the basin, such as the Szamos/Someş Tableland and the Mezőség/Câmpia Transilvaniei regions bear the climatic features of the Transylvanian Basin (Figure 10.,11.). Accordingly, the climate of the Mezőség/Câmpia Transilvaniei in Transylvania bears the temperate continental climatic features of the Transylvanian Basin. In its area no great differences appear in the figures of the meteorological and the climatic elements. In the western parts annual mean temperature is between 8 and 9 °C, whereas it decreases to 7 °C in the east. Precipitation is less in the west, the annual mean is about 500 mm, while in the east it increases to 600-700 mm. Despite the fact that most precipitation falls in summer (90-250 mm), this amount of water is not enough to counterbalance evaporation. Therefore, there is a great water loss in both the water output of the rivers and the ground water reserve. This water loss of some 100 mm increases dryness in Mezőség/Câmpia Transilvaniei in Transylvania. Western, northwestern winds prevail. The comparatively little precipitation as well as the great size of aquifers and permeable layers of the surface all decrease the figure of surface drainage. That is the reason why a denser drainage network could not form.

Thanks to the unique influence of Transylvania the meteorological and climatic elements and factors determine the formation and division of different regional climate types. Accordingly, three main regional climate systems take shape, within these, areas reflecting different climatic features exist according to the altitudinal levels. At high altitudes cold, mountain climate prevails, frequent strong winds are characteristic of these regions. On the hilly areas we can distinguish two climatic regions: the climatic regions of low and high hilly areas. Considerable differences do not occur in the climate of the border areas of the Câmpia Tisei/Great Plain.

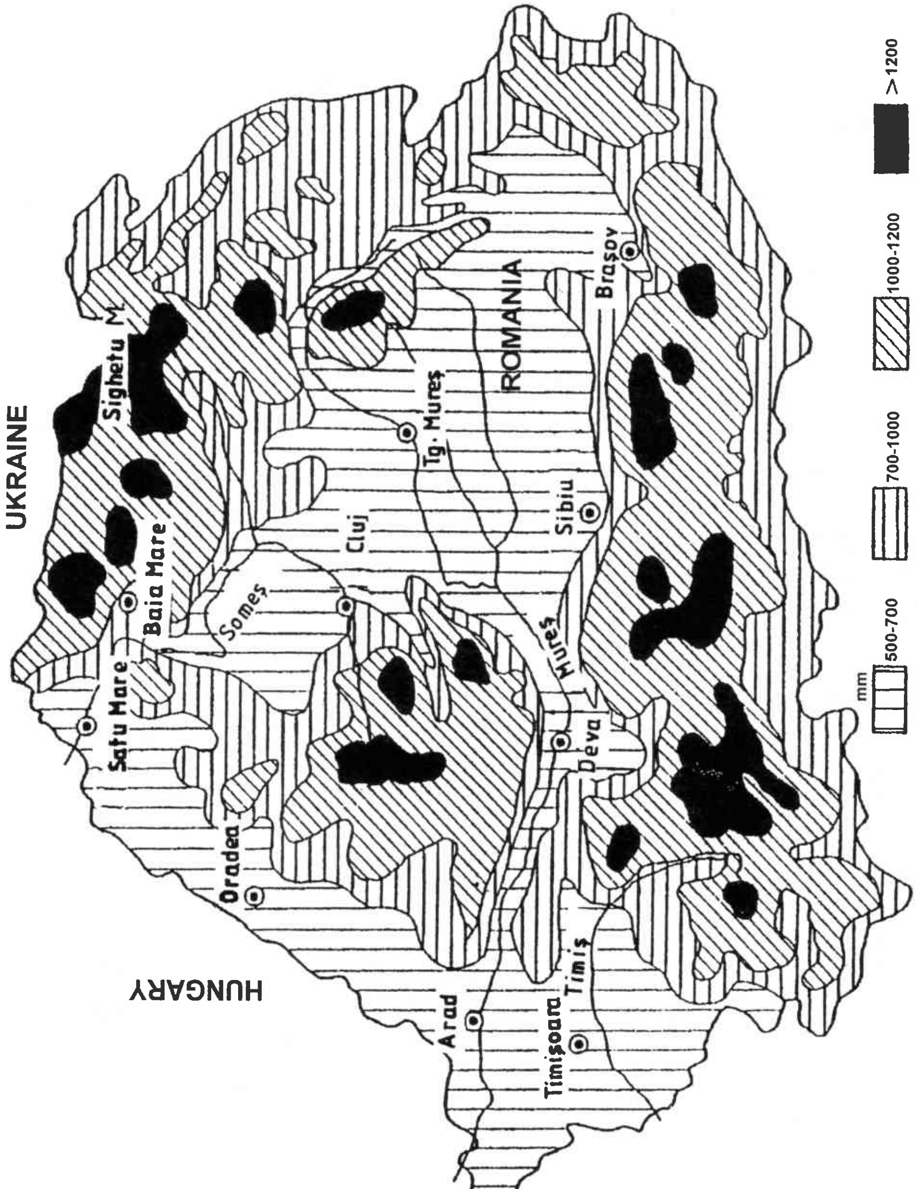

Figure 9. Regional distribution of annual precipitation in Transylvania (after the study book Geografia României for form XII)

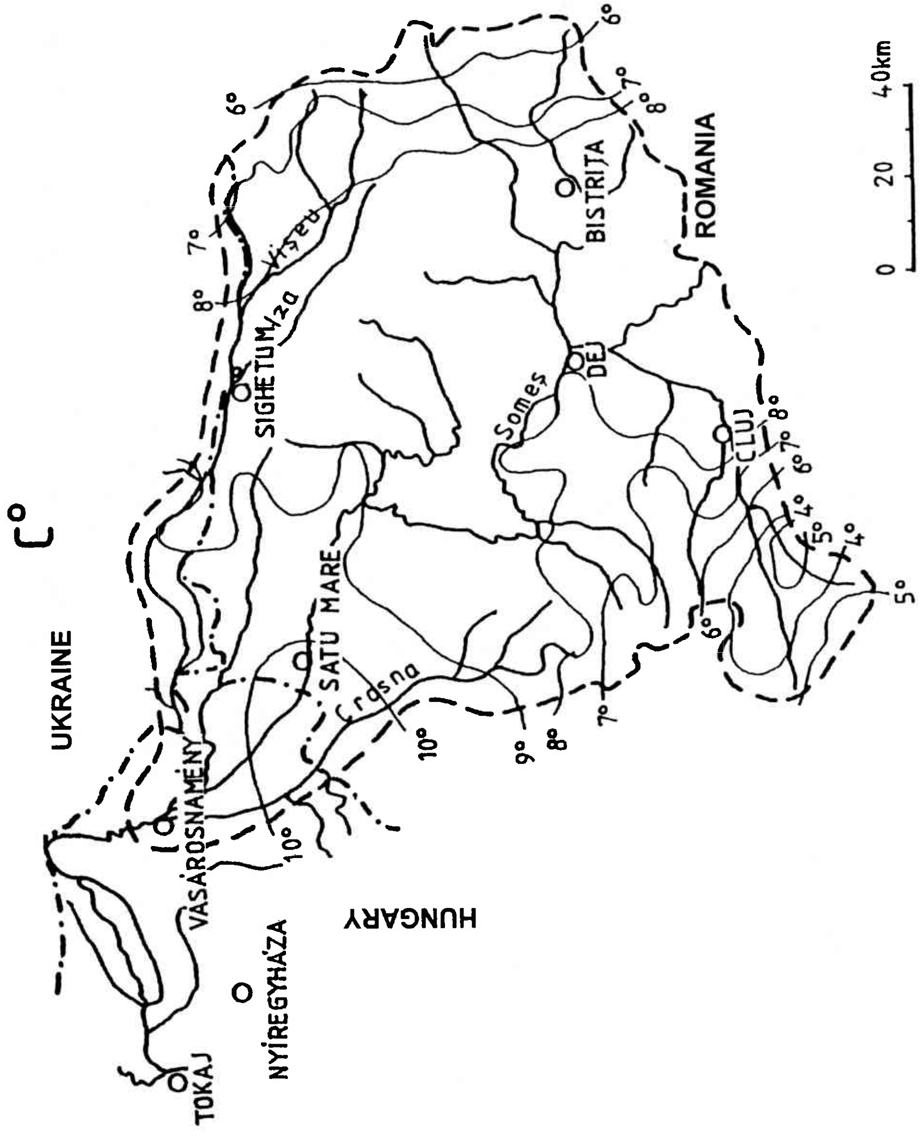

Figure 10. Regional distribution of annual mean temperature and precipitation in the river system of the Szamos/Someş-Kraszna/Crasna

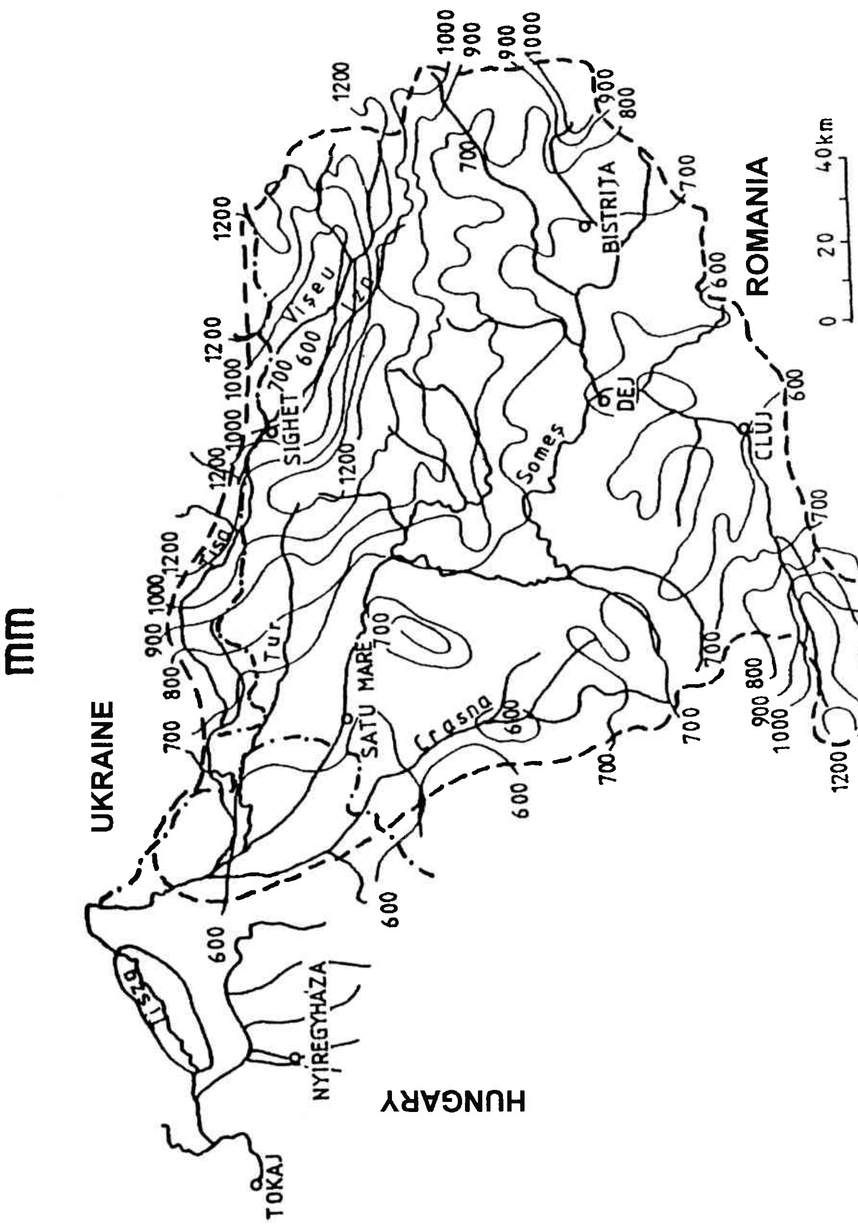

Figure 11. Regional distribution of annual mean temperature and precipitation in the river system of the Szamos/Someş-Kraszna/Crasna

Hydrological features of the basin

The interplay of the relief, climate and the composition of the rock quality of the region determined the formation of a drainage network with a comparatively dense and unique distribution in Transylvania. The direction of the watercourses was greatly influenced by the location and surface of the large relief groups. The rivers of a well-developed, roughly radially spreading drainage network drain the waters of the Transylvanian mountainous area. In the Eastern Carpathians the rivers flow in two directions: east, beyond the Carpathians and west, crossing the Transylvanian Basin to the plain of the Tisza/Tisa. The two exceptions are the River Olt leaving Transylvania southward, and the Bodza bending southeast.

The most common surface is the one created by the watercourses in the entire region of Transylvania, the Carpathians, the Transylvanian Basin, Szilágyság, the western hilly area and the Great Plain. In this group the watercourses have played a decisive role since the end of the Tertiary.

The beginning in the shaping of the relief was the formation of the watercourses, drainage networks and catchment areas. In the Carpathians the transversal watercourses etched through the mountain ranges at various locations and determined the formation and development of transverse valleys.

According to the spatial location of the drainage basins, to its relation to the main catchment area and to the climatic effects controlling and influencing the water output, the drainage network of Transylvania divides into different groups (Figure 12.).

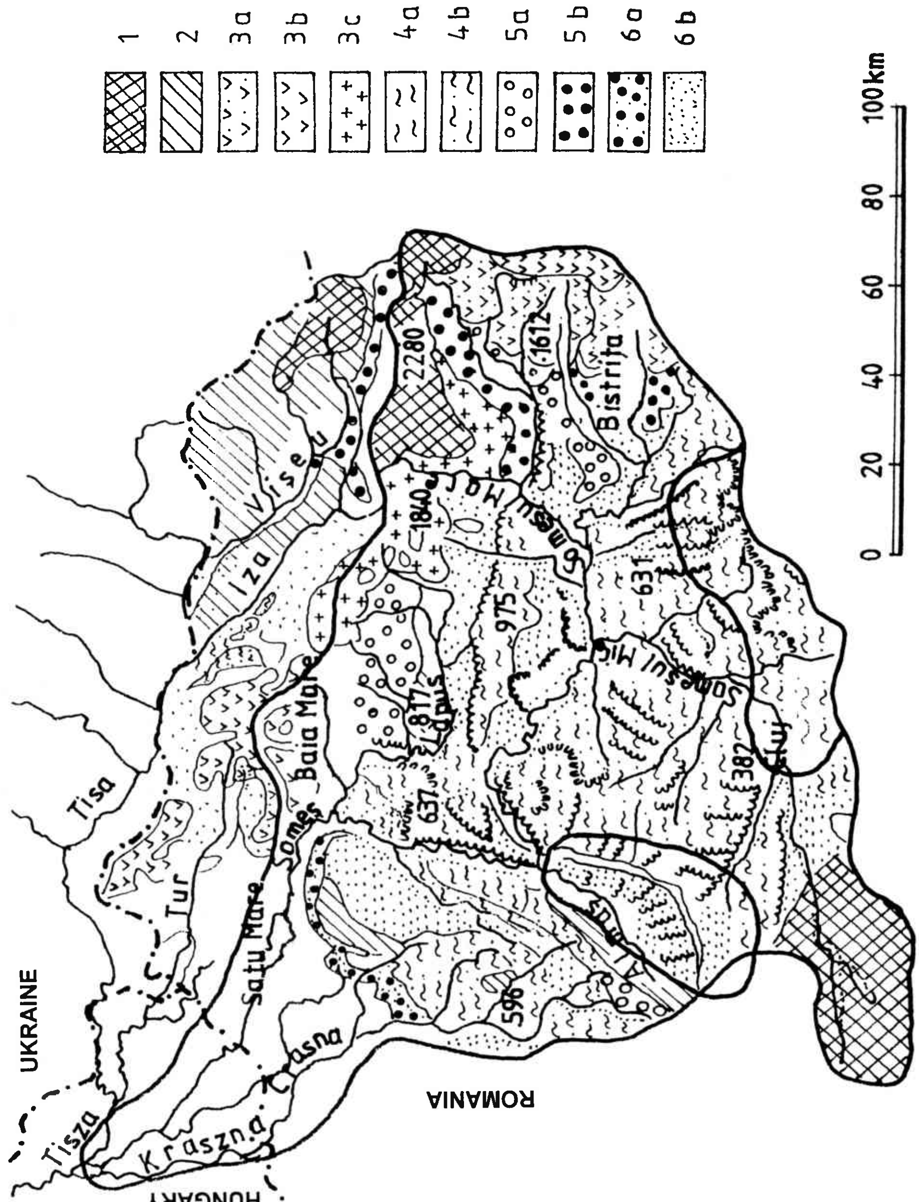

Figure 12. Topographic features of the drainage basin of the Szamos/Someş and the Kraszna/Crasna Edited by Andó M.

1. crystalline rock high mountains (1500-2000 m), 2. low folded mountains (500-1500 m), 3. a. low volcanic cratogens, 3. b. volcanic cones, craters, 3. c. volcanic mountains and plateaus, 4. a. high hill formations (700-1200 m), 4. b. low hill formations (150-300 m), 5. a. elevated piedmonts of hilly areas, 5. b. structural tablelands, 5. c. terraced tablelands, 6. a. accumulation plains in front of mountains, 6. b. flood plains, sandy plains

The northwestern group includes the tributaries of the Tisza/Tisa: the Visó/Vişeu, the Iza, the Szaplocna/Săpânţa, the Mára/Mara and the Túr/Tur Stream. They flow towards the Upper Tisza/Tisa and the Szamos/Someş from the northern slopes of the Gutin/Gutâi, the Cibles/Ţibleş and the Radna/Rodna Mts. and from the Avas/Oaş Mountains.

The western group is three large river systems, including the drainage basins of the Szamos/Someş, the Maros/Mureş and the Körösök/Crişuri. The Maros/Mureş crosses the entire region of Transylvania. The river of the Gyergyó/Giurgeui Mountains breaks through the intramountainous section of Maroshévíz/Topliţa -Déda/Deda, and enters the Transylvanian Basin at Déda/Deda. Its water output and significance are increased by several tributaries of various size: the Görgény, the Nyárád, the Kis- and Nagy-Küküllo/Târnava Mică and Mare, the Sebes/Sebeţ Stream and the Sztrigy/Strei on the left, on the right the main watercourse of the Mezőség/Câmpia Transilvaniei, the Ludas/Luduş Stream, a large tributary rising in the Móc region, the Aranyos/Arieş, the Fel-Gyógy/Geoagiu Stream and the Ompoly/Ampoi. The two large branches of the Szamos/Someş flowing in from opposite directions, the Nagy and the Kis-Szamos/Someşul Mare and Mic unite at Dés/Dej. The Nagy-Szamos/Someşul Mare drains the waters of tributaries rising in the Radna/Rodna and Borgó/Bârgău Mts., and the Kelemen/Căliman Mts.: the Ilva/Ilva, the Les/Leşu, the Sajó/Şieu, the Rebra/Rebra, the Beszterce/Bistriţa, the Árnyas/Anieş and the Szalóca/Sălăuţa. The Kis-Szamos/Someşul Mic drains and transports the waters of the Hideg- and the Meleg-Szamos/Someşul Rece and Cald, flowing through the eastern side of the Transylvanian mountainous area, the waters of the Papfalv/Popeşti Stream and the Nádas from the region of the Szamos/Someş Tableland situated in the Transylvanian Basin, and the waters of the Füzes/Fizeş Stream from the Mezőség/Câmpia Transilvaniei in Transylvania, to Dés/Dej, towards the Nagy-Szamos/Someţul Mare. Below Dés/Dej its largest tributaries are the Almás/Almaţ and the Egregy/Agrij on the left and the Lápos/Lapuş on the right. Two major rivers of Szilágyság are the Berettyó/Barcău and the Kraszna/Crasna. The former is the tributary of the Körös/Crişul, the latter is of the Szamos/Someş. The Körösök/Crişuri, are significant watercourses flowing through the western side of the Transylvanian mountainous area. They drain and transport the waters of the Réz/Plopiş Mountains, the Vlădeasa, the Bihar/Bihor Mountains, Királyerdő/Pădurea Craiului, the Bél/Codru Mountains, the Transylvanian Ore Mountains and the Zaránd/Zărand Mountains into the River Tisza/Tisa.

Streams	Distance from mouth, km^2	Catchment area, km^2	Characteristic water discharge, m^3/s			Gauging station
			low water	average	flood	
Someşul Mare	24	4371	2	44	1760	Beclean
Someşul Mic	82,2	1192	0,5	13,4	2010	Cluj
Şieu	7	1809	0,6	13,4	950	Şinterag
Fizeş	41,1	439	0,04	1,1	50	Fizeşu G.
Someş	294,8	8845	3,7	68,5	2200	Dej
Almaş	23,1	552	0,035	1,6	165	Hida
Sălaj	1,8	457	0,005	2,27	780	Sălsig
Lăpuş	8	1487	0,54	20,8	1350	Lăpuşel
Szamos	47,6	15282	15	120	2360	Csenger
Kraszna	22,8	2976	0,04	3	260	Kocsord

Table 1. River regime of the Szamos/Someş-Kraszna/Crasna and their tributaries

The southwestern group includes the minor watercourses of the Bánság/Banat and Temesköz/Câmpia Timişului The largest one is the Temes/Timiş, the Béga/Bega is second, of which bed was made navigable a long time ago, and the next is the Berzova/Bârzava.

It is only the River Olt that belongs to the southern group in Transylvania. It drains the waters of some 13,500 sq. km. Its catchment area stretches over regional units of different relief. Its river-head area is in the crystalline range of the Eastern Carpathians, in the Gyergyó/Giurgeui Mts.

The primary formative effect of the watercourses is valley formation in Transylvania as well. Most of the Transylvanian river valleys divide into three: the upper section is in the mountains, the middle section is in the hilly areas, and the lower section, especially in the case of the major rivers, is the plain or the comparatively wide valley plains.

The valley plains are present almost everywhere along the Transylvanian rivers, they are only absent in the mountainous sections and the gorge portions. In the enclosed intramountainous basins and on the valley plains there are a number of fields of peat and peat bog with stagnant water.

The relief formations of the watercourses, the valleys, valley plains, terraces and the aggradation plains play a significant part in Transylvania, too, concerning the economy and land development. Regarding the course and the degree of the longitudinal river profile the drainage of stagnant waters, and by that increasing the utilization value of the areas in question, are necessary at several basin and valley sections.

The density of the drainage network is not uniform in Transylvania. It is higher in the mountainous areas: the figure is 0.8-1 km/sq. km on the land of the Lápos/Lăpuş-Avas/Oaş in the Bihar/Bihor Mountains, in the Kelemen/Căliman Mts., the Northern-Görgény/Gurghiu Mts. and the Szárkő/Ţarcu Mountains. At other locations of the mountain range it is 0.6-0.8. The same figure is 0.4-0.6 in the Transylvanian Basin, the Szilágyság/Sălaj hilly area, along the Alsó-Homoród/Homorodu de Jos and the western hilly area. It is 0.2-0.4 km/sq. km on the plains of the Temes/Timiş and the Körösök/Crişuri. Density is lowest in the plain regions south of Arad, where it barely reaches 0.2 km/sq. km.

River regime: The Transylvanian rivers are fed mainly by rainwater. The proportion of snow-broth and the contribution of ground water are very small. The consequence of this is fluctuating river regime, water output. At times of ample precipitation water output may rise to the level of flooding, which was the case in 1970 and 1975. On the basis of the chronological realization of the river regimes we can distinguish various types of river regime.

One of such types includes the river regime of the western rivers of the Transylvanian mountainous area, of the rivers of the northern volcanic ranges (the Avas/Oaş, the Gutăi, the Cibles/Ţibleş) as well as the rivers of the Bánság/Banat mountainous area. These rivers are characterized by an increase of the water output in spring lasting 1 or 2 months (March-April). It is followed by a decrease of the water output connected with the dry weather between July and November. During wintertime floods, resulting from snow-broth output frequently occur.

Decreases of water output come in winter at levels higher than 1000 m and in summer and autumn at lower altitudes.

The second type exists in the Eastern and Southern Carpathians and on the eastern slopes of the Transylvanian mountainous area. With rivers having their river-head areas at lower altitudes than 1600-1800 m low levels of water are a regular occurrence in winter concerning this type. The frequency of a rise of water levels from snow melt and rainwater in spring hardly reaches 10-20%. The main sources feeding the rivers are snow and rainwater; the amount of ground water is small, except for the rivers of the intracarpathian basins, where ground water exceeds 35% of the annual mean water output.

Orohydrographical conditions of the catchment area of the Szamos/Someş and the Kraszna/Crasna

The drainage basin of the Szamos/Someş is much larger than that of the Upper Tisza/Tisa, some 15,880 sq. km (19./31.o.). While the catchment area of the River Tisza/Tisa is virtually open in the west-southwest, that of the Szamos/Someş is closed from the humid air masses in the same direction by the 1836 and 1849 m high peaks of the Bihar/Bihor Mountains and in the south by the ring of the Southern Carpathians. The drainage basin of the Szamos/Someş is, for that matter, closed by the 1800-2300 m high peaks of the Radna/Rodna Mts. in the north and by the peaks of the Eastern Carpathians in the east (Figure 13.).

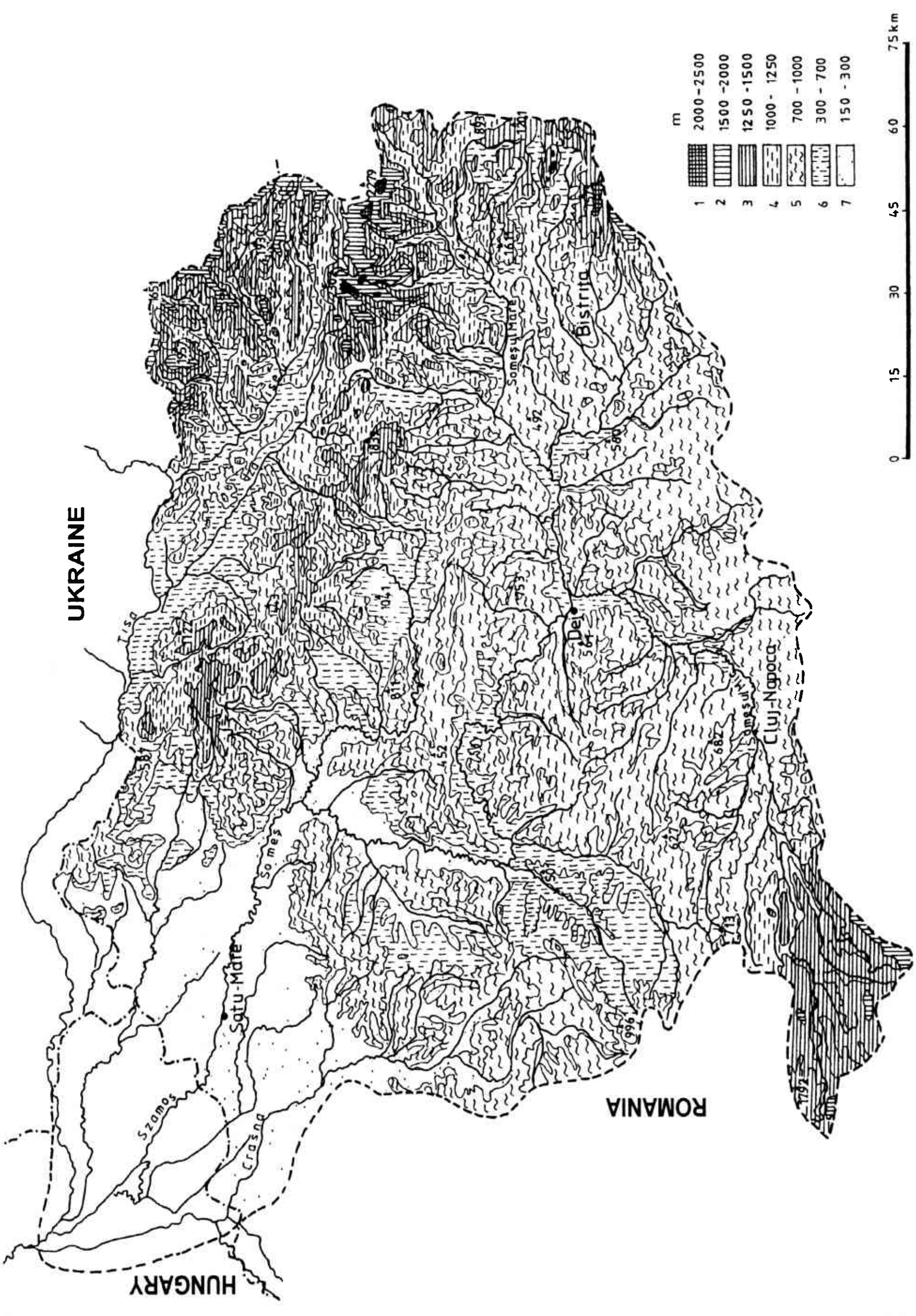

Figure 13. Location above sea level and hydrographic features of the catchment areas of the Szamos/Someş and the Kraszna/Crasna

Air currents arriving from the northwest can penetrate this area most easily. Because most of the catchment area is a low-lying or medium-height mountainous region and at the same time the watershed mountains lying at its southwestern edge are not very high either, air masses bringing precipitation mainly feed the Maros/Mureş valley after passing over this watershed. As a result of all these, in the river-head areas the annual average of precipitation is 800-1000 mm, whereas in the heart of the Transylvanian Basin it is only about 600 mm, which is not increased remarkably by the areas of the Gutin/Gutâi, the Lápos/Lăpuş and the Radna/Rodna Mountains, though rich in precipitation (Nagybánya/Baia-Mare 953 mm, Kapnikbánya/Cavnic 1263 mm).

Distribution of the annual amount of precipitation can be explained by the orographical structure of the region. This part of the Carpathian Mountains runs approximately in a NW-SE direction. Arriving in the Carpathian Basin mainly from the southwest or the west, however, air masses carrying precipitation change their course northeastward because the frontier mountains bounding Transylvania in the west constitute an obstacle. As a result, these air masses are forced to bank up, and ascended they precipitate some of their humidity because of dynamic cooling. Precipitation is also enhanced by the channel effect: the area tends to narrow northeastward. Here we deal with the wettest region of not only the Tisza/Tisa Valley but the whole Carpathian Basin. Increase in precipitation can already be detected in our country 60-80 km from the foot of the mountains. Obviously, the southeastern slopes of the mountain ranges get the most precipitation, so there is a great deal of precipitation even on the southwestern slopes of the Avas/Oaş and the Kőhát/Igniş.

The surface conditions of the catchment area of the Szamos/Someş are complicated and the conditions of precipitation are varied. The Szamos/Someş is formed by two large branches, the Nagy- and the Kis-Szamos/Someşul Mare and Mic. Of the two it is the Nagy-Szamos/Someşul Mare that rises in a wetter region, and, as its name suggests, this is the main river. The source of the Nagy-Szamos/Someşul Mare is on the southern slope of the Radna/Rodna Mts. This huge range runs E-W, but because its southern slope can only receive air currents from the dry Transylvanian Basin, precipitation is much lower here than on the slopes of the Maramuresh Mts. facing southwest.

The terraced valley of the Nagy-Szamos/Someşul Mare below the Radna/Rodna Saddle opens into the Transylvanian Basin below Naszód/Năsăud. At Bethlen it receives the Beszterce/Bistriţa expanded by the Sajó/Sieu and unites with the Kis-Szamos/Someşul Mic at Dés/Dej. Two source rivers of the latter, the Hideg- and the Meleg-Szamos/Someşul Rece and Cald rise in the Gyalu/Gilău Mts. and Bihar/Bihor, respectively. They unite beyond Gyalu/Gilău. The united Szamos/Someş after receiving the Almás/Almaş and the Egregy/Agrij enters the Zsibó/Jibou Basin, and then through the Cikó/Ţicău Pass enters the enclosed Kővár/Ighniş Basin. It receives the Lápos/Lăpuş flowing from the Gutai, and it enters the Great Plain below Szinérváralja/Seini. Its tributary, the Kraszna/Crasna collects the waters of Szilágyság, in the same way as the Berettyó/Barcău does running into the Körös/Crişul. The running of both the Szamos/Someş and the Maros/Mureş is mainly balanced, characteristic of valley-tract rivers.

The upper section of the Szamos/Someş is situated in the Transylvanian Basin, more precisely in the mountain frame bounding the basin in the inside, so this part of its catchment area is characterized by Transylvanian precipitation conditions, a great drought in winter and a comparative abundance in precipitation in summer, whereas annual distribution of precipitation is more even at the lower section of the river. Nevertheless, the influence of the mountains on the conditions of precipitation can be observed in the Transylvanian section as well.

The catchment area of the Szamos/Someş is much bigger than that of the Tisza/Tisa, it is 15,461.3 sq. km together with the drainage basins of the Homoród and Balkány streams (Figure 14.).

In the east the river-head areas of the Nagy-Szamos/Someşul Mare and the Sajó/Sieu in Transylvania are surrounded by the 2000-2300 m high mountain chain. In the west, in the Bihar/Bihor Mountains the individual peaks rise up to 1800 m at the sources of the Meleg- and the Hideg-Szamos/Someş (together the Kis-Szamos/Someşul Mic). The base rock of the mountain range is shale, which is broken through by trachyte rocks in the Kelemen/Căliman Mountains and by granite rocks in the Bihar/Bihor Mountains. Further trachyte rocks are found from Kapnikbánya/Cavnic to Huszt/Hust between the Tisza/Tisa and the Szamos/Someş. Most of the drainage basin is, however, low and medium-height mountainous area covered by the argillaceous, marly deposits formed later in the Tertiary. At quite a number of locations the sediments of the evaporated Neogene sea, thick layers of gypsum and salt emerge to the surface. On the whole, the relief is lower than in the catchment area of the Tisza/Tisa, and the mountain slopes are not so steep.

The Kis-Szamos/Someşul Mic rises on the western slope of the Gyalu/Gilău Mts., an area sheltered from rain. Because of the great height above sea level the amount of precipitation slightly exceeds 1000 mm, but towards the east, around Kolozsvár/Cluj it decreases under 600 mm. The Kis-Szamos/Someşul Mic bending north toward the edge of the Transylvanian Basin enters an area a little richer in precipitation, so the amount of precipitation down the river do not decrease, but increase. The two branches of the Szamos/Someş unite at Dés/Dej, then meandering greatly it arrives in the Great Plain. At this river section it receives a considerable amount of water from the right, because it gains more than 1000 mm from the southwestern slopes of the Cibles/Ţibleş and the Kőhát/Igniş, and 1200 mm from the same part of the Gutin/Gutâi (Kapnikbánya/Cavnic 1263 mm); these figures being similar to those of the Máramaros/Maramuresh Mts.. At this section of the Kis-Szamos/Someşul Mic the higher parts of the surrounding mountains do not receive much less precipitation than the mountainous area around the River Tarac.

Between the confluence of the Szamos/Someşes and the Meszes/Meseş Mountains, indicating the boundary of the Transylvanian Basin, conditions of precipitation are the same, only the difference between the amount in summer and winter is slightly smaller and, though feeble, the secondary maximum of October presents itself again.

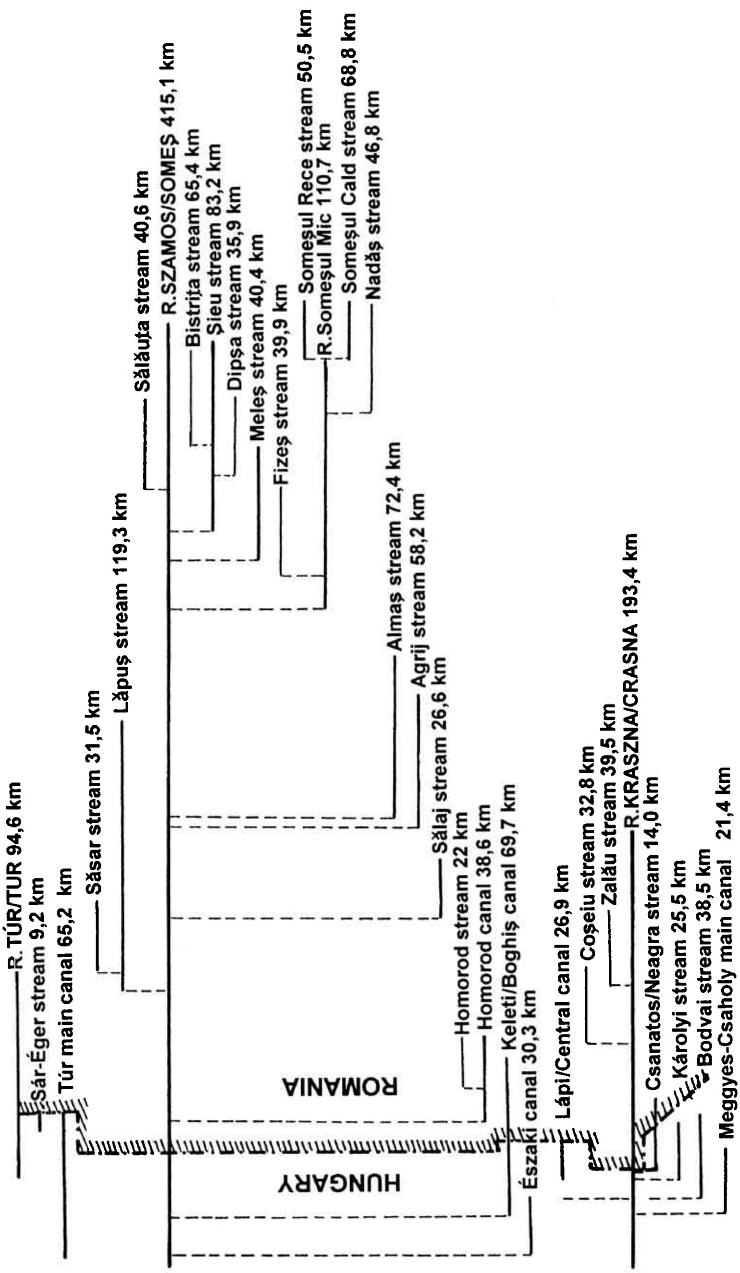

Figure 14. Schematic picture of the drainage network of the Szamos/Someş-Kraszna/Crasna

In the Lápos/Lăpuş valley joining the Szamos/Someş valley from the right the effect of the mountains towering in the north can already be detected, so the rains gliding upwards come to the foreground and the distribution resembles the conditions of the right bank of the Nagy-Szamos/Someşul Mare. This distribution of precipitation is more remarkable at the foot of the Gutin/Gutâi, where the difference of the driest and the wettest months is only 4% of the annual figure.

Around the river-section of the Szamos/Someş on the Câmpia Tisei/Great Plain precipitation gradually decreases, and because the entire catchment area of the Szamos/Someş receives less precipitation, with the exception of the Gutin/Gutâi area, than the drainage basin of the Upper Tisza/Tisa, its mean water output is lower than that of the Tisza/Tisa, despite its larger catchment area.

The section of the Tisza/Tisa between the Szamos/Someş and the Bodrog is a drier area, where annual precipitation is at places lower than 600 mm. It is only the Kraszna/Crasna that flows from a region with more precipitation, from the south, but even its river-head area has a maximum of 7-800 mm of annual average precipitation. The figure is only about 600 mm at most sections of its course.

The water of the Kraszna/Crasna used to sprawl over the Ecsedi swamp, and here it encountered waters flowing over the left bank of the Szamos/Someş. The Kraszna/Crasna enters the plain at Ákos/Acâş; from Nagymajtény/Moftinu Mare a newly dug canal on the western side of the swamp drain its waters straight into the Tisza/Tisa. The soil of the drainage basin in the mountainous area is semi-permeable. The river-head area of the Kraszna/Crasna is much lower than that of the Szamos/Someş. The waters of the Kraszna/Crasna flood at the same time as those of the Szamos/Someş. The flood wave passes the plain section slowly, so it comes later compared to not only that of the Tisza/Tisa, but to the Szamos/Someş too. It stretches along the watershed mountain ridges from the Szamos/Someş, and flows down on the land intersected by brooks between the Berettyó/Barcău and the watershed in the same direction between Ákos and Nagymajtény. It takes place in a way that at large floods, because of the dams of certain mills, the water flows over its bed, and does not return again to the river. It breaks into the Érmellék/Câmpia Ierului and from there flows into the Berettyó/Barcău. The tributaries Homorod/Homorod and Sóspatak/Păriul Sărat of the Kraszna/Crasna were drained into the Szamos/Someş beyond Szatmárnémet/Satu-Mare.

The drainage basin of the Szamos/Someş generally receives less precipitation than that of the Tisza/Tisa. Annual average precipitation is 600-700 mm. The precipitation maximum in the Transylvanian Basin falls on the summer months. The winter, spring and summer floods of the Szamos/Someş usually occur together with those of the Tisza/Tisa. In autumn, however, major rainfall is rare in the Transylvanian Basin, and the high water levels of the Szamos/Someş do not usually increase the flood waves of the Tisza/Tisa in autumn, in October.

The flood waves resulting from rainfall on the Szamos/Someş reach the confluence with a one or two day delay. But on its catchment area, situated further south, snow usually melts earlier, so the flood waves of the Szamos/Someş resulting from thaw arrive at Vásárosnamény earlier than those of the Tisza/Tisa. Dip of the Szamos/Someş is quite high all along.

The Szamos/Someş valley is long, from its spring to its confluence with the Tisza/Tisa the waters travel 439.2 km. On the long journey the flood waves of the Szamos/Someş even up, all the more so because the Szamos/Someş is not fed by considerable watercourses at the lower section.

The Szamos/Someş deposits its gravel below Szatmárnémedi, at Vetés/Vetiş, from there on it transports significant amounts of sharp sand.

Finally, at the plain section of the Szamos/Someş conditions of precipitation are the same as at the plain section of the Upper Tisza/Tisa, only the amounts of precipitation are smaller, because this region lies farther from the mountain frame increasing precipitation. If we compare the conditions of precipitation in the catchment areas of the Szamos/Someş and the Upper Tisza/Tisa, we will find that the annual distribution of precipitation is more continental in the region of the Szamos/Someş, because the winter is drier and the summer is wetter. This allows us to conclude that the role of a front moving upwards is less prominent in the creation of precipitation.

The rivers are well-supplied by water. They have two highs: the early spring high at the time of thaw and the early summer one connected to continental rainfall. In accordance with the extreme climatic conditions of Transylvania the summer floods are larger and more violent. The floods run down rapidly, the flood wave culminates quickly, because the surface rock composition is primarily impervious both in the mountainous area and the Transylvanian Basin. Let the hydrological account of the creation of orographic precipitation serve as evidence.

Meteorological and hydrological conditions in 1970 in the Transylvanian Basin and in the catchment areas of the Szamos/Someş and the Maros/Mureş

The catastrophic flood originated from the flowage of the precipitation falling from the early summer pseudo-monsoon-like cyclone. The northeastern and eastern regions of the drainage basin of the Tisza/Tisa were especially affected by the intense precipitation activity of May 12 and 13. It caused lasting high water levels in the tributaries.

The weather

As a result of the precipitation falling in the first months of 1970 the soil was completely saturated by water. For example until the end of April there were ten significant flood waves running down the Szamos/Someş, all of which exceeded the average height of the river. Precipitation activity in January and April was higher by 93% at Beszterce/Bistriţa, 53% at Dés/Dej, 62% at Etéd/Atid, 58% at Székelyudvarhely/Odorheiu Secuiesc, 57% at Balázsfalva/Blaj and 42% at Maramarossziget/Sighetu Marmaţiei than the annual average.

In areas sheltered from westerly winds precipitation activity was close to the average: 12% at Kolozsvár/Cluj, 13% at Szatmárnémet/Satu Mare and 16% at Nagybánya/Baia Mare. Precipitation activity on 12 and 13 May, directly exploding the catastrophic flood centred over the northwestern parts of the country. In the middle of the rain zone precipitation fell continuously for 26-27 hours, whereas at the edges there were some interruptions. Precipitation activity commenced with an intensity of 10 mm/hour (12

May, 1970, 14 to 15 hours) and intensifying and abating periods followed each other rhythmically according to when the westerly wind reached the western slopes of the Carpathians. In most parts of the country precipitation of these days was between 10 and 50 mm. It reached 50-120 mm on the western slopes of the Eastern Carpathians, especially in the Avas/Oaş-Gutăi unit and in the Kelemen/Căliman Mts.

The degree of this natural phenomenon was determined by the great spatial dimension (about 25,000 sq. km on Romanian territory) and the intensity of the precipitation activity (over 50 mm).

Aerological measuring confirmed the presence of a permanent wind from the northwest (300°) on a front formed along tropical air masses and beside polar cold air masses. Concentration of humidity of the tropical air mass was 15-20 gr/m^3, and 6-12 gr/m^3 of the cold air masses. The synoptic condition took up the form of an orographic cyclogenesis-like situation over the area of the Upper Tisza/Tisa and its tributaries.

This condition and the position of the slopes provide an explanation of the extremely high amount of precipitation of certain regions. While in the mountainous area of the Avas/Oaş-Gutăi and the parts of the Radna/Rodna Mts. facing west even 100-120 mm of precipitation fell, on the slopes facing southeast and east, even in the higher mountainous area there was scant precipitation. Eg: on Ráró/Rarău peak (1650 m) only 31 mm, on Csalhó/Ceahlău peak (1907 m) only 11 mm.

At the same time, at the foot of the Kelemen/Căliman Mts. the situation was as follows: Teke 126.8 mm, Ragla/Ragla 179.5 mm, Beszterce/Bistriţa 110.4 mm.

At the river-head area of the Maros/Mureş, in the Gyergyó/Giurgeu Basin only 30-50 mm fell on average. Eg: Maroshévíz/Topliţa 45.9 mm, Gyergyóalfalu/Joseni 25.1 mm.

Air masses forced southeastward caused precipitation of 100-120 mm at the foot of the volcanic mountain chain, to the south, in Székelyudvarhely/Odorheiu-Secuiesc only 65.8 mm, in Brassó 30 mm and in Kézdivásárhely/Târgu-Secuiesc only 29 mm. Of the 25,000 sq. km bounded by the 50 mm isohyet 37% had 50-80 mm, 38% had 80-100 mm, 15% had 100-120 mm, 8% had 120-150 mm and 2% had more than 150 mm.

The greatest intensity of precipitation was in Beszterce/Bistriţa at 15 hours on 12 May, 1970, when it reached 3 mm/min.(Exactly 6 mm was measured between 15 hours and 15.10.)

At the time the flood came into existence temperature of the air was between 4-12 °C in low-lying areas, and 0 °C at the height of 1800-2000 m.

Flowage of surface waters

The most powerful rise formed between 14 and 19 hours on 12 May on the western slopes of the Eastern Carpathians. The highest water level occurred between 5 and 9 hours on 13 May in the rivers of the mountainous areas. These rises happening at the same time on the upper sections of the Nagy-Szamos/Someşul Mare, the Visó/Vişeu, the Maros/Mureş and the Küküllő/Târnave arrived at (ran on) the high water levels of spring together.

An example that describes its degree: the Nagy-Szamos/Someşul Mare yielded 40 m^3/sec at Óradna/Rodna Veche, which is 8 times higher than the average water output.

Surface flowage in the areas affected by the flood exceeded 20 mm everywhere, in the Fernezey/Firiza Basin and at the upper section of the Túr/Tur it reached even 100-150 mm.

In the whole area the percentage of permeation taking place was extremely low, a very great proportion of the precipitation that fell got to the rivers as surface flowage. It reached quite a high figure primarily on the slopes facing northwest. It was much lower (20-30 mm) in the inner Carpathian Basin, the flood wave did not form here. It is noteworthy that the flood wave of the Maros/Mureş formed only below Maroshévíz/Toplița, and was created from the flood waves of the tributaries flowing down from the Kelemen/Căliman and Görgény/Gurghiu Mts. To the water of these streams the amount of water from thaw was added.

At the same time, parts of the upper section of the Szamos/Someş sheltered from westerly winds had only a flowage of a mere 27 mm.

The following rivers provided the great amount of flowage: Rebra/Rebra 71 mm, Szálva/Salva 95 mm, Beszterce/Bistrița 88 mm, Bodok/Bodoc 61 mm and the Sajó/Şieu 51 mm.

The same situation took shape in the Maramuresh Basin, too. There in the comparatively protected Iza Basin flowage barely reached 45 mm, in the Visó/Vişeu Basin 64 mm, whereas in the Túr/Tur Basin with a western exposure it reached 84 mm. In the Fernezey/Firiza drainage area of 95 sq. km flowage was 153 mm.

The flowage coefficient counted on the basis of the amount of total flowage, came close to 1.00, which points out the extremely huge water resources of the time period and areas concerned.

That is precisely the reason why we must deduct the amount of water already in the river-bed when counting surface flowage (masses of water before 12 and 13 May).

On the ensuing days (14-16 of May) there were minor local rains (10-14 mm). These to some extent affected the flood-waves already formed with small secondary flood-waves, which got flattened entering the major rivers. Figures of both precipitation and flowage (both as a mean figure counted on the catchment area) are in a quite close relationship with the mean height of the respective catchment area. It follows that, although the flowage obey the same laws, the regional generalization is quite difficult without knowing the local distribution precisely. In the outer regions, especially in the orographically sheltered ones distribution of height is as follows: both precipitation and flowage show a declining trend above 600-1000 m, whereas the increasing figures of flowage refer to the soil's greater saturation with water.

We emphasize again the orographic influence exerted on the dynamics of the air masses and at the same time on the regional and quantitative distribution of precipitation. That is exactly the reason for all the further geographical factors remaining under the dominance of this influence. The high water content of the soil was an additional factor that provided the great flowage in the Transylvanian forests.

A characteristic feature of the formation of the floods in 1970 is the extraordinary influence of the Carpathians on the atmospheric conditions, by which quite a broad area was affected concerning precipitation. The large rain zone coming into being on the northwestern slopes of the Eastern Carpathians together with the great water content of the soil led to the formation of synchronous flood waves and large rivers even in the mountains.

The freshwaters of Transylvania: lakes and swamps

The individual lakes occupy a small area; concerning their formation they are partly mounded, partly dammed up and partly deepened lakes. The are situated at two major levels: in the Transylvanian Basin and in the rock realm of the high mountains glaciated in the ice age.

The several hundred tiny lakes of the north of the Transylvanian Basin, of the Mezőség/Câmpia Transilvaniei, are predominantly of natural origin. Human modifying activity (obstruction, deepening, damming and fishpond culture) was confined to mostly exploiting the natural conditions. Various factors played a role in the formation of the lakes in the Mezőség/Câmpia. On the uneven surface of the clay slopes of the Mezőség/Câmpia Transilvaniei lakes were often created in the depressions. But the landslides themselves may narrow the stream valleys so much that the water of the stream easily swells into a lake, or it is easy to swell by human intervention. In certain valleys the lakes are distributed in a line resembling a string of beads. What is responsible for the frequent alternation of low and high dip in certain valleys is the structure and composition of the basin. The stagnant stream of low dip once again easily swells into a lake or it can easily be swollen by some effort. We may mention that dams built by beavers perhaps played a part in creating some lakes.

The present geographical and geological literature provides an accurate account of these quite unique surface conditions and hydromorphological features of the Mezőség/Câmpia Transilvaniei.

As long as the Mediterranean-stage strata and the members of the Sarmatian deposits are detectable in one of the border areas of the Mezőség/Câmpia Transilvaniei we can confidently allege that the region is of the Mezőség/Câmpia Transilvaniei -type, even if it does not seem supported by a physical geographical point of view. The series of strata above are accompanied by characteristic morphological formations: slipped lands, lakes, valleys showing senile qualities, coffins, etc., firm proofs of the geological findings (Figure 15.).

In the Palaeogene the Mezőség/Câmpia Transilvaniei was a sea bay, where a distinctive series of red clay strata was created, especially at the edges. After that, in the second part of the Tertiary, fundamental changes occurred in the formation of its relief features. These profoundly influenced the shaping of the Mezőség/Câmpia Transilvaniei, too. In the Mediterranean stage the Mezőség/Câmpia Transilvaniei, more accurately the Transylvanian sea bay communicated with the Hungarian inland sea through two gates: the present Szamos/Someş and Maros/Mureş gates.

In the Helvetian stage fault lines intersected the Mezőség/Câmpia Transilvaniei area, and intense volcanic activity began at the edges.

It is the movements of the Mediterranean stage that directed the formation of the present drainage network of the Mezőség/Câmpia Transilvaniei.

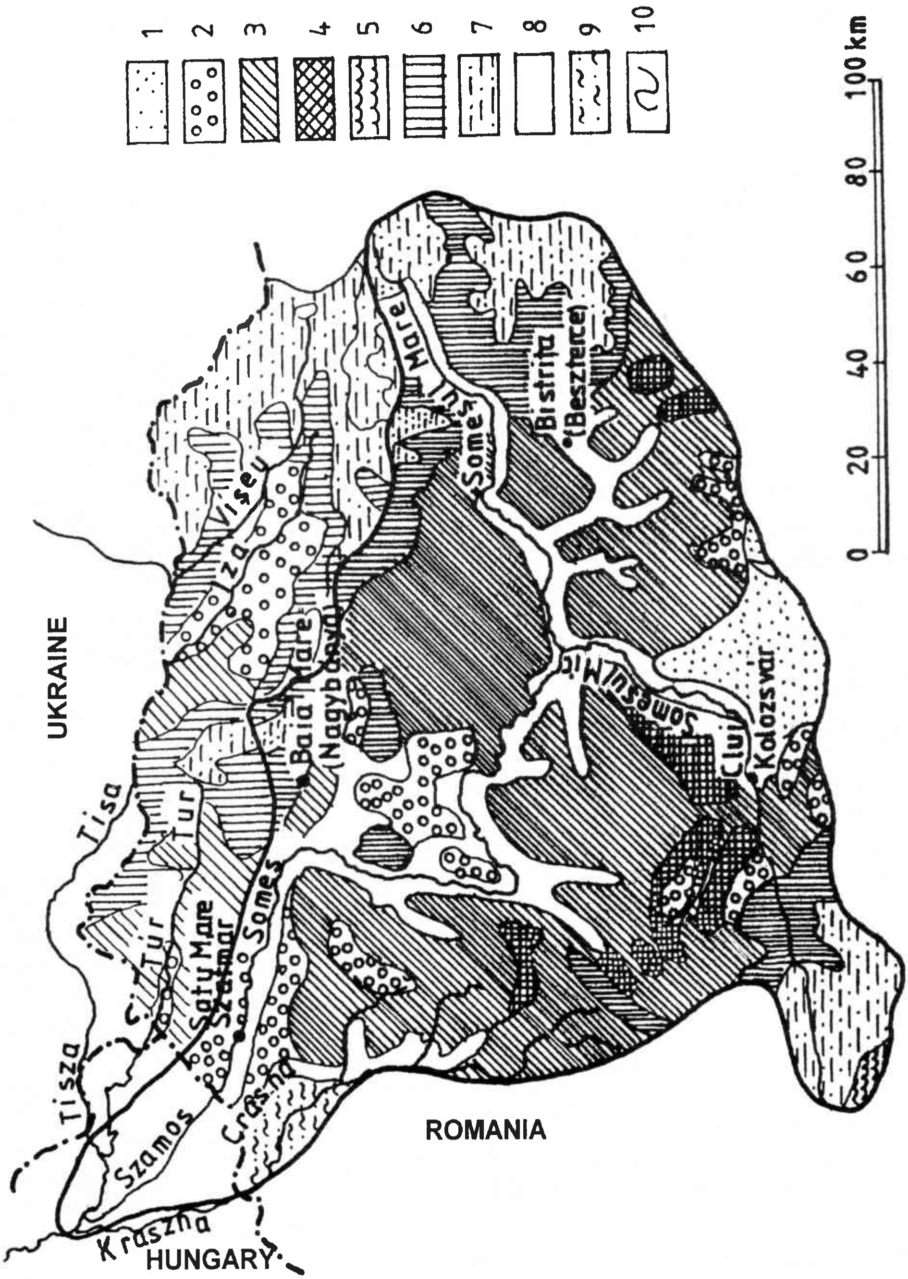

Figure 15. Soils of the catchment area of the Szamos/Someş-Kraszna/Crasna

1. chernozem, 2. brown forest soil, 3. podsolic brown forest soil, 4. pseudorendzina, rendzina soil, 5 red rendzina formed on limestone rocks, 6. brown forest soil of the mountains, 7. brown acid mountain podsol, 8. alluvial soil, 9. marsh and gley soil, 10. boundary of the catchment area

The main role in the formation of the drainage network must be attributed to the fault lines which, after Helvetian-stage tectonic disturbances, interfered with the hydrographical formation of the northern half of the Mezőség/Câmpia Transilvaniei by tiltings of an approximately N-S direction in the Pliocene. The general western slopingness of the basin forced the drainage network to find a western direction within the frames of the fault lines. So the direction of the streams in the northern part of the Mezőség/Câmpia Transilvaniei is roughly NW-SE. A fault line system at right angles to this direction can also be detected, which has created a chessboard-like morphological fault system.

Examining the morphological features of the Mezőség/Câmpia Transilvaniei we must, in any case, point out the causes that either facilitated or hindered the formation or construction of lakes in the nature.

The first, fairly conspicuous morphological feature is the frequency of landslips and creeps. The Sarmatian sandstones sliding down on the slippery surface of the Mediterranean clays or the collapsed fragments of emerging bassets undoubtedly play a great role in the blockage of the valleys and thus the creation of lake surfaces. We need not, however, assume that the measures beginning to slide shall move down to the bottom of a valley. In the hollows of the landslides water will accumulate anyway, and will create the small water surfaces that we may call landslip lakes.

Another morphological feature is the shape and slopingness of the valleys, which, together with a geological factor, the presence of Mediterranean substances, explain the circumstances of the creation of not only the individual lakes, but of entire series, strings of them.

The valleys of the Mezőség/Câmpia Transilvaniei are long, and although they show senile forms at places, they are narrow, or at least they narrow at certain locations so much that either their natural or artificial blockage almost offers itself. These gate-like necks induced the bronze-age man to construct artificial fishponds. The impermeability of the clay deposits in the valley bottoms only helped the formation or construction of lakes.

The slopingness of the valleys in the Mezőség/Câmpia Transilvaniei is also a matter of interest. At first it seems obvious that a low slopingness explains the creation of the lake series. These valleys dip very much in absolute figures, but they have a stepped structure so they have comparatively long stretches of low dip, and therefore sections of low and high dip alternate. Every section of low dip abound in lakes, unless the creation of lakes is disturbed by local factors.

Gullies also belong to the typical scenic units of the Mezőség/Câmpia Transilvaniei, which literally shave the arable soil off the deforested lands. Detrital cones of sometimes huge size of these torrents block the valleys or break the surface of the lakes, and by that contribute to the creation and sedimentation of the lakes. In the case of Lake Hodos/Ţaga we can see a prominent detrital cone, which divides the lake into two basins.

The wide and flat hilltops, which are called „goatbacks“ by the people in the Mezőség/Câmpia Transilvaniei, bassets of the tuff shelves and the frequent salt efflorescence belong to the scenic units of the Mezőség/Câmpia Transilvaniei as much as the gleaming lake surfaces, which have made the region practically the country of a thousand lakes.

Natural plant cover

Transylvania is part of the Carpathian flora region concerning the Eastern Carpathians, the Mezőség/Câmpia Transilvaniei, the Southern Carpathians and the Eastern Hungarian Island Mountains. It is only the Lower Danube region that belongs to the flora region of the Eastern Balkan. In its flora the Central European components are dominant with 43%, but thanks to the high degree of continentality of our region their share is lower than, for example, in the Western Carpathians or in Transdanubia. Alpine species are represented by 10.7%, and East Balkan species by 7%. The unique character of Transylvania is also manifested by the numerous indigenous species. Their proportion is the highest (7%) here, of the whole Carpathian Basin (Figure 16.).

The geographical picture of the vegetation of our region is a scaled-down picture of the natural plant cover of the whole large Carpathian Basin, divided into altitudinal zones. The natural plant cover of the low, enclosed, dry Transylvanian Basin is, just as that of the Great Plain, the wooded steppe on the „coffins" of the sliding land with needle grass, Volga pheasant's eye and Siberian milkwort. The offsets are covered by oak, beech and fir forests. In accordance with the strong continentality of Transylvania the lower and upper boundaries of each zone have settled higher than in the western parts of the Carpathian Basin. At the edges of the Transylvanian Basin and in the plain foreground of the Eastern Island Mountains, on the Tertiary hilly areas the oak zone ranges wide up to a height of 850-950 m.

In their rich undergrowth a number of Balkan and indigenous shrubby and weedy plants can be found. Lilac and maybe walnut are also indigenous in this zone.

The beech zone surrounds Bihar/Bihor and the Transylvanian Basin. Its upper boundary is at about 1300 m. In the north the endemic hawkweed, Transylvanian liverleaf and Josika syringa (Syringa Josikaea) are characteristic in its undergrowth.

The spruce forests crown the Eastern and Southern Carpathians in an uninterrupted zone. Formerly they covered the surface of even the Gyergyó/Giurgeu and Csík/Ciuc basins, too. The spruce zone is situated at a height of 1000-1500 m in the Eastern Carpathians, 1040-1680 m in the Southern Carpathians and the isolated spruce forests are at 1090-1530 m in Bihar/Bihor. Northern Carpathians, present themselves emerging from the spruce zone in island-like patches between 1540-2000, 2100 m. Its typical species are mugho pine (Pinus mugo), rhododendron, cranberry and juniper.

The region of the Lower Danube is a gate area concerning plant geography, too, through which a number of eastern and southern plants entered the Carpathian Basin and a great many of them stopped in front of the gate for ever. The beech zone descends the lowest here within the area of the Carpathian Basin. At lower levels semitropical trees and shrubs appear (eastern hornbeam, nettle-tree, Turkish hazel, holm oak, white linden). The slopes are covered by syringa and fustet shrubs. On the eroded cavernous limestone plateaus and rocks Austrian pines of the Bánság/Banat spread the branches of their crowns like those of stone pines do.

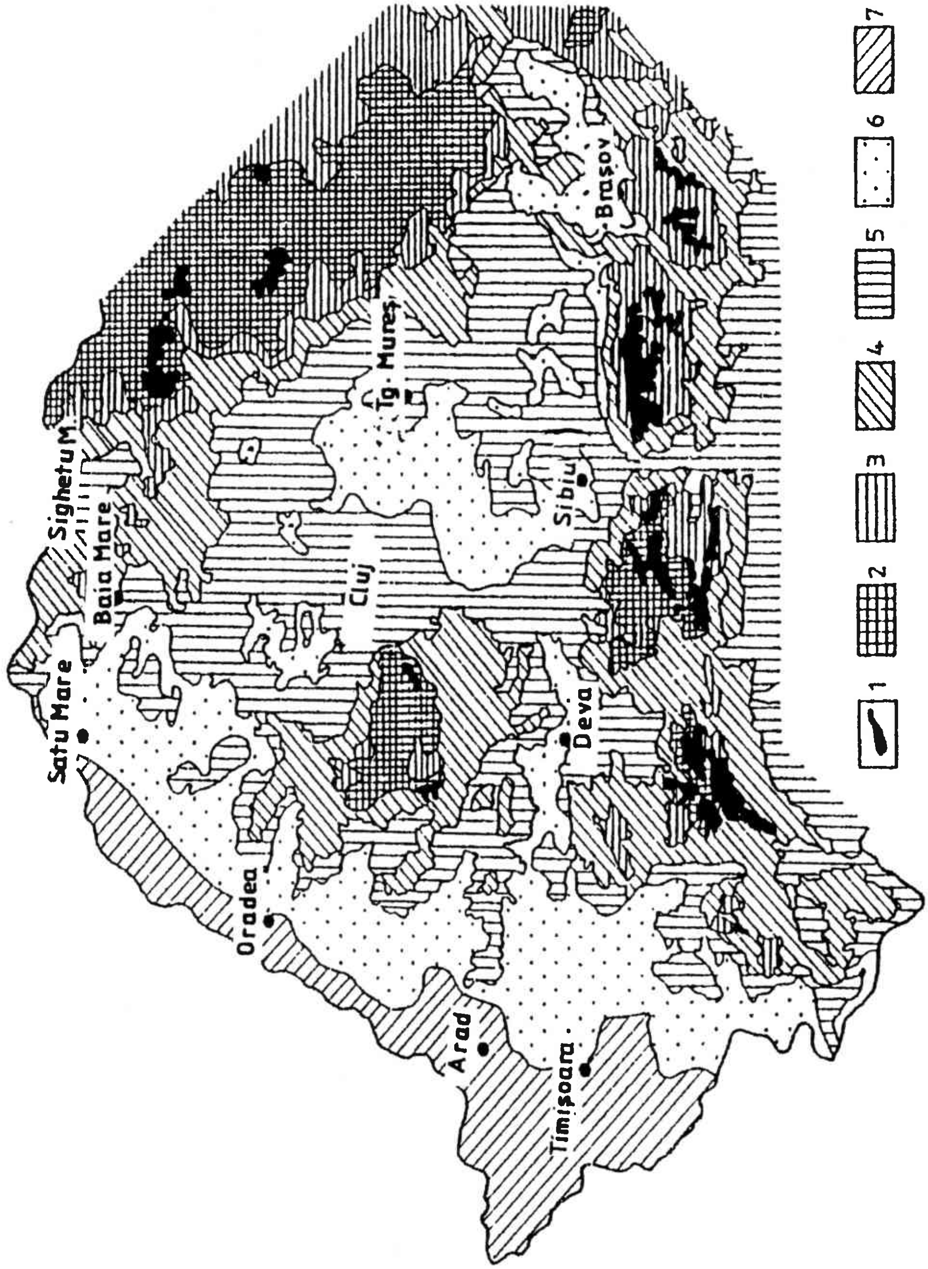

Figure 16. Vegetation of Transylvania

1. alpine and subalpine zone, 2. spruce and Scotch pine zone, 3. mixed forests of fir and beech, 4. beech zone, 5. mixed forests of oak and beech, 6. durmast and turkey oak forests 7. wooded steppe zone, (after the study book Geografia României for form XII)

The picture of the original, compact wooded land gradually changed in the course of the appearance, settlement, life and struggle of man. First, down on the plain, in the low hilly areas, in the low mountains and at the foot of them the forests were replaced by meadows dominated by herbs, especially grass. This process was accelerated at the rate of the growth of agriculture and animal rearing.

But the forests, though in patches or decreasing in extent, have survived. Therefore every scenic unit of Transylvania can be classified as a biogeographical region, or zone ranging from the wooded steppe, determined by the relief of the heath (Heide) region, to the high-mountain coniferous woods.

The varied relief of the mountains, the hilly areas and the plains cause local climatic variations in Transylvania.

Accordingly, increase in the height of the relief bring along gradual decrease in temperature and increase in the amount of precipitation. As a result, vertical levels characterized by ecosystems of different features take shape.

From a height of approximately 300-400 m, where the local climatic and bioecological influence of the relief is apparent, to a height of 900-1300 m the vegetation of the forests is dominated by durmast (up to 800 m) and beech (up to 1300 m). Above this, from 1200 to 1550 m spruce forests are most common, the areas covered by juniper and the shrubby dwarf pine form above 1600 m, and between 1900 and 2200 m the dwarf shrubs of the Transylvanian rhododendron can be found. Above that level up to the highest peaks only alpine meadows and dwarf shrubs are present.

Because of the geographical location and the bioclimatological and ecological factors determined by this location the whole Transylvanian flora region belongs to the nemoral zone of the temperate-climate forests. The forests are present from the Bánsági Plain (Temesköz)/Câmpia Banatului (Timişului) to the high, snowy alpine zone of the mountains. The boundary between two levels is not a rigid line. Local penetrations occur at several places, the reason for which is nothing else than the relief laid out in depth, the exposure of the slopes and the existence of differences in light, shade and temperature in Transylvania.

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