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# LITHOSTRATIGRAPHIC AND HYDROGEOLOGIC CONSIDERATIONS REGARDING PLIOCENE-QUATERNARY DEPOSITS FROM SFANTU GHEORGHE AND TARGU SECUIESC SEDIMENTARY DEPRESSIONS, ROMANIA

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## SUMMARY

The paper presents some lithostratigraphic and hydrogeologic considerations of Neogene and Quaternary deposits from Sfântu Gheorghe and Târgu Secuiesc depressions, based on information from recent drilling programme.

Several hydrogeological cross-sections are presented here to support the geological interpretation and tectonic evolution of the Pliocene-Quaternary deposits in the area.

Key words: lithostratigraphy, hydrogeology, Sfântu Gheorghe depression, Târgu Secuiesc depression, groundwater, aquifer strata.

## INTRODUCTION

Starting from Pliocene, the tectonic evolution of the Sfântu Gheorghe and Târgu Secuiesc depressions was favourable for developement of molasse deposits, with high lithological variability and conditions for lignite layers accumulation.

This paper is based on new information obtained from water bores, geological drillholes and also from drillholes mainly drilled to assess the potential for the presence of new lignite layers in the area, with emphasis on geology and faunal content of the Pliocene and Quaternary sediments.

A number of drillholes from Sfantu Gheorghe and Targu Secuiesc depressions have been investigated by the author. The results are present using several cross-sections and synthetic lithostratigraphic columns, which provide a new base to interpret the geology of the area as well as the groundwater potential.

## GENERAL GEOLOGY AND GEOMORPHOLOGY OF THE AREA

Based on their geomorphology, Sfântu Gheorghe and Târgu Secuiesc depressions are considered to be part of the Braşov Basin, and are developed on its north-eastern side.

Braşov Basin is situated between Oriental and Meridional Carpathians Chain of Romania and has a tectonic origin. It has been formed at the end of the Pliocene period by the high subsidence of the area, with sediments deposited into a lacustrine environment based on the fresh water input from nearby mountains rivers.

Sfântu Gheorghe depression is characterized by a well-defined piedmont, known as Câmpu Frumos, and a low flooded plain and a marsh areas drained by Olt, Negru and Târlug Rivers (Iancu, 1971). Câmpu Frumos is situated in the flooded plain of the Olt and Negru Rivers as low terraces. A large flooded plain is developed between these two main rivers,

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while in their area of confluence, which also coincides with the highest subsidence rate of the Braşov Basin, mainly marsh prevailed.

Târgu Secuiesc depression does occupy a high plain and is drained by the Negru River and its tributaries (Pişota et al.,1975).

Târgu Secuiesc and Sfântu Gheorghe depressions are linked by the Reci Valley. This deep valley is divided by the Negru River into two distinctive morphological units: a high plain, situated on the right river bank, also known as the Reci piedmont, and dune systems developed on the left hand side of the river valley.

From geological point of view, Sfântu Gheorghe and Târgu Secuiesc depressions are considered post-tectonics, developed over the Carpathian basement flysch deposits of different ages (Cretaceous at Sfântu Gheorghe depression, and Cretaceous-Palaeogene at the Târgu Secuiesc depression). Underlying the basement, unconformable, the Pliocene-Quaternary molasse deposits developed (Figure 1).

Lithologically the Pliocene-Quaternary deposits consist of a succession of sands, pebbles, clay and rare gravels, with intercalations of Pliocene lignite layers.

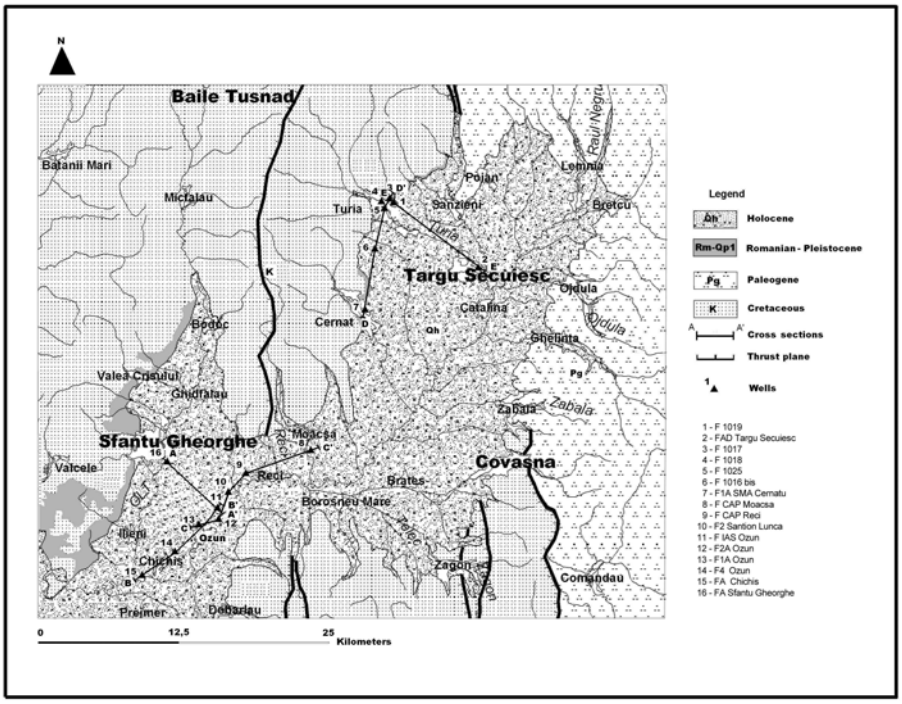


Fig. 1 Geological map of Sfantu Gheorghe and Targu Secuiesc with location of geological an hydrogeological wells (after simplified Romanian geological map, scale 1: 200 000, Covasna and Brasov sheets )

## CONSIDERATIONS ON LITHOSTRATIGRAPHY AND HYDROGEOLOGY OF THE SFANTU GHEORGHE DEPRESSION

The basement of the Sfântu Gheorghe depression is mainly formed by Cretaceous flysch deposits, which also can be seen in the outcrops of the Baraolt Mountains. Unconformable underlying the Cretaceous basement a thick sequence of Pliocene and Quaternary sediments deposited, which form the main study of the paper and are described in details below.

### PLIOCENE-ROMANIAN STAGE

Pliocene deposits represent a succession of marl, clay and sand sediments, between 50 to 150m thick, which also include lignite layers.

The outcrops of the Romanian deposits are largely exposed in the western side of the Sfântu Gheorghe depression, and their thickness vary from 5 metres in marginal areas to over 300m in the central part of the depression.

The lignite layers, developed at 35 to 85m below the surface, with thickness between 5 to 29m, are exposed and exploited in a quarry near Valea Crişului locality.

Intensive drilling programme, including water bores and geological drillholes, as well as drilling focussed to discover more lignite layers in the area, helped to understand the geological framework of the area and provided useful information about the lithology and helped in interpretation and correlation of the sediments.

Based on the logs and detailed studies of core samples from selected drillholes in the western part of the Ilieni locality, a lithological succession of the deposits has been described, including clay, sandy clay and grey sand with lignite layers. Cross sections show that these are lenses deposits and their thickness varies from 0.02 to 0.6m.

Also four out of 31 water bores drilled near Sfântu Gheorghe town, in the Olt River flood plain, intersected one or more lignite layers at different depths (between 18 to 30m below the surface), followed by Early Pleistocene marl sediments (4-6m thick) and modern alluvial deposits of the Olt River (15 to 20m thick).

The age of this lithological complex with lignite layers is Romanian based on mammal faunas with *Anancus arverniensis* CROIZET & JOBERT and also the first appearance of *Ursus* spp. , both described in the lignite layers at Ilieni locality.

Similar mammal faunas with *Anancus avernensis* has been described by Rădulescu *et* al., 2003, in the north-western side of the Sfântu Gheorghe town. The age of these faunas is Romanian, the end of Gilbert epoch, about 3.6 Ma.

**QUATERNARY**

In the Sfântu Gheorghe depression the Quaternary is represented by Early, Middle and Upper Pleistocene and Holocene.

Outcrops of Early and Middle Pleistocene deposits are developed only on the western side of the depression, the rest of the area being covered by delluviall and prolluvial sediments.

Lithologically these sediments contain a sequence of sand, sandy clay, pebble and gravel sediments, with adjacent calcareous tuffs.

Along the Ilieni Creek, immediately on the western side of the village, there are several outcrops of terrace deposits consisted of fine to medium coarse quartz grained sand, yellowish-reddish in color, slightly unconsolidated, up to 2-3m thick, followed by a sandy marl bed with fragments of unidentifiable faunas. On an outcrop on Debren Valley, in western part of Sfântu Gheorghe town, the succession start with fine quartz grained, yellowish sand (up to 2.2m thick) overlaid by fossiliferous sandy clay (Bandrabur, 1964).

Moulds of *Viviparus* sp. and *Dreissena* sp. have been observed in the calcareous tuffs, outcropping west-south-west near Arcuş locality.

On the eastern side of the Sfântu Gheorghe depression small outcrops of Early-Middle Pleistocene age can be observed along Petrecu Creek, and on the western side of the Ghidfalău locality, immediatelly under the terrace deposits of the Olt River.

The Late Pleistocene deposits are widespread in the area and consist of medium to fine quartz grained sand, occasionally coarse quartz grained sand, grayish or yellowish in color, containing intercalations of pebbles and boulders of andesitic rocks.

The Late Pleistocene age of these deposits has been assigned based on the presence of mammal faunas including *Mammuthus* (*Mammonteus) primigenius* BLUMENBACH*, Coelodonta antiquitatis* (BLUMENBACH) and *Bizon priscus* BOJAR.

Alluvial deposits of similar age have been developed on the lower terrace of the Olt River, containing also mammal faunas (Liteanu *et* al., 1962).

Holocene period is represented by alluvial and delluvial deposits, mainly argillitic silt, sandy, with rare pebbles and thickness between 2 to 10m, assigned to the Early Holocene, while the alluvial plain is assigned to the Late Holocene.

Hydrogeological cross sections and geological interpretation of the lithology in the Sfântu Gheorghe depression conclude that the Romanian deposits are mainly represented by marl followed by lignitic clay and lignite layers, while the Quaternary sediments are more variate lithologically and also have a lateral facies variability. Towards the margins of the depression the Quaternary facies is predominantly detritic (pebbles, sands, gravels) with argillaceous intercalations subordinated. In the central part of the depression the pelitic facies dominates, while the detritic one is subordinated (Plates 2, 3, and 4).

The Romanian-Pleistocene boundary is based exclusively on lithological criteria and interpretation and is placed at the upper part of the marl-lignitic sequence.

## HYDROGEOLOGY

The presence of high permeability beds within Quaternary and, subsequent, Romanian deposits of the Sfântu Gheorghe depression have been favorable for the accumulation of high and important groundwater resources in the area.

The hydrogeological conditions depend on multiple factors, such as: variability of the thickness of the deposits, lithology and facies.

The research in the area show the presence of a phreatic groundwater substrata, hosted in Quaternary deposits, and a deeper one hosted in the Pliocene deposits.

The *phreatic aquifer* substratum is hosted in the terrace deposits of the Olt River and Negru Creek, in recent sediments of the alluvial plain of the above rivers and also in the piedmont deposits near Săcele locality.

In the flooded plain of the Olt River the aquifer strata is well developed and the permeable deposits, up to 23m thick, consist of pebbles with gravels and sand and rare thin sandy clay intercalations.

Some springs are present on the left side of the base of Olt River terrace along the portions where it is erroded by the water.

Strong drainage caused by the Olt River is observed at Ghidfălău locality towards north. The aquifer strata from terrace gain most of the water from precipitations, drainage of the aquifer lenses from delluvial-prolluvial deposits of the depression and, possible, from deepest aquifer strata.

General flowing direction of phreatic aquifer strata is north to south, with locally changing directions to NW-SE (on the right) and NE-SW (on the left) of the Olt River banks. The mean multi-annual hystrostatic level in the flood plain area usually occurs at a depth not exceeding 1-2m, while in the terrace areas it is much deeper, up to 20m from the surface level.

The second phreatic aquifer strata from Sfântu Gheorghe depression is hosted into the psamitic-psefitic deposits of the alluvial plain of the Olt and Negru Rivers.

A phreatic aquifer stratum is also considered to be the groundwater present within delluvial and delluvial-prolluvial deposits overlaying the basement and at the morphological contact between the mountain chain and the plain. Those strata are developed as lenses and their life existence is controlled by precipitation and the pressure of groundwater level. Their debit is insignificant and do not represent important target for exploitation.

The aquifer strata hosted into Quaternary deposits is represented by pebbles and sands, and was well investigated by intensive drilling program. It has a high debit and the permeability coefficients are varying between 5-200 meter per day, with transmissivity 100-500 $m^2$/day. Only at Ilieni locality transmissivity is >500 $m^2$/day.

The Pliocene deposits host a multiple aquifer strata on the top and bottom of the lignite layers. The main characterisitics of the aquifer include ascending level and the artesian character of the bottom strata, low debits (0.2 to 0.36 l/day) and mean transmissivity of cca 1 $m^2$/day (Ţenu et al., 1985).

The porous-permeable deposits, intersected in numerous water bores, are between 100 to 150m thick, with a variable debit (2.5 to 4 litre/second).

An example from Sfântu Gheorghe water bore (with a total depth of 212m) show that porous-permeable desposits, mainly represented by sands, pebbles, gravels and clays, are developed as lenses up to160m depth. The marl-lignitic Pliocene horizon has a reduced capacity for groudwater storage.

Another example from Chichiş water bore (with a total depth of 200m) show the presence of two multiple aquifer strata of granular type.

An aquifer stratum 1, intersected between 25 to 110m, is represented by pebbles and gravels into a sand matrix with intercalations or marl and sandy marl towards the base, which also contain few lignite layers.

Aquifer strata 2 (between 180-200m interval) are represented by sand and sandy clay graded into clay.

The well presents artesian level having piezometric head of + 0.8m and the yield of 1 l/sec.During pumping test there were obtained yields of 3.31-5.2 l/sec. for drawdowns of 18.8-31.3m. The specific yield has the value of 0.17 l/sec./m, indicating an aquifer with low pontential. The determinated hydrogeological parameters have also low values: K= 0.387 m/day, T = 17.55 $m^2$/day.

## TARGU SECUIESC DEPRESSION

Târgu Secuiesc is an intramontane depression, post-tectonic, with a Carpathian flysch basement, formed by subsidence during Rhodonian tectonic movements and filled up with Pliocene-Quaternary molasse sedimentary cover.

The basement is represented by Cretaceous-Palaeogene flysch deposits, distributed along north-south fault alignments and folded from west to east direction.

Sedimentary cover of the Târgu Secuiesc depression is composed of Pliocene (Romanian stage) and Quaternary sediments, represented by and sands, clays, sandy clay with alternance of pebbles and rare gravels. The thickness of these sediments varies along east-west direction, from 6m at the margins of the basin and up to 100m in the central part of the basin (e.g. drillhole from Covasna railway station).

The sedimentary cover of the basin starts with Romanian deposits, which unconformable overlay the Cretaceous-Palaeogene basement flysch deposits.

Rare Romanian outcrops are present on a small area in northern part of the Târgu Secuiesc depression, at NW of Cernatu de Jos locality. They unconformable overly the Cretaceous basement flysch deposits and are represented by yellowish and off-white sand, up to 10m thick, with numerous lignite intercalations (all together up to 2m). These thin lignite layers have been quarried in the past.

The age of these sand deposits has been assigned to Middle Romanian (Rădulescu *et* al., 2003 b.) based on mammal remains faunas preserved at Cernatu sand quarry. These deposits are predominantly pelitic (clay, sandy clay, clay with calcareous concretions and marl) with intercalations of medium to fine quartz grained sand which with lignite layers and lignitic clay. They form a clay-lignite unit which is up to 300-350 thick in the central part of the basin (Plates 5 and 6).

The interpretation of geological cross sections, based on information provided by logs and core samples descriptions from drillholes and water bore, suggest the presence of several faults along north-western side of the Târgu Secuiesc depression, formed and activated during Valahian tectonic movements (Plate 5).

## QUATERNARY

Quaternary is represented by Pleistocene and Holocene deposits.

The Early Pleistocene outcrops are exposed on the western side of the Târgu Secuiesc depression and are constituted of an alternance of sands, pebbles and clays, with lenticular appearance.

At Cernatu de Jos quarry medium quartz grained sand, off-white to greyish-yellowish in colour, with intercalations of coarse quartz grained sand, occasionally with pebbles and sandstone lenses have been exposed during mining and have a total thickness of 2-4m. They are fossiliferous with small gastropod faunas including *Viviparus* sp., *Bulimus* sp. and *Theodoxus* sp. The age of those deposits is Early Pleistocene and has been assigned based on similar lithological and faunal characteristics described on the western side of the Sfântu Gheorghe depression by Bandrabur, 1964b.

Middle Pleistocene deposits have been observed and described from core samples collected from a historical drillhole near Covasna rail station. Here there is an alternance of sands, pebbles and rare gravels with Cretaceous-Palaeogene flysch basement fragments, with intercalations of clays and sandy clay.

The Late Pleistocene sediments are represented by prolluvial fans, which constitute the Dalnic, Covasna and Ghelinţa piedmont, and by terrace deposits of Negru River and Turia Creek, with a total thickness of 8-12m. They consist of sands and pebbles with andesite fragments. A molar tooth of *Coelodonta antiquitalis* has been found and described from these deposits (Bandrabur, 1967), which confirm the Late Pleistocene age.

In the Covasna-Tufalău-Peteni area the sediments intersected by historical drillhole at Covasna railstation are represented by an alternance of sands, pebbles, occasionally gravels, with sandy clay intercalations which also contain rounded bedrocks (Bandrabur, 1964 a). Based on lithological similarities of the above deposits with those described from Baraolt Basin and Olt Valley, they have been assigned to the Late Pleistocene-Holocene interval.

Holocene is represented by prolluvial terrace deposits of 4-6m thick including sandy silts, sandy clays and argillaceous sands, yellowish-reddish, with a thickness of 1-10m

Early Holocene include Negru River's and Turia Creek's lower terrace alluvial deposits represented by coarse to medium grained andesitic sands, greyish to off-white, with small pebbles, rounded with a total thickness of 2-3m.

The Late Holocene is represented by flood plain alluvium and alluvial fans sediments.

The synthetic lithostratigraphic column of Pliocene and Quaternary deposits is represented in Figure 2.

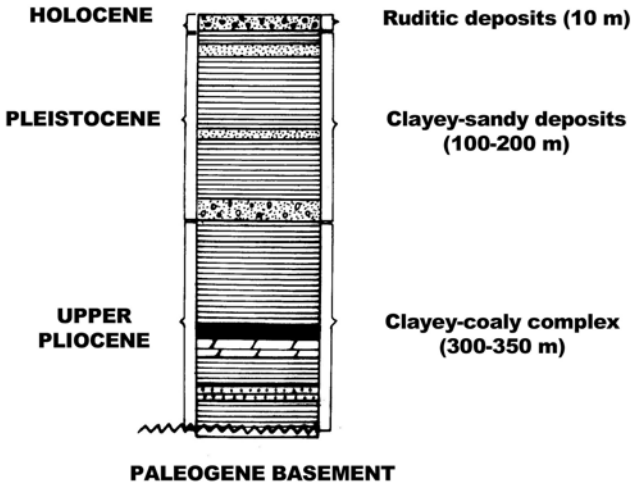


Fig. 2 Lithostratigrafical column for the eastern area of the Targu Secuiesc depression (Ojudula)

## HYDROGEOLOGY

The molasse deposits from Târgu Secuiesc depression host two aquifer strata: phreatic and deep aquifer.

The *phreatic aquifer* strata is hosted in the Holocene permeable flood plain deposits constitute of pebbles and gravels with sand intercalations, with a total thickness of 4-10m .In the terrace area the phreatic aquifer strata is present in sandy clay with clayey sand intercalations which can be up to 20m thick. This particular aquifer stratum can also be present in the piedmont areas.

The phreatic aquifer is influenced by a strong drainage generated by Negru River, Caşin and Turia Creeks, with no influence from smaller creeks, such as Capolna, Ojdula and Valea Mare.

The general flow direction of phreatic aquifer strata in the Târgu Secuiesc depression is north to south, slightly changed locally (NW to SE in Dalnic piedmont and Turia Creek, and W to E in Ghelința piedmont). It gains most of the water from precipitations and, on a few segments, from local network drainage.

The mean potential values for this phreatic aquifer include hydraulic conductivities of 10-30 m/day and transmissivity between 50-100 $m^2$/day. The highest

transmissivity values have been recorded near Sânzieni locality (500-1000 $m^2$/day).

The *deep aquifer* has a multi-strata character and is hosted within Romanian-Early Pleistocene deposits, being investigated and observed only by drilling.

A historical drillhole drilled in 1910, up to 230m deep in the backyard of the former townhouse in Târgu Secuiesc town, intersected four aquifer strata hosted in the Pleistocene deposits including coarse and medium quartz grained sands, occasionally gravels. These four aquifers are developed between 40-56m, 73-89m, 133-134m and 216-230m intervals.

Another water bore in the Târgu Secuiesc town, drilled to a depth of 340m intersectd Quaternary deposits up to 145m followed by Romanian sediments.

The Quaternary deposits are mainly detritic and represented by sands, pebbles and gravels, and subordinate pelitic (clay and sandy clay). On the other hand, Romanian deposits are prodiminantly pelitic at the base of the succesion (fine, micaceous clay, with rare lignite layers and fine to medium quartz grained sand, clayey) and subordinate detritic towards the top (coarse quartz grained sands with pebbles).

Three aquifer strata were intersected by this water bore and thei main characteristics are present below.

Aquifer 1, between 65 to 140m depth, is artesian and hosted within Early Pleistocene deposits, with piezometric level $N_p$ + 2.30 m and debits between 6-11 litre/second for elevation of the piezometric surface between 4-6.5m.

Aquifer 2, between 186 to 250m depth, and aquifer 3 (301 to 326m) are both hosted within Romanian deposits. The piezometric surface of those aquifer strata is situated at 4 m depth with elevations between 4.8 to 10m and debits varying from 1.7 to 3.7 litre/second.

Based on their debits aquifer 1 has a higher potential comparative to aquifers 2 and 3 and the calculations were based on the grain size of the sediments (1.5 to 1.7 l/s/m for aquifer 1 and 0.35-0.37 l/s/m for aquifers 2 and 3). These values indicated for the Quaternary aquifer a potential better than the Romanian one.

## CONCLUSIONS

Sfântu Gheorghe and Târgu Secuies depressions are post-tectonic with Carpathian flysch basement of Cretaceous age in the case of Sfântu Gheorghe depression, and Cretaceous-Palaeogene for Târgu Secuies depression. The sedimentary Pliocene-Quaternary cover has a molasse character and unconformable overly the flysch deposits.

Based on hydrogeological cross-sections, the Quaternary deposits from Sfântu Gheorghe depression are lithologically more variat and with lateral facies distribution comparative to Romanian sediments.

From tectonic point of view, on the north-western side of the Târgu Secuiesc depression is affected by a several faults activated during Vahalian orogeny, all being observed in the core samples from intensive drilling programme in the area.

From hydrogeologic perspective Sfântu Gheorghe depression has a wide distribution of porous-permeable deposits, with different grain size, thickness and facies, which is more favourable for groundwater accumulation than Târgu Secuiesc depression.

This lithofaciesal constitution determinates accumulation better conditions of groundwater for Quaternary deposits in the Sfantu Gheorghe depression, comparatively with the Targu Secuiesc depression ones.

**REFERECENS**

BANDRABUR T. (1964 a) - *Cercetări hidrogeologice în regiunea Covasna - Tufalău - Peteni.* D.S.Com.Geol., XLIX/1, (1961 - 1962), p. 193 - 211, 3 pl., Bucureşti

BANDRABUR T. (1964 b) - *Contribuţii la cunoaşterea geologiei şi hidrogeologiei depozitelor cuaternare din bazinul Sf. Gheorghe.*D.S. Inst.Geol., L, partea a II a, (1962 - 1963), p. 415 - 432, 1 pl., Bucureşti

BANDRABUR T. (1967) - *Observaţii geologice şi hidrogeologice în zona Tg. Secuiesc.* St. tehn. econ., seria E, nr. 9, p. 87 - 105, 3 pl., Bucureşti

DUMITRESCU I. SĂNDULESCU, M. BANDRABUR, T. SĂNDULESCU, J. (1968) – *Harta geologică a României, scara 1:200.000, foaia Covasna*

IANCU M. (1971) – *Judeţele patriei. Judeţul Braşov.* Edit. Acad. Rom., 159 p., Bucureşti

PISOTA I., MIHAI E., Iovănescu M. (1975) - *Judeţele patriei. Judeţul Covasna*. Edit. Acad.Rom., 139 p., Bucureşti

PATRULIUS D., DIMITRESCU R., GHERASI N. (1968) – *Harta geologică a României, scara 1:200.000, foaia Braşov*

RĂDULESCU C., SAMSON P., ŞTIUCĂ E., HOROI V. (2003 b) *Mammals. In „Chronostratigraphie und Neostratotypen.* Romanien"Bd.X, Edit.Acad.Rom., p. 481-513, Bucureşti

ŢENU A., DAVIDESCU F.D., SLĂVESCU A., CUNESCU M. (1985) - *Elemente noi privind hidrogeologia Depresiunii Sfântu Gheorghe.* Hidrotehnica,30, 5, p. 129 - 134, Bucureşti