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HYDROGEOLOGICAL CONTRIBUTIONS FOR THE EXISTENCE OF THE GETIC NAPPE IN THE MOTRU SEC–BAIA DE ARAMĂ REGION

BY

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Tracer investigations proved the continuity of the limestones of the Danubian Unit under the crystalline schists of the Motru Sec-Baia de Aramă zone and hence the existence of the Getic Nappe was established in this area by use of a hydrogeological metod.

1. INTRODUCTION

The overthrust nappe structure of the Southern Carpathians was first noted by G. Murgoci (1905), who distinguished two great tectonic units, the Getic Nappe and the Danubian Autochthon. The former consists of a huge overthrust nappe covering partially the deposits of the latter.

In 1936 Al. Codarcea observed the existance of two distinct phases in the evolution of the Getic Nappe. In the first phase, the Getic Domain, initially situated west of the Danubian Domain from which it was separated by a cordillera of Cretaceous flysch formations, partially overthrust the Danubian Domain, including in its base and front the Cretaceous flysch that is thus an independent unit referred to as the Severin Nappe.

The second Getic phase that took place during the Laramian paroxism led to the tectonic covering of the Danubian Unit by the Getic Nappe (with the Severin Nappe at the base). The first phase of the Getic Nappe thrusting is assigned to the Lower Aptian-Upper Aptian interval, and the main thrust to the Senonian (Săndulescu, 1984).

The present-day tectonic picture, which is the conjoined result of the research carried out by numerous geologists, is drawn on the geologic maps of Romania (scale 1 : 50.000), those drawn by Pop et al. (1975) and Bercia et al. (1977) being the geological base for our research.

2. HYDROGEOLOGICAL ENVIRONMENT

The zone under examination is situated west of the Motru River and includes the inter river between its tributaries, Motru Sec and Bulba, the latter running through Baia de Aramă locality before flowing into the Motru River. In geomorphological terms, this area represents the north-eastern extremity of the Mehedinţi Mountains and Plateau. The morphology of the karstic Mehedinţi Plateau and its correlation with the general drainage trends directions are the object of a compendium paper published by Goran in 1978.

In terms of geology, the area is built up of the northeastern end of the Bahna Outlier (Getic crystalline rocks) lying over the Severin Nappe deposits, consisting of an ophiolite formation with basalts and satined clays, the over-all array resting on the Danubian Domain deposits (fig. 1).

At the base of the Danubian Domain, Lainici-Păiuşi series paragneisses and Tismana granies underly the sedimentary deposits consisting largely of metric beds of Middle Jurasic-Neocomian limestones, as well as Barremian-Aptian massive limestones of Urgonian type and Neo-Cretaceous wildflysch formation.

Hydrogeological studies performed by Slăvoacă and Orăşeanu[1] (1970) showed that in the Urgonian limestones north of the Bahna Outlier that belongs to the Getic Nappe, important water seepage occurs in the ground, both from the Motru Sec river and its tributaries on wildflysch covered grounds. The latter lose all their water for almost the entire year once they run on limestones.

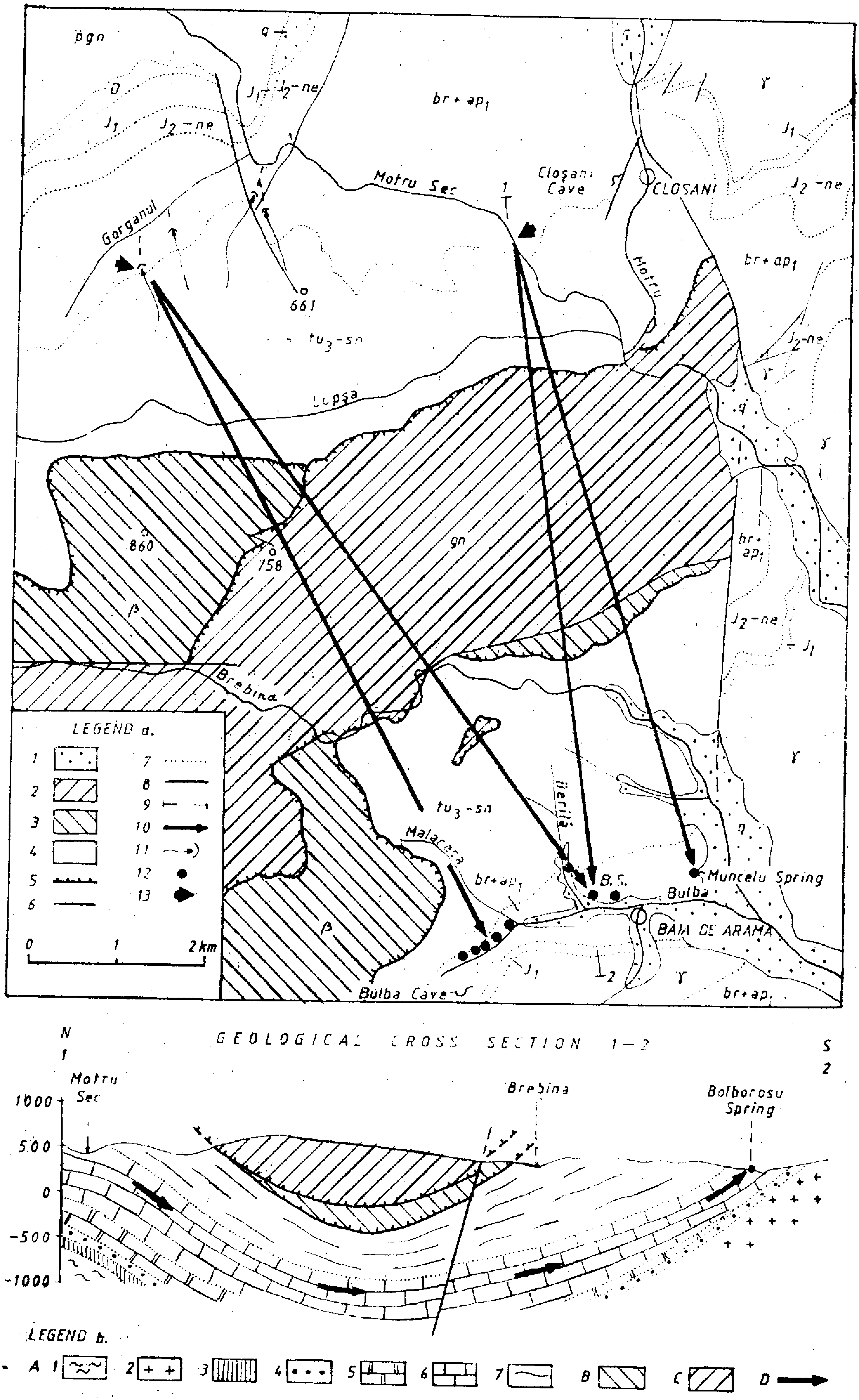
In the limestone strip that crops out south of the Bahna Outlier and is crosed on strike by the Bulba Brook, the hydrogeolog.c environment is quite the opposite ; there are high-flow springs abound and no seepage occurs in the limestone substratum. On the left bank of the Bulba Brook, springs are spraun on an area lying east of the confluence with the Malareca Brook as far as the Muncel Spring (30 l/sec), including the springs neighbouring the junction with the Găina Brook and those on Pîrîul lui Berilă and Bolborosu Spring (20 l/sec).

3. TRACER INVESTIGATIONS IN KARST

From the insurgences evidenced by hydrogeological research we selected for study a tributary of the Gorgan Brook that loses its water in the bed over several tens of meters distance as soon as it leaves the slightly permeable deposits of the Cretaceous flysch.

Fig. 1. Main underground drainage directions in Motru Sec—Baia de Aramă area (the geologic base after Pop et al. 1975 and Bercia et al 1977). gn-gneiss ; pgn-paragneiss . γ-granite ; β-basalt ; J_1-lower Jurasic ; J_2-ne -upper Jurasic-Neocomian ; br+ap_1 — Barremian+lower Aptian ; tu_3-snupper Turonian-Senonian ; q-Quaternary ; B. S. -Bolborosu spring.
Legend a : 1 — Quaternary ; 2 — Getic nappe ; 3 — Severin nappe ; 4 — Danubian unit ; 5 — overthrust front ; 6 — fault ; 7 — geological boundary ; 8 — boundary of quaternary formations ; 9 — geological cross section 1—2 ; 10 — traced underground direction ; 11 — swallet ; 12 — spring ; 13 — tracer release location. Legend b : A — Danubian unit : 1 — paragneiss ; 2 — granite ; 3 — chlorite shists (Devonian) ; 4 — conglomerates, sandstones (J_1), 5 — limestones (J_2-ne) ; 6 — limestones (br+ap_1) ; 7 — wildflysch formation (tu_3+sn) ; B — Severin nappe ; C — Getic nappe ; C — Getic nappe ; D — traced underground flow direction.

[1] Slăvoacă D., Orăşeanu I. (1970) — Cercetări hidrogeologice în zona Motru Sec—Baia de Aramă. Raport IPGG, Bucharest.


pgn
br + ap1
Motru Sec
Cloşani Cave
CLOŞANI
Gorganul
661
tu3-sn
Lupşa
Motru
860
758
gn
Brebina
LEGEND a.
0 1 2 km
Malacasa
br+ap1
B.S.
Bulba
Muncelu Spring
BAIA DE ARAMĂ
Bulba Cave
GEOLOGICAL CROSS SECTION 1—2
Motru Sec
Brebina
Bolborosu Spring
1000
500
0
-500
-1000
LEGEND b.

The relation between this insurgence and the Baia de Aramă springs, through the Jurassic-Cretaceous limestones, under the Getic crystalline rocks of Bahna Outlier were checked with the aid of radioactive tracers in July 1970.

The chemical analysis of the waters in the above-mentioned slope and of ahe springs in Baia de Aramă showed the presence of sodium iodine in 0,1 mg/l concentrations, hence, the tracer used was ^{131}I since the environment was extremely stimulating for it.

At the springs in the Baia de Aramă zone are a source of drinking water, the tracer had to be used in such quantities that the radioactive concentrations range below the maximum level tolerated by law.

The device used for in situ measuring of the ^{131}I concentrations permitted the measurement of concentrations bigger than 10^{-6} Ci/cm^3. However, as such high concentrations were not allowed, the tracer was concentrated on filteres with active coal.

Measurements performed on filteres collected from the Muncelu and Bolborosu springs showed the presence of ^{131}I. The tracer was first identified 96 hours after the injection. The calculation of the recovered tracer mass balance shows a value of 3.5x10^5 m^3 dynamic reserves.

The underground relation between the drained waters of the Motru Sec basin and the Baia de Aramă springs was proved. As for the Motru Sec river, the presence of partial water loss in the narrow joints of the riverbed where the river crosses the limestones suggested certain connexions with the same springs in Baia de Aramă area.

The first question of interest was the flow lost per unit volume by the Motru Sec river. The formula proposed by Hull (1958),

$$Q = \frac{A}{\int_0^T C dt},$$

permits an exact and rapid determination of the river loss.

The measurement of the flow rate per unit volume by use of this procedure consists in determining the integral $\int_0^T$ Cdt at some downstream detective point after having injected an amount of tracer A. Note that the restriction ordinarily set in other methods than the cross-sectional area should by known and constant is no longer necessary here. This means that the flow rate in natural streams with irregular cross-sectional areas can be determined with the aid of this method.

Using NH_4Br^{82} as a tracer and a scintillation detector measuring the counting rate R instead of concentration C, we have determined the Motru Sec river flow per unit volume by mean of the relation

$$Q = \frac{A}{(1/f)\int_0^T R dt}$$

where f is a calibration factor and $\int_0^T R dt = N$, is the total number of pulses measured upon passage of the radioactive cloud. The upstream flow was measured in the area of crystalline schists development, north of the karst zone. and the downstream flow was determined in the area where Motru Sec passes through the Cretaceous flysch deposits. Measu-

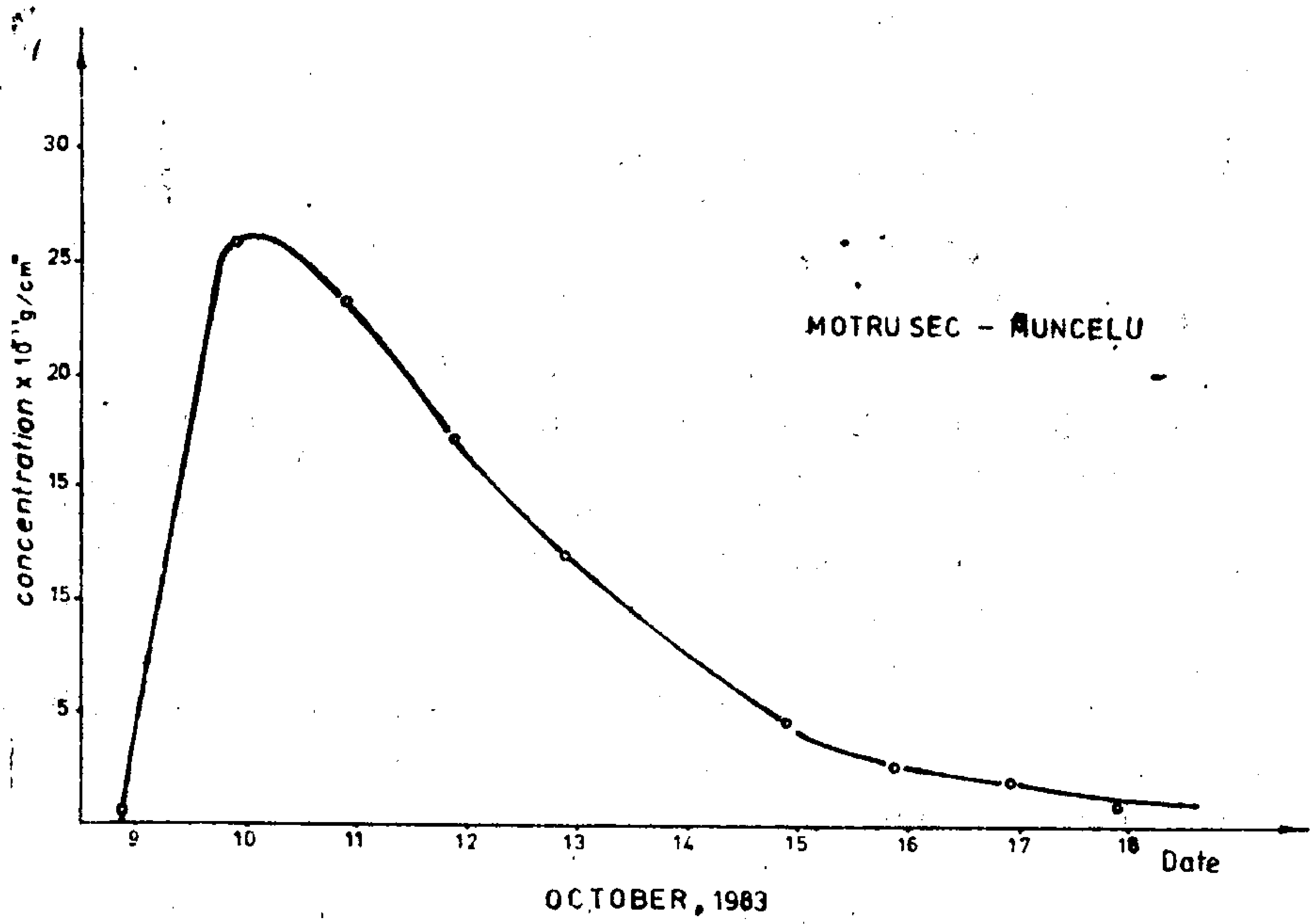


Fig. 2. Transfer curve obtained for the Motru Sec swallet-Muncelu spring experiment.

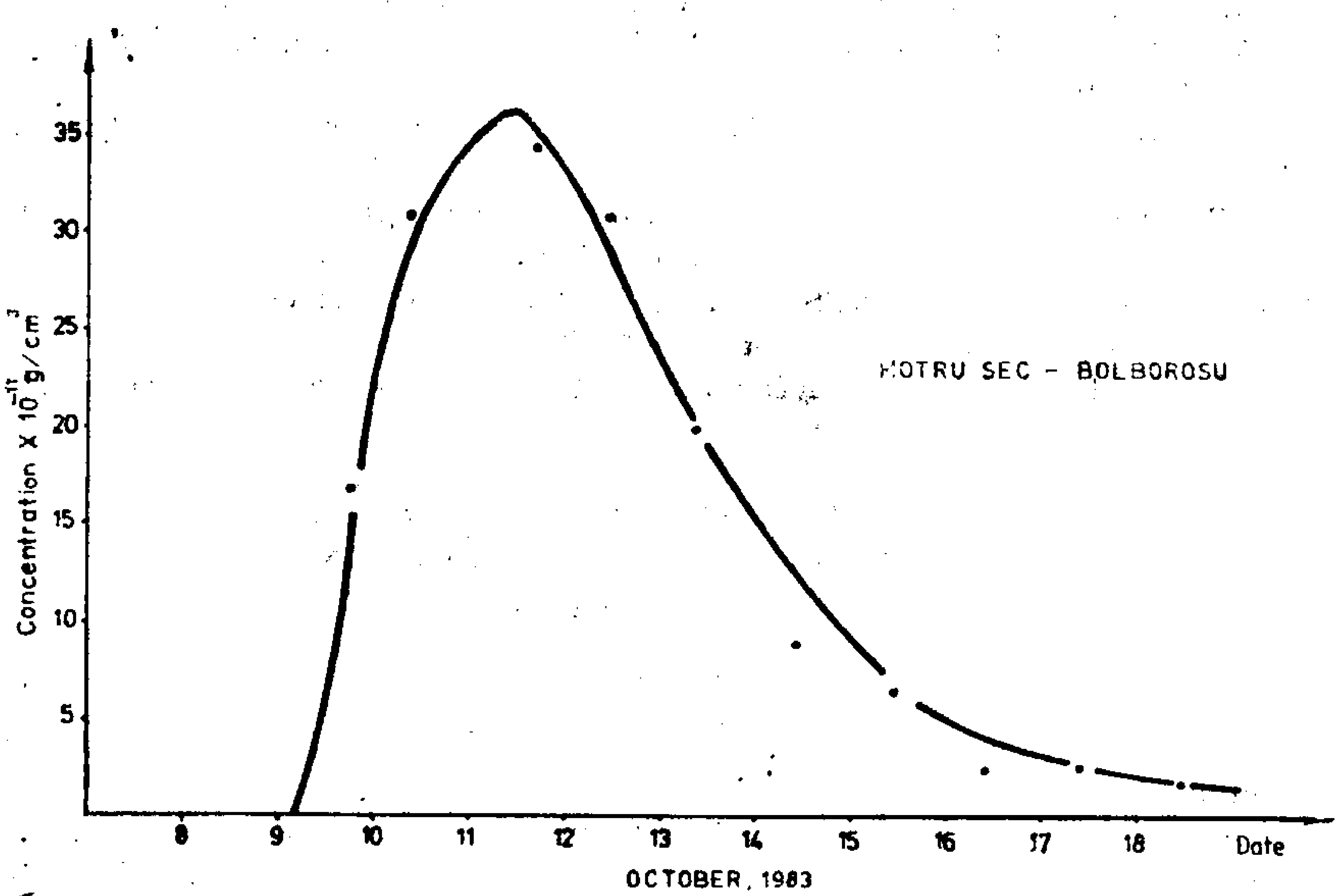


Fig. 3. Transfer curve obtained for the Motru Sec swallet-Bolborosu spring experiment.

rements carried out in July 10, 1970 indicated a water loss of 100 l/sec.

For marking the Motru Sec seepage area a method of ecologic tracing was necessary. The tracer had to have a very great detection sensitivity or else important amounts of it hat to be put into water. Thys was done as late as October 1983, when the In-EDTA tracer permiting ecologic tracing, was available. Measurement were performed by use of the activation analysis, the minimum detactable concentration being 10^{-12} g/cm^3.

The water samples collected from the main springs at Baia de Aramă, Muncelu and Bolborosu, showed that the tracer appeared almost simultaneously in both places, after about 120 hours. As shown in fig. 2 and 3, where the transfer curves obtained are drawn, underground drainage between Motru Sec river and Baia de Aramă springs was proved. The average transit period was of 206 hours for both springs. The shape of the curves and the average transit period show that marking follows a flow pattern typical of pipe-like karst holes, without intermediate transit in the additional subsystems, determinations being done at the end of a droughty season.

Tracer investigations proved the continuity of the limestones of the Danubian Unit under the crystalline schists of the Motru Sec — Baia de Aramă zone, and hence the existance of the Getic Nappe was established in this area, by use of a hydrogeological method.

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CONTRIBUȚII HIDROGEOLOGICE LA STABILIREA EXISTENȚEI PÎNZEI GETICE ÎN ZONA MOTRU SEC — BAIA DE ARAMĂ

Rezumat

Cercetările hidrogeologice efectuate în zona Motru Sec—Baia de Aramă au pus în evidență în fișia de calcare situată la nord de banda de șisturi cristaline atribuite pînzei getice, prezența unor mari pierderi de ape în subteran, atît din rîul Motru Sec cît și din afluenții lui formați pe terenurile înconjurătoare necarstice. În aceleași calcare, repartizate structural domeniului danubian, care aflorează la sud de șisturile cristaline situația hidrogeologică este opusă și se individualizează prin prezența a numeroase izvoare.

Marcările cu trasori radioactivi (131-I) şi activabili (In-EDTA) efectuate în această zonă au stabilit legătura hidrogeologică dintre pierderile şi aporturile menţionate anterior, dovedind continuitatea calcarelor unităţii danubiene pe sub şisturile cristaline din zona Motru Sec-Baia de Aramă şi implicit existenţa pînzei getice în această regiune.

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