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Im memory of Gabor Halasi
who knew and loved
these places so much.

HYDROGEOLOGICAL STUDY OF MONEASA AREA (CODRU MOMA MOUNTAINS)

BY

I. ORAŞEANU

The complex hydrogeological research work conducted in the Moneasa area indicated the presence in the deposits of the Finiş Nappe of a strong hydrogeological karst system, which is partially thermalized at its southern terminus, at its contact with the impermeable deposits of the Moma Nappe.

Numerous tracer labellings, pumping tests and hydrogeological balances outlined the hydrogeological features of this karst aquifer and the relationships between cold and thermal karst waters.

The Moneasa area, situated in the Apuseni Mountains, in the western-central part of the Codru-Moma massif, is well known for its thermal waters (24 to 32.8°C), which are exploited through four springs and three wells. Traversed by the same-name brook, a tributary of the Crişul Alb in Sebiş, the aforesaid area distinguishes itself owing to a great morphological variety, which is an outcome of a complex geological structure.

The terrains situated north of the Moneasa Valley, which geographically speaking, belong to the Codru Mountains, boast a varied relief, with major features facing the North-South running parallel to the direction of the geological structure. The morphology of this sector is dominated by the Izoi summit, the altitude of which top 1,000 m (1,097.7 m in the Izoi peak) wherefrom the relief collapses more than 400 m to the East to the lithologic contact depressions of Brătcoaia and Izoi-Tinoasa, continuing its fall to the East down to the Megheş valley, which is situated at an average altitude of roughly 350 m.

The left-hand slope of the Moneasa valley is exclusively made up of the rough Permian deposits of the Moma Mountains and features a rough terrain with deep torrential valleys and steep-walled slopes.

The water in the area are collected by the Moneasa brook, which run across a tectonic valley clasely folloing the overthrust plane of the Moma Nappe over the Finiş Nappe. The supply of the brook in the area under discussion is assymetrical, with tributaries which mainly feature karstifiable deposits (the Megheş, the Băilor, the Scăriţa and the Pietros brook) on right side only.

The Moneasa's meadow at the confluence with the Megheş and the Băilor brooks, situated at an average altitude of 285 m, has a maximum width of roughly 100 m and, partially, is the site of the balneal spa here.

The Megheş brook gathers its waters from under the Dîmbul Zocarului hill and the karstic depression of Izoi-Tinoasa. It boasts a norrow valley with steep-walled slopes and tributaries which are supplied by permanent karstic sources (the Viezuroiu, Răchitaru and Megheşul Sec brooks).

The Băilor brook has its major source in the Grota Ursului resurgent cave ; its downstream valley is narow and highly erosive in character. The valley upstream of the cave, known as the Feredeu valley, is dry and grassy, with stabilized slopes.

The morphology of the karstic terrains is dominated by the lithologic contact depressions Brătcoaia and Izoi-Tinoasa, adding to which are numerous other exokarst (lapies, sinkholes) and endokarst (56 caves and potholes) formations.

The lithologic contact depressions develop on Triassic limestones and dolomites at the contact with the Werfenian quartzitic sandstones partially featured by the Izoi crest. The runoff water from that crest infiltrates into the underground through impenetrable ponors, with the depressions lacking a main collector. They form an endorheic zone, that has no epigene hydrologic relationship with the neighbouring hydrologic network.

The endokarst is represented by numerous caves and potholes, noteworthy among which are :

— Peştera cu Apă de la Moară, a resurgent cave which is 2,012 m long, with a level difference of 35 m. It is through it that the waters in the cave from Merăzerie (which is 538 m long), situated 630 m to the North-East, are drained ; at present there is no speleological connection between the two caves ;

— The Grota Ursului cave is 250 m long and was discovered by G. Halasi in 1984 at the end of explorations in the 20 m long siphon wherefrom the Grota Ursului spring emerges. The cave was subsequently intercepted through a mining drift to make it suitable for tourist purposes.

The most remarkable karst feature in the Moneasa area is the pothole in the Teia valley. It is situated in the eastern part of the area, nearby a marble quarri, and is made up of red breccious limestones. It is 1,337.5 m long, has a 90 m level difference and was discovered in 1982 after the bottom of a lake formed by the sterile excavated from the quarry, which barred the course of the Teia brook, had caved in (Göpfrich, 1986).

The climate of the Moneasa area is continental, rendered moderate by median mountains, and Mediterranean influences are also felt. Over 1951—1960 a meteorological station operated in Moneasa and registered an average annual value of precipitations of 1,122.63 mm and a temperature of 9.5°C. Hydrometeorological activities were resumed in the summer of 1972, when the representative hydrologic basin of Moneasa and the Izoi Meteorological station were created.

1. A HISTORY OF HYDROGEOLOGICAL RESEARCH

The village of Moneasa is attested for the first time in the year 1200 in a sketch at the Țara Crișurilor Museum in Oradea, and the thermal springs here, which have been known ever since the times of the Romans, are mentioned in 1597 in a letter sent to the commander of the Dezna fortress, a stronghold belonging to the Transylvanian army of Sigismund Bathori, who was a supported of Michael the Brave (Coțoi, 1974).

Nendtvich Karoly conducted the first chemical analysis of the thermal springs at Moneasa in 1865 and a year later Kéry (Bittner) Imre decribed them for the first time and made a number of recommendations concerning their utilization.

The first well for thermal waters at Moneasa was drilled down to 316 m over the 1890—1895 interval; its initial discharge was of 16.6 l/s of water with a temperature of 25°C. With the building of Ward No. 1 on the Băilor brook in 1891 treatments being given for stomach complaints and rheumatism (Marki, 1895).

The first spring radioactivity measurements were conducted by Athanasiu in 1927. In 1932, Țeposu and Pușcariu referred in their book "România balneară și turistică" (Balneal and Tourist Romania) to the existence of four springs with a temperature of 20—32°C and a discharge of 14,000 to 15,000 hectolitres. The authors belive that the therapeutical value of the spa is due to the thermality of the waters there which, from a chemical point of view, are "indifferent" waters, as well as to weather conditions.

In 1951 the Balneology and Physiotherapy Institute in Bucharest released the first complete chemical analysis of the waters and in 1958 Pаucă published a synthesis study concerning the thermal springs West of the Apuseni Mountains considering that the waters at Moneasa are a mixture of "hundreds-of-metres-deep waters, which rise under vapour pressure" and cold karst waters and pointing to the difficulty of deliniating the springs protection area.

As for the hydrogeological research work conducted in the past 20 years in the Moneasa area, noteworthy are the complete water radioactivity measurements performed by Szabo and Iosif in 1967, the first tracer labellings to establish the genesis of thermal waters, conducted by Slăvoacă, Orășeanu and Gașpar[1] in 1970, the first detailed hydro-

[1] SLĂVOACĂ D., ORĂȘEANU I. (1970), *Hydrogeological report.* I.P.G.G. București.

geological study of the spa made by Orăşeanu in 1973 [2], the drilling of five new hydrogeological boreboles in 1972—1987 interval, a complete geophysical investigation conducted by Apostol et al. (1975), and the calculation of exploitable thermal-water reserves and the deliniation of the hydrogeologic protection area around the geothermal reservoir, accomplished by Orăşeanu and Orăşeanu in 1976 [3].

In 1978 Halasi published two works on the Moneasa endokarst and in 1985, together with Gisela Halasi and Birtalan, he described the exploration and morphology of the Grota Ursului cave (the cave at Băi).

2. GEOLOGICAL DATA

Opinions on the geology of the Moneasa area are closely linked to geologic knowledge of the Codru Moma Mountains. In 1936 Rozlozsnic mentioned the existence of three tectonic units, which feature the particularities of nappes, and in 1941 Paucă published the first map and the first complete geological study of the Codru Moma Mountains.

Subsequent geological research work provided for a detailed description of the structure of the Codru Moma Mountains, a structure within which authors Bleahu (1965) and Bleahu et al. (1968, 1979, 1981) distinguish the Finiş, Moma and Dieva nappes in the Moneasa area.

In 1983, as an outcome of research work conducted with a view to printing the Dumbrăviţa sheet (1984), Ştefănescu et al., refer to a new tectonic unit in the Codru Mountains — the nappe of Seasa — and separate, within the Finiş Nappe in the Moneasa area, the chimeric nappes of Armanu and Seasa and the mediterranean nappe of Finiş.

From a geological point of view, the Moneasa area is situated in the area where the Moma Nappe thrust over the Finiş Nappe. The Finiş Nappe formations make up a homocline that faces the North-South, approximately, and contains Permian Rhyolitic Formation and Werfenian quartzitic sandstones in its bed. They support a thick stack of predominantly limy facies including black dolomites (Anisian), black limestones with cherts — the Roşia Formation (Ladinian), white dolomites and violet breccious limestones (Carnian), marly, argillaceous shales and silty marls interbedded with rare decimetric black limestones and quartzitic sandstones — Codru Formation (Norian), argillaceous or silty shales with rare decimetric interbeds of dolomites, limestones and quartzitic sandstones — the Carpathian Keuper (Rhaetian), massive nodular and breccious red limestones — "Moneasa marble" (Lower Jurassic) followed by a flysch-like formation consisting of interbeds of marls, shales and sandstones (Tithonic and Neocomian).

The S_5 (4666) well, drilled in the centre of the spa, indicates a rapid disappearance of the limy formations of the Finiş Nappe to the South, under the Permian silty shales and basalts of the Moma Nappe. They rise in steps to the South, under the Permian deposits, and the thickness

[2] ORĂŞEANU I. (1973), *Hydrogeological report*, I.P.G.G. Bucureşti.
[3] ORĂŞEANU I., ORĂŞEANU NICOLLE (1976), *Hydrogeological report*. I.P.G.G. Bucureşti.

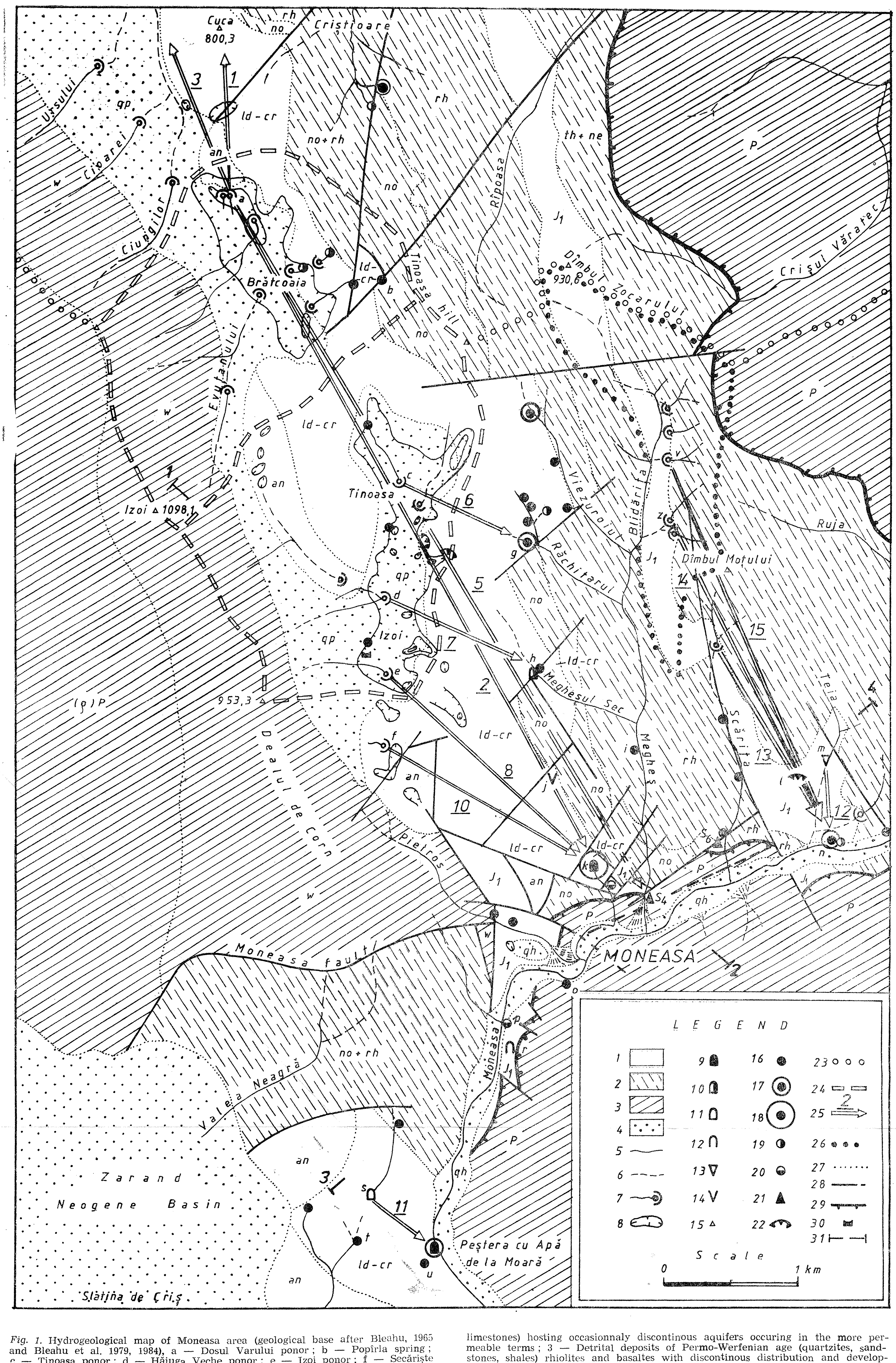


Fig. 1. Hydrogeological map of Moneasa area (geological base after Bleahu, 1965 and Bleahu et al. 1979, 1984), a — Dosul Varului ponor ; b — Popîrla spring ; c — Tinoasa ponor ; d — Hăiuga Veche ponor ; e — Izoi ponor ; f — Secărişte ponor ; g — Răchitaru spring ; h — Cave and spring of Megheşul Sec brook ; i — Cioroiul lui Petac spring ; j — Feredeu pothole ; k — Grota Ursului spring ; l — Moneasa quarry ; m — Teia pothole ; n — Piatra cu Lapte spring ; o — Mundy spring ; p — subthermal spring from stadium ; r — Liliecilor cave ; s — Merăzerie cave ; t — Fîntîna de Giurast spring ; u — Fîntîna Chiţuleşti ; v — Blidăriţa ponor ; z — Ponor of Pîrîul dintre Pietre brook ; qh — Holocen ; qp — Pleistocen ; th+ne — Tithonian+Neocomian ; J_1 — Lower Jurassic ; rh — Rhaetian ; no — Norian ; no+rh — Norian+Rhaetian ; ld—cr — Ladinian—Carnian ; an — Anisian ; w — Werfenian ; P — Permian ; (ρ)P — Permian rhiolites.

Legend : 1 — Carbonate mesozoic series (limestones, dolomites) of great thickness, highly karstified and tectonically intensely fractured, exhibiting large infiltration capacity and strong groundwater flow ; 2 — Mainly detrital and flysch-like series, including rock-complexes of variable permeability (shales, marls, sandstones, limestones) hosting occasionnaly discontinous aquifers occuring in the more permeable terms ; 3 — Detrital deposits of Permo-Werfenian age (quartzites, sandstones, shales) rhiolites and basaltes with discontinous distribution and development of permeability ; 4 — Detrital deposits of Neogene age (sands, gravels, marls) hosting limited aquifer accumulation ; 5 — Perennial river ; 6 — Temporary river ; 7 — Ponor ; 8 — Karstic depression ; 9 — Perennial outflow cave ; 10 — Temporary outflow cave ; 11 — Perennial inflow cave ; 12 — Fossil cave ; 13 — Perennial inflow pothole ; 14 — Fossil pothole ; 15 — Summit (elevation above the mean sea level in metres) ; 16 — Spring with average flow under 1 l/sec. ; 17 — Spring with average flow betweeen 1 and 10 l/sec. ; 18 — Spring with average flow between 100 and 150 l/sec. ; 19 — Overflow spring ; 20 — Thermal spring ; 21 — Hydrogeological well ; 22 — Quarry ; 23 — Superficial watershed between Crişul Negru and Crişu lAlb rivers ; 24 — Limit of endorheic areas ; 25 — Underground connections established by tracing method (2 is the indicative of the tracing operation in the table No. 1) ; 26 — Megheş brook — Piatra cu Lapte spring diffluence surface ; 27 — Geological limit ; 28 — Fault ; 29 — Overthrust ; 30 — Meteorological station ; 31 — Direction of the hydrogeological cross section.

of Triassic limestones declines gradually, reaching only 65 m in the aforesaid well.

The formations of the Finiş Nappe, nearby the area of contact with the Moma Nappe, are highly tectonized and divided into a number of blocks by two fault systems — an older one facing the north-north-west — south-south-east, along the geological structure, and a newer one facing the north-east — south-west, which is perpendicular on the former.

The seismic and geoelectrical research conducted by Apostol et al. (1975) as well as the data supplied by hydrogeologic drillings show the overthrust plane of the Moma Nappe to have different inclinations, the avarage value of which is of 55° to the south. Close to the surface the inclination of the contact is grater being intercepted by the S_4 (4664) well at an angle of 70°. The F_3 well, drilled in the camping site, traversed only Permian deposits at a depth of 197 m to the bottom.

The second major tectonic element of the area is the Moneasa fault. It follows an east-west direction, perpendicular to the direction of the Finiş homocline which is cut, thus placing the Triassic limestones in the southern compartment, which was moved to the west, and the Werfenian sandstones in the northern compartment in direct contact. The fault continues under the deposits of the Moma Nappe, being responsible for the southern rise of sandstones and limestones, a rise highlighted by well S_5.

3. HYDROGEOLOGICAL CHARACTERIZATION OF THE MONEASA AREA

The great lithological variety and the different degree of fractured of the formations in the geological structure of the Moneasa area, which, from a hydrogeological poin of view, reflects in different ways of supply, accumulation, circulation and discharge of underground waters, led to the indentification of four types of formations boasting distinct geologic, structural and hydrogeologic features (fig. 1).

a. Mesozoic carbonatic succession (limestones and dolomites) which are great thickness, intensely fissured and highly karstified, and characterized by a high infiltration capacity and an active circulation of underground waters. The hydrogeology of these deposits will be enlarged upon in the following chapter.

b. Paleozoic and Mesozoic consolidated detritic deposits (sandstones, conglomerates, subordinated schists) and Paleozoic magmatites characterized by permeability through fissures and/or interstices with discontinous distribution and levelopment. Underground water circulation is limited to the alterated surface areas and to fractured zones and supplies episodic springs with low discharges of up to 1 l/s.

The Werfenian quartzitic sandstones make the bed of the aquiferous accumulations located in carbonate deposits, in relation to which they can be considered as virtually impermeable, the limit between the two types of deposits being, from a hydrogeological viewpoint, a perfect barrier. Furthermore, the quartzitic sandstones on the eastern slope of the Izoi crest play an important hydrogeological role by concentrating the water derived from precipitation and directing surface flow to karst terrains, primarily to the Brătcoaia and Izoi-Tinoasa depressions. Owing to their contribution with surface waters, these terrains account for more than 40 per cent of the supply of karst aquiferous accumulations.

c. Norian, Rhaetian succesions and Thitonic-Neocomian flysch-like formation characterized by strong heterogeneity, made up of rock complexes of various permeabilities (clays, siltites, sandstones, limestones), which may contain discontinuous aquifers located in the more permeable elements. They form a continuous north-to-south strip east to the carbonate formations and make the virtually impermeable roof of karst aquiferous accumulation. Springs are rare on the surfaces under these deposits and they have low discharges and are linked to the sandstone-limestone intercalations.

d. Quaternary non-consolidated detritic deposits, represented by the Moneasa brook alluvia, are characterized by a notable circulation of underground waters ; owing to their small expanse and thickness, their hydrogeological importance is strictly local.

The Quaternary deposits covering the karst depressions of Brătcoaia and Izoi-Tinoasa, mainly represented by blocks of quartzitic sandstones, limestones and dolomites, have small thicknesses and contain local suspended aquiferous accumulations, which have no influence on the hydrogeological conditions of karst aquiferous accumulations.

4. HYDROGEOLOGY OF KARSTIC TERRAINS

The main limestones and dolomites sequence in the area, north of the Moneasa valley, is 1—2 km in breadth and has a monocline structure. To the north the structure continues also in the Finiş brook basin and to the south it is brutally cut by the overthrust plane of the Permian deposits of the Moma Nappe.

Located in these carbonate deposits are important aquiferous accumulations, which discharge to the south mainly through the Grota Ursului spring and subordinately through the springs on the Viezuroiul, Răchitarul, Megheşul Sec and Pietros brooks. With the view to establishing the direction of flow of underground waters and flow dynamics, starting 1970 I have conducted tracer labellings here with the contribution of E. Gaşpar, Nicolle Orăşeanu, D. Slăvoacă and E. Anghel. These labellings provided for the establishment of fourteen drainage directions (Table 1).

The labellings performed in 1977 and 1986 in the Dosul Varului ponor, situated in the northern part of the karst depression of Brătcoaia, pointed to the presence of an important underground diffluence of infiltrated waters, as the tracers employed, Iodine-131 and In-EDTA, were involved in a northbound flow, to the Finiş and Feredeu springs and a southbound flow to the resurgent cave of Grota Ursului, the No. 1 ther-thermal spring and the thermal-water wells S_2 and S_4 at Moneasa. The labellings proved that in the Brătcoaia depression area the underground watershed between the basin of the Finiş brook, a tributary of the Crişul Negru, and the Moneasa, a tributary of the Crişul Alb, can be found

Table 1

Results of tracing operations on Moneasa karstic area

Numer of drainage on hydrogeological map	Ponor, H(m)		Resurgence, H(m)		L(m)/ΔH(m)	Tracer used	t hours	V m/hour	Date of labelling	Authors of tracing operations
1	Dosul Varului ponor	720	Feredeu spring	415	6000/305	Iod-131	58	103.0	10.09.1977	I. Orăşeanu, E. Gaşpar, N. Orăşeanu
2	Dosul Varului ponor	720	Grota Ursului spring	320	5800/400	Iod-131	48	120.0	10.09.1977	I. Orăşeanu, E. Gaşpar, N. Orăşeanu
3	Dosul Varului ponor	720	Finişului spring	490	2100/230	In-EDTA	168	12.5	19.07.1986	I. Orăşeanu, E. Gaşpar, N. Orăşeanu
1	Dosul Varului ponor	720	Feredeu spring	415	6000/305	In-EDTA	96	62.5	19.07.1986	I. Orăşeanu, E. Gaşpar, N. Orăşeanu
4*	Dosul Varului ponor	720	Thermal spring. No. 1	298	5900/422	In-EDTA	600	9.8	19.07.1986	I. Orăşeanu, E. Gaşpar, N. Orăşeanu
5	Dosul Varului ponor	720	Well S_4 (4664)	296	6250/424	In-EDTA	480	13.0	19.07.1986	I. Orăşeanu, E. Gaşpar, N. Orăşeanu
6	Tinoasa ponor	657	Răchitarul spring	525	1075/132	Fluoresceine	43	22.0	11.07.1973	I. Orăşeanu
7	Hăiuga Veshe ponor	699	Megheşul Sec spring	440	1200/229	Iod-131	1	1200.0	17.07.1974	I. Orăşeanu, E. Gaşpar, N. Orăşeanu
8	Izoi ponor	680	Grota Ursului spring	320	2130/360	HTO	6	355.0	20.06.1970	D. Slăvoacă, I. Orăşeanu, E. Gaşpar
9*	Izoi ponor	680	Subthermal spring a	295	2180/385	HTO	6	363.0	20.06.1970	D. Slăvoacă, I. Orăşeanu, E. Gaşpar
10	Săcărişte ponor	685	Grota Ursului spring	320	1840/365	HTO	5	368,0	25.06.1970	D. Slăvoacă, I. Orăşeanu, E. Gaşpar
11	Tăul Bivolilor ponor (Merăzerie cave)	294	Peştera cu Apă de la Moară cave	250	630/44	Fluoresceine	8	80.0	25.07.1974	I. Orăşeanu, E. Gaşpar, N. Orăşeanu
12	Toia ponor	450	Piatra cu Lapte spring	310	650/140	Iod-131	25	16.0	1972	M. Tănăsescu et al.
13	Losses of Scăriţa brook	540	Piatra cu Lapte spring	310	1700/230	Fluoresceine	48	35.4	12.05.1987	I. Orăşeanu
14	Losses of Pîrîul dintre Pietre brook	560	Piatra cu Lapte spring	310	2680/350	Rhodamine B	70	38.3	11.05.1987	I. Orăşeanu
15	Losses of Blidăriţa brook	630	Piatra cu Lapte spring	310	3100/320	In-EDTA	72	43.0	13.06.1987	I. Orăşeanu, E. Gaşpar

H = Elevation above the mean sea level ;
L = Horizontal distance between losses and spring ;
ΔH = Difference in elevation between losses and spring ;
V = Apparent velocity ;
t = Time of first arrival of tracers ;
* Drainage direction is not drawn on the hydrogeological map.

The karst area limited by Brătcoaia, Tinoasa, Izoi and Moneasa, together with its slope basin that expands to the Izoi crest, forms a unique hydrogeological karst system, which is partially thermalized at its southern end. It boast a north-to-south flow of underground waters and a discharge preferentially made through the Grota Ursului spring. The waters that cannot be involved in this flow, owing to the limited conveyance capacity of channels and fissures, drain to the east through the overflow springs in the Răchitaru and Meghesul Sec valleys. The hydrogeological relations between the waters infiltrated through the Tinoasa and Hăiuga Veche ponors and the aforesaid springs were also attested through tracer labellings.

To determine the parameters of underground waters flow in the Moneasa area over October 1975 — September 1976 systematic measurements were performed, in cooperation with the collectivity at the Moneasa hydrologic station[4], of the discharges and the temperatures of the brooks Moneasa, Megheș and Pietros, of the Băilor brook up- and downstream of the thermal sources in the Ward 1 area, as well as of all the caught thermal sources(springs 1, 2, 4 and 5) and the wells S_1, S_2, S_4, and S_5 (fig. 2). Measurements were also performed of the precipitations at Izoi and Boroaia (three kms east of the spa) and of air temperature at Izoi and Moneasa.

Processing of the hydro-meteorological data, conducted at the No. 1 gauging cross section on the Băilor brook, which controls the Grota Ursului spring discharge, indicate for the mentioned spring an mean annual discharge of 121.42 l/sec. with the extreme limits ranging from 32 to 938 l/sec. The $Q_{max.\ daily}/Q_{min.\ daily}$ variability index of the spring is of 29.3, and the sensible fluctuation of its discharge is also illustred by the long fluctuation interval of the $Q_{mean\ year}/Q_{mean\ month}$ ratio shown in figure 3

The diagram of the classified flows of the Grota Ursului spring (fig. 4) shows a slope break of the line for a value of 654 l/sec., a break determined by the overflow phemomena. It is rather difficult to accurately assess the overflow sources which give birth to this phenomenon as it can be generated both by the operation of the sources in the basins of the Răchitarul and Meghesul Sec brooks, mainly of the temporary resurgent cave of the latter's valley, and by modifications occured in the distribution of the discharges of the endorheic basin of Brătcoaia, with a preferential direction to the Finiș basin.

By processing the hydrographs of the discharges measured in the No. 1 gauging cross section on the Băilor brook in periods lacking precipitations the hydrogeological parameters of the karst aquifer discharging through the Grota Ursului spring could be computed.

The recession curve of the Grota Ursului spring in the interval spanning June 4, 1976 — July 29, 1976, when it was not influenced by significant contributions from precipitations, is represented by a broken line with three slopes featuring the α_1, α_2, and α_3 discharge coefficients (fig. 5).

[4] PALFY F., GROZA MARIA-ANA, CRIȘAN S., ONCEAN N., ONCEAN NUȚA, CONDEA T., ZACOI G. (1976), *Hydrological dates*, S. H. Moneasa.

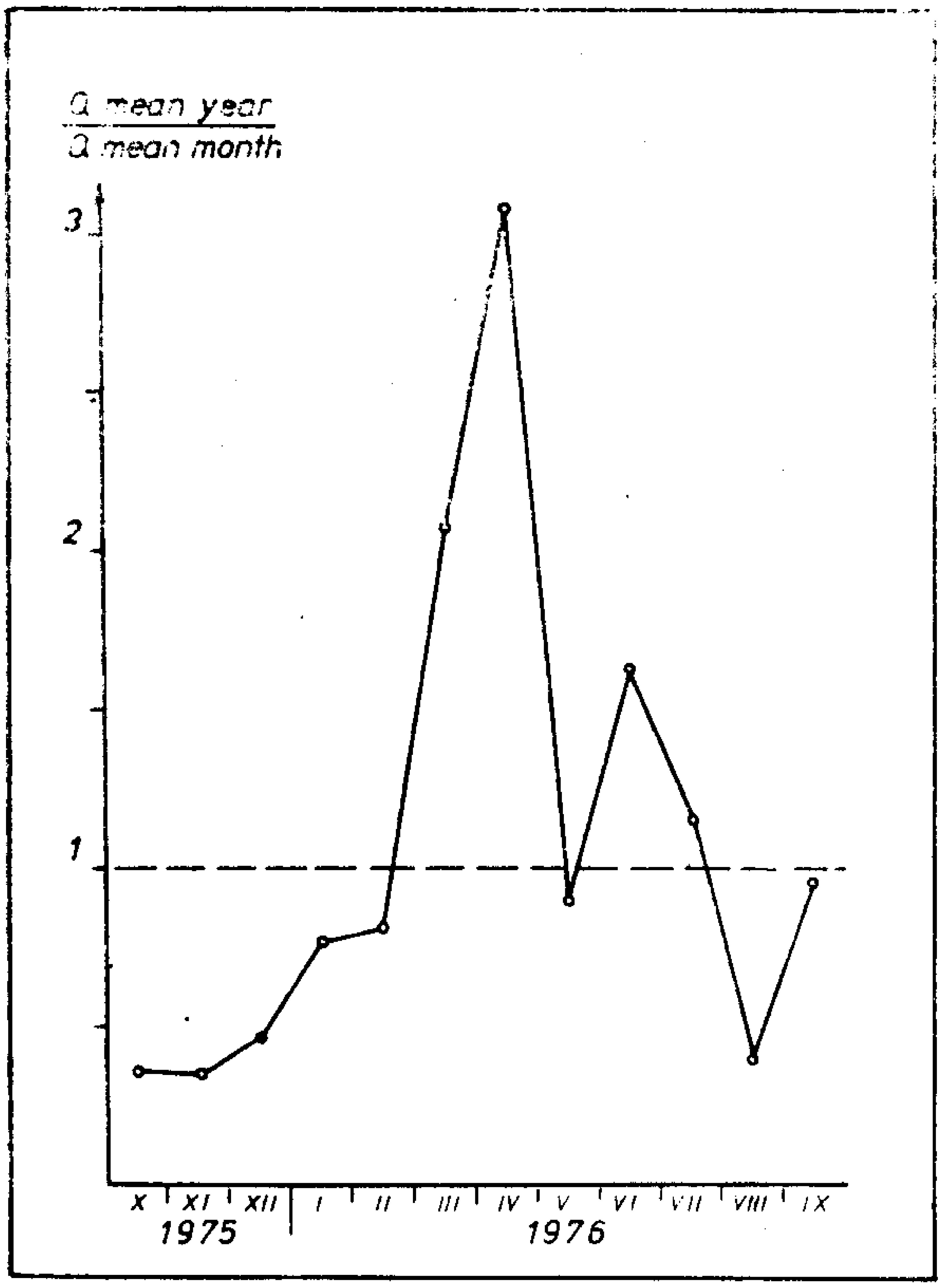


Fig. 3. Variation of ratio Q mean year / Q mean month of Grota Ursului spring.

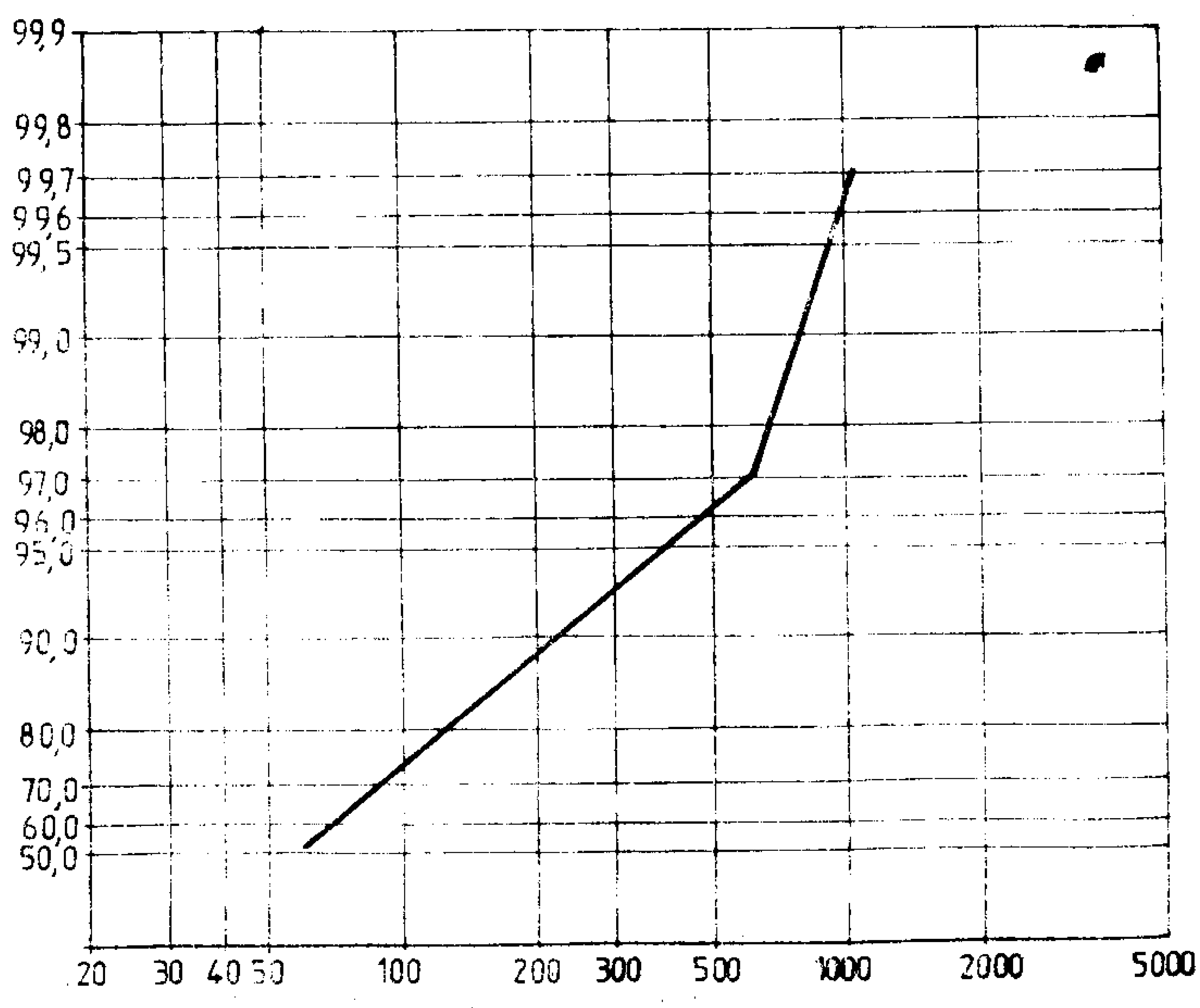


Fig. 4. The diagram of the classified flows of the Grota Ursului spring in X.1975—IX.1976 time interval (probability paper).

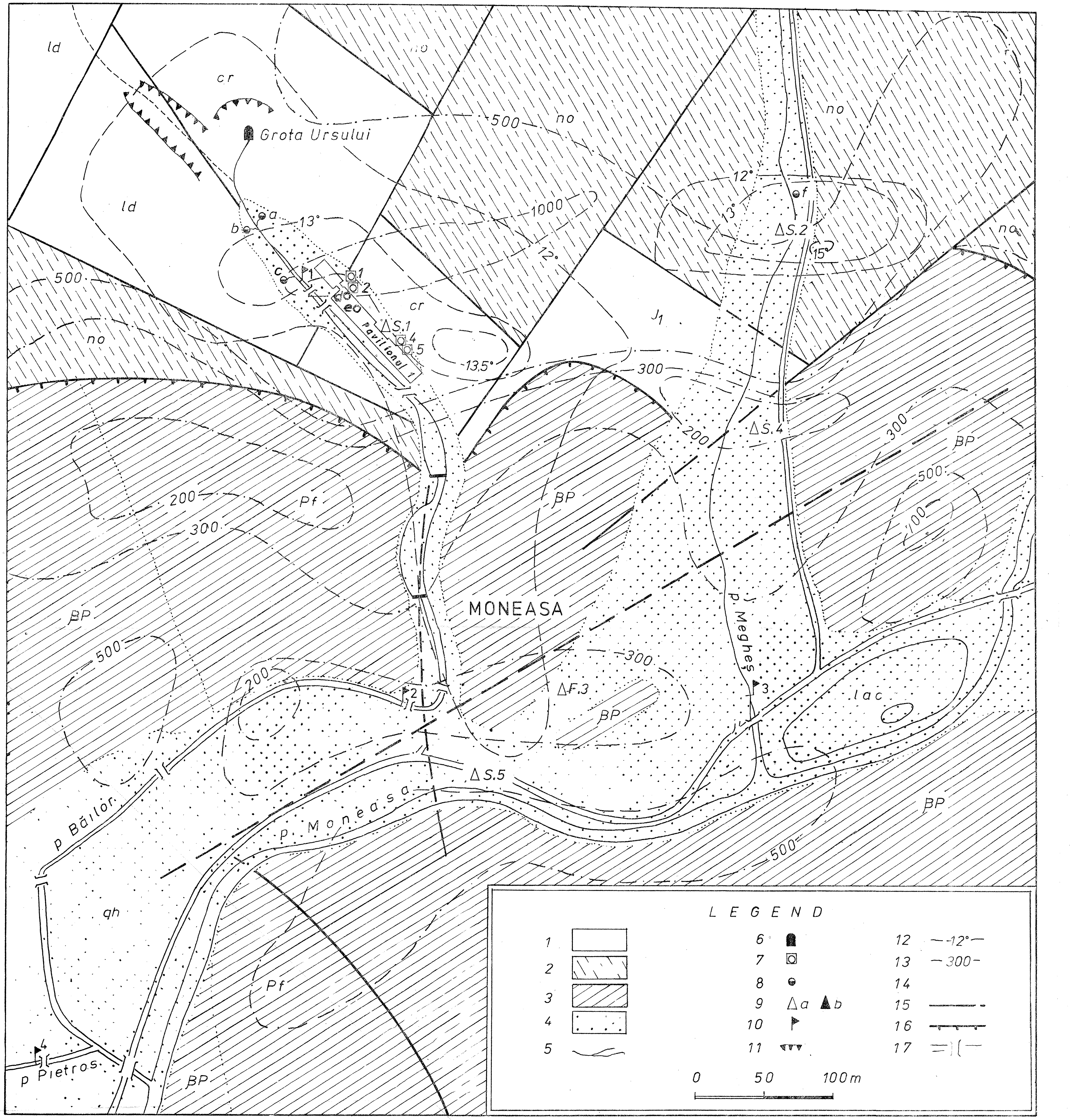


Fig. 2. Hydrogeological map of Moneasa spa (geological base after Bleahu et al. 1979, geophysical data after Apostol et al. 1975); qh — Holocene; J_1 — Lower Jurassic; no — Norian; cr — Carnian; ld — Ladinian; βP — Permian basaltes; Pf — Permian Feldspathic Formation.

Legend: Numbers 1 to 5 as in fig. 1; 6 — Perennial outflow cave; 7 — Caught spring; 8 — Subthermal spring; 9 — Hydrogeological well (a), Geological borehole (b); 10 — Gauging cross section; 11 — Abrupt; 12 — Isoline of equal temperature (°C); 13 — Isolines of equal apparent resistance (in ohm-m); 14 — Geological boundary; 15 — Fault; 16 — Overthrust; 17 — Bridge.

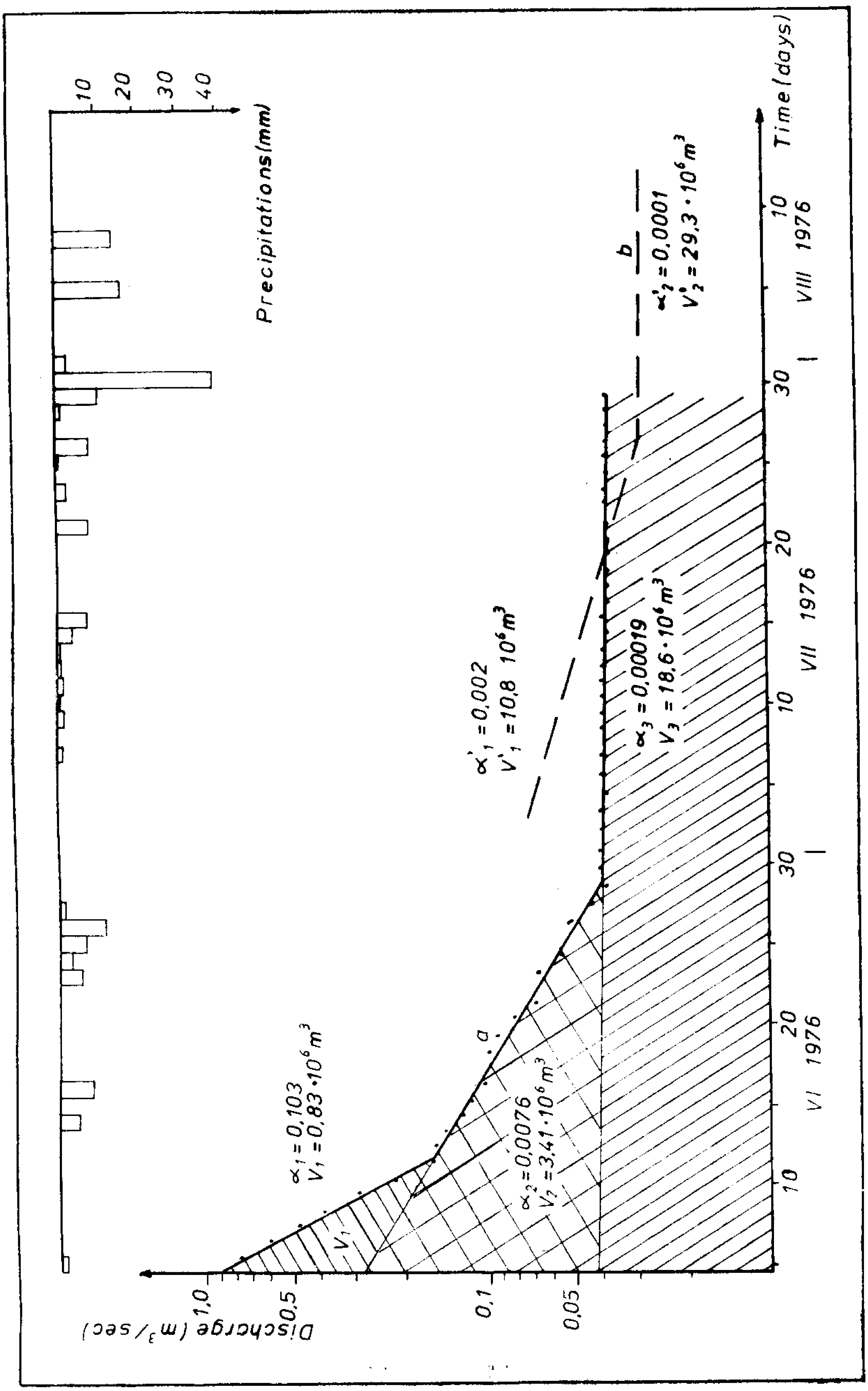


Fig. 5. The recession curve of the Grota Ursului spring (a) and of the uncaught thermal springs in Băilor brook (b) in June—August 1976 time interval.

Coeficient $\alpha_1 = 0.103$ designates the discharge of karst void spaces and channels where, in an interval of seven days, a volume of $0.83 \cdot 10^6$ cu.m. of water are discharged in turbulent conditions. The discharge of the systems of partially karstified fissures is characterized by coefficient $\alpha_2 = 0.0076$, last for 17 days or so and releases a volume of $3{,}41 \cdot 10^6$ cu.m. of water from the karst aquifer.

Coefficient $\alpha_3 = 0.00019$ represents the discharge of the water stored in rock fissures, in inactive subterranean void spaces and their alluvia. The most substantial value of these reservoiris is of $18.6 \cdot 10^6$ cu.m. and their discharge is prevailingly laminar.

At the southern end of the strip of Lower Jurassic limestones, which develops in the eastern part of the area — limestones which are improperly called "Moneasa Marble" — a hydrogeological karst system is located, which is mainly supplied by the waters infiltrated through the Teia, Scăriţa and Blidăriţa ponors, a system that discharges through the permanent Piatra cu Lapte spring and temporary, through the over flow sources situated immediately upstream.

The waters infiltrated through the channel of Blidăriţa brook and its tributaries are exclusively directed to the Piatra cu Lapte spring. They traverse the hydrogeological karst system in an average interval of 72 hours and follow a piston-type flow (fig. 6).

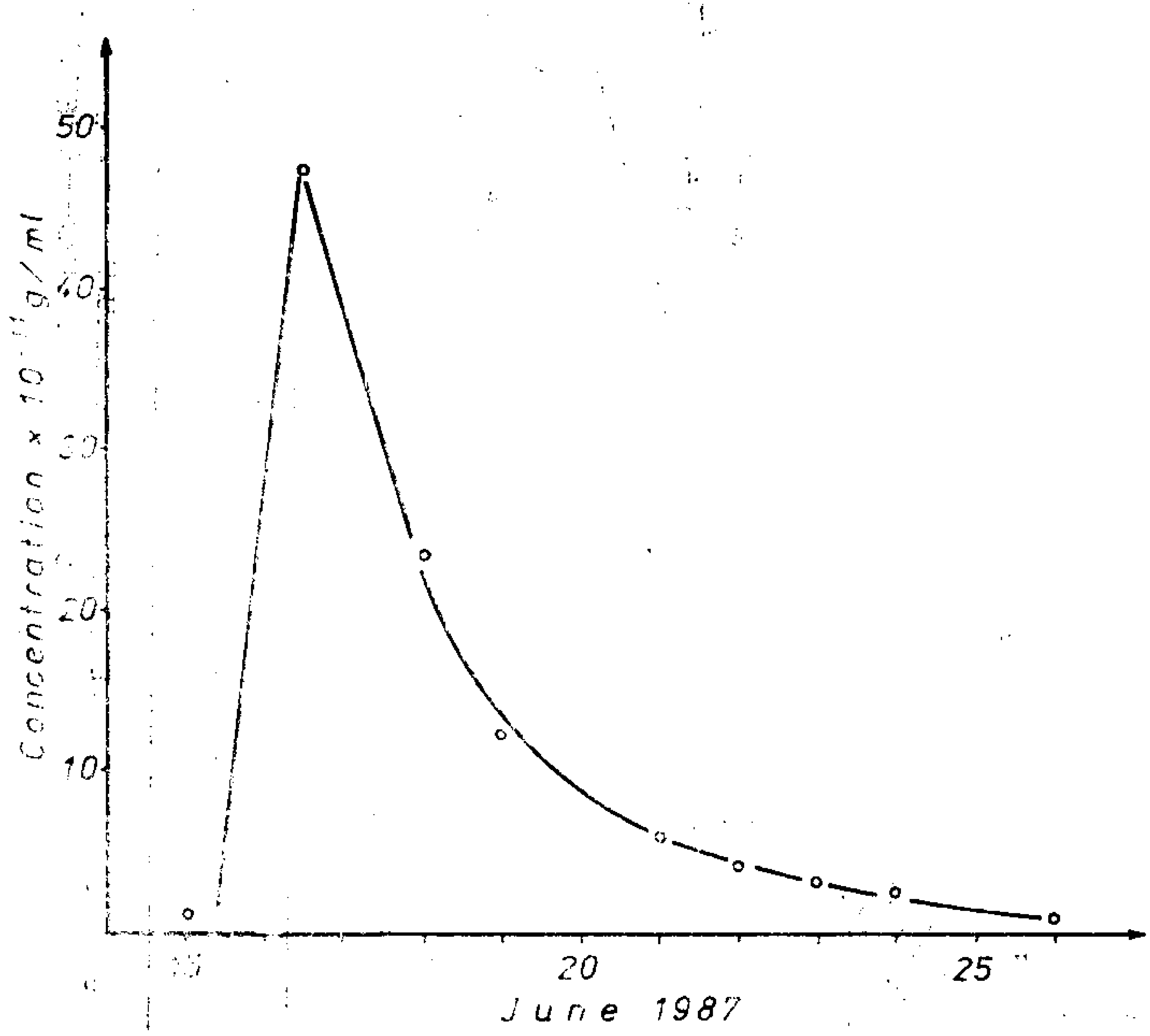


Fig. 6. Time variation of In-EDTA tracer concentration measured in Piatra cu Lapte spring after labelling the losses in flow in Blidăriţa riverbed.

5. THERMAL WATERS

The thermal waters at Moneasa — both natural emergences and those emerging through wells — are karst waters that appear in the carbonate deposits of the Finiş homocline, nearby the contact with the

Table 2

Cold and thermal water sources in Moneasa spa area

Nr. crt.	Source	Elevation a.s.l. (m)	Depth (m)	Q (l/s)	T (°C)
1	Well S_1	292,59	316,0	2,45	24,0
2	Well S_2 (4663)	302,59	604,0	0,4	28,5
3	Well S_4 (4664)	296,97	836,4	3,0	32,5
4	Well S_5 (4666)	284,95	424,6	7,0	14,0
5	Spring no. 1	293,96	—	3,29	24,0
6	Spring no. 2	293,90	—	3,32	24,0
7	Spring no. 4	292,69	—	} 4,30	31,0
8	Spring no. 5	292,59	—		31,2
9	Uncought thermal waters in Băilor brook	290,0 — 296	—	50,0	22
10	Unconght cold waters in Băilor brook	296—320	—	40,0	10,8
	Grota Ursului spring	320	—	121,42	8,0

impermeable deposits of the Moma Nappe. They belong to the category of hypothermal (20—37°C) and subthermal (10—20°C) waters. The values of the discharges and temperatures of the sources outlined in table 2 represent the averages of a series of daily observations conducted in the hydrologic year October 1975 — September 1976 and of the expeditionary observations made in the past 20 years.

The main natural thermal-water sources are situated on the Băilor brook, downstream of the Grotă Ursului spring, on a distance of 180 m before the brook enters the Permian terrains (fig. 2). Their temperature rises as they approach the contact with the deposits of Moma Nappe (fig. 7).

The average flow value of water contributions from the Băilor brook, computed on the basis of data supplied by observations made in the No. 1 and 2 gauging cross sections, are of 50 l/sec. of hypothermal waters with a temperature of 22°C, contributions of which roughly 43 l/sec. are water with a temperature of 22°C which is not caught. The value of these contributions is readily noticeable in the case of the lower discharges of the Grota Ursului spring, especially through the temperature rises registered by the Băilor brook downstream of the sources (fig. 8 and 9).

The recession curve of uncaught thermal waters on Băilor brook (fig. 5) shows presence of an important accumulations stored in partially karstified fissures and in rock fissures. The curve has two segments with different slopes and indicate a meteoric source of thermal waters. The approximate underground transit time is 30 days.

The No. 1, 2, 4 and 5 thermal springs are caught and used for internal treatment (No. 1), potable water supply (No. 1 and 2 and well S_5) and balneal treatment (No. 2, 4 and 5 and wells S_1, S_2 and S_4). The

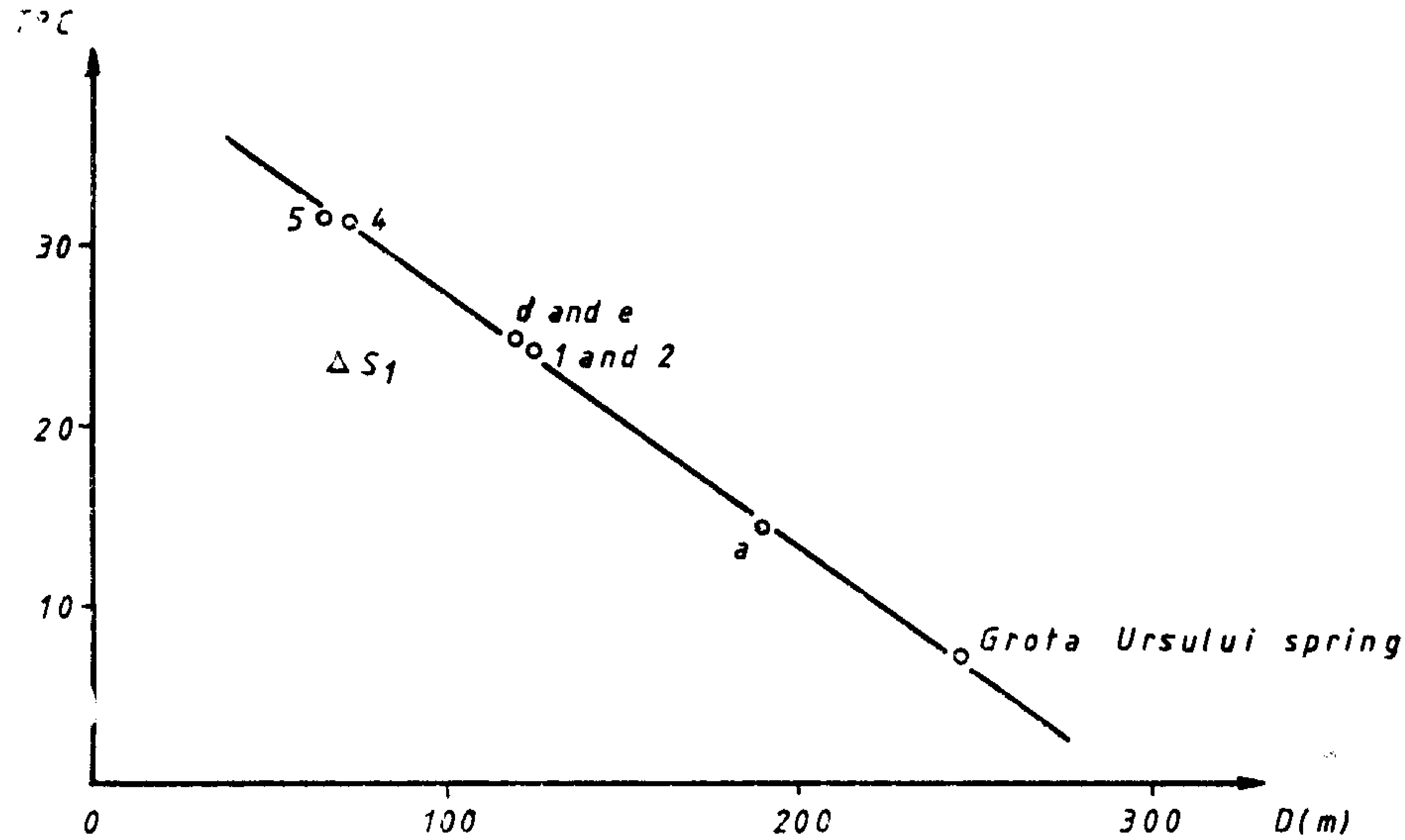


Fig. 7. The relation between sources temperatures and distance from overthrust front in Băilor brook.

"c" and "d" thermal sources (fig. 2) appear at the base of the wall of the channel situated upstream part of No. 1 Ward and they have an overall discharge of roughly 23 l/sec. and a temperature of 24.5°C. They are not caught and they represent losses from the No. 2 spring.

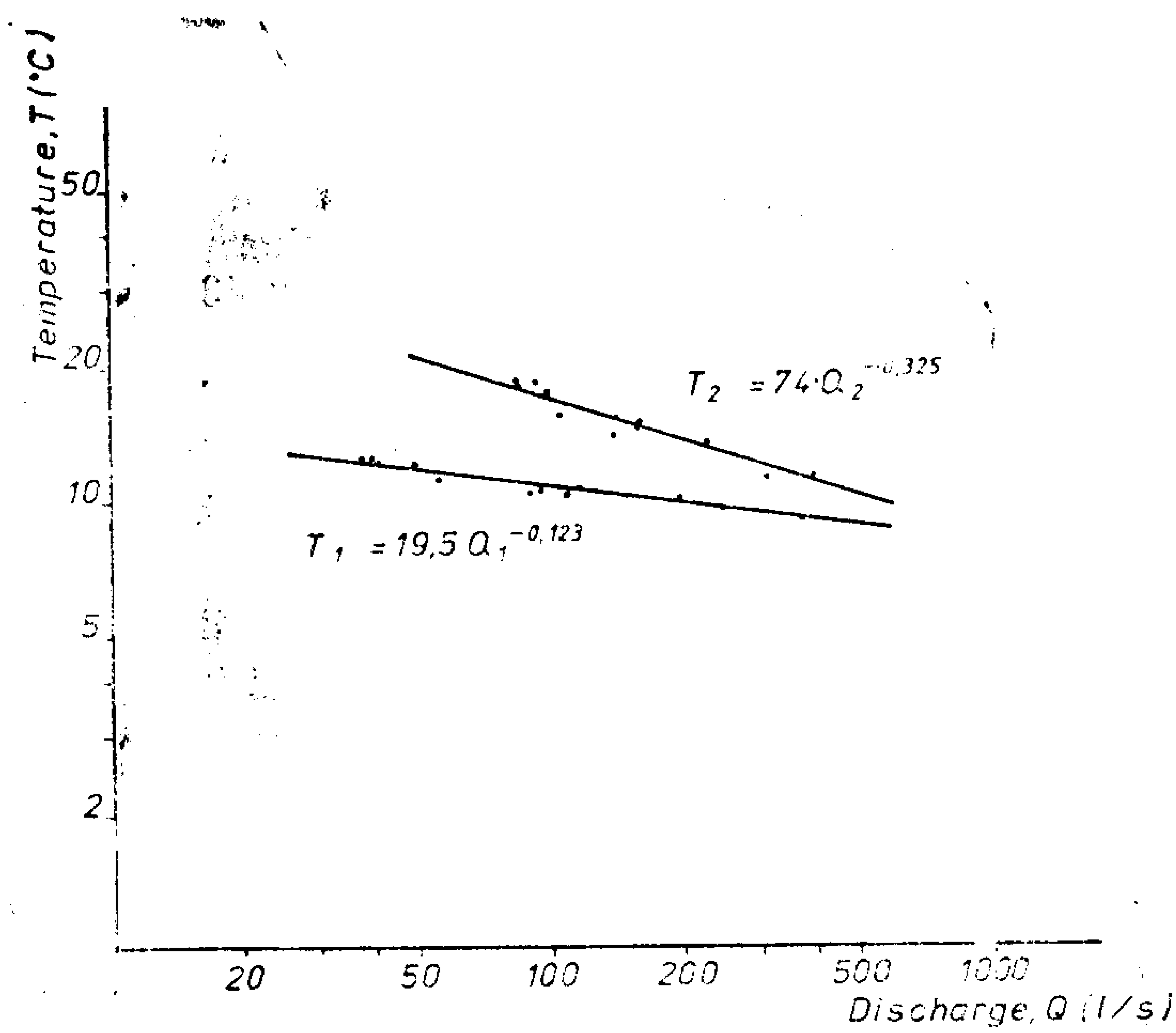
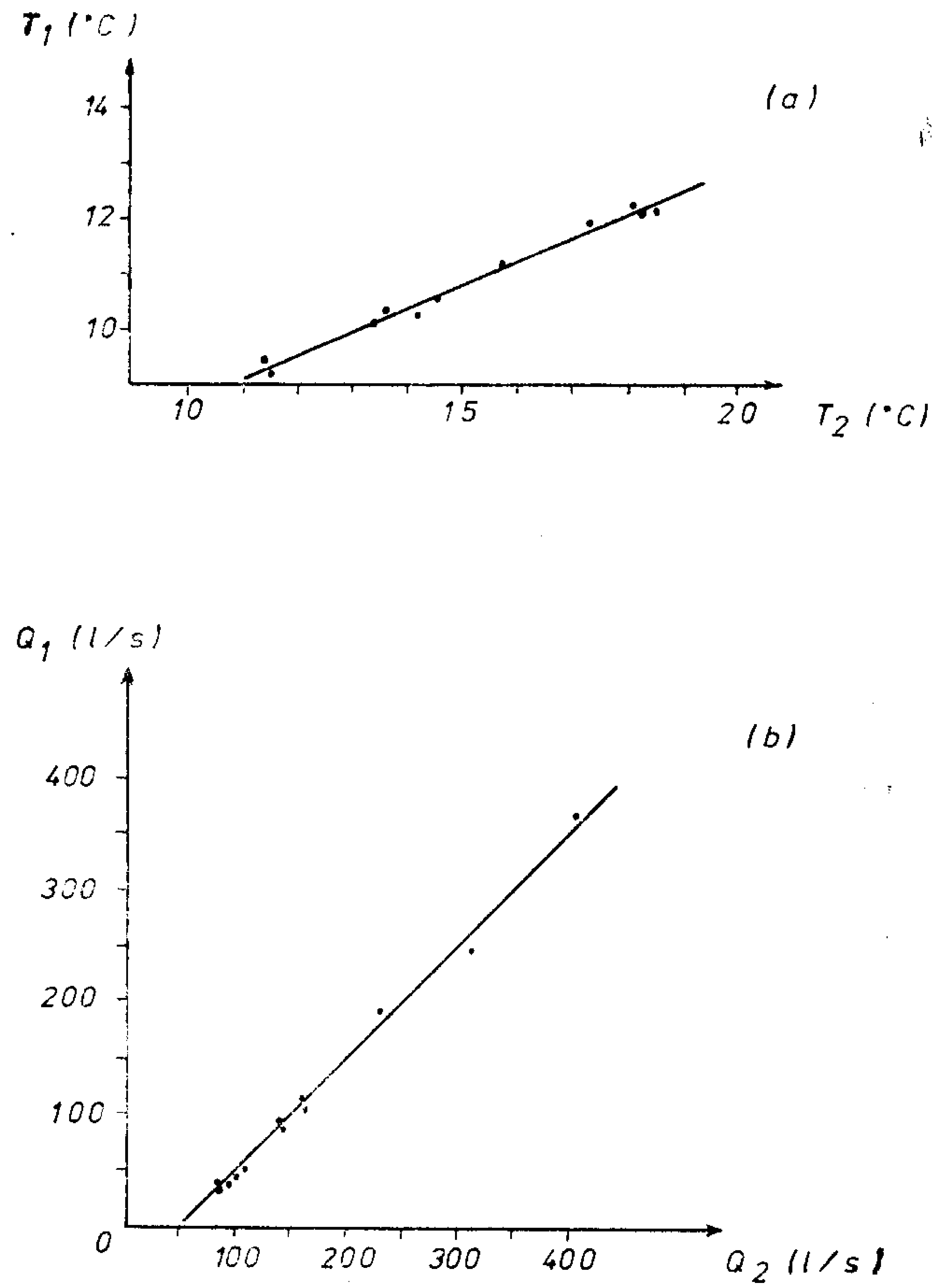


Fig. 8. The relation between mean month temperatures and mean month discharges of the Băilor brook in gauging cross sections No. 1 and 2 in X.1975—IX 1976 time interval (log-log paper).

Fig. 9. The relation between mean month temperatures (a) and mean month discharges (b) of Băilor brook measured in gauging cross section 1 and 2 in X. 1975—XI. 1976 time interval



From a geothermal viewpoint, the whole area of the Băilor brook is an abnormal area with the maximum point situated close to the No. 4 and 5 sprigns (fig. 2). The anomaly follows the direction of the geological structure of the deposits of the Finiș Nappe, traverses the overthrust front of the Moma Nappe and continues, with a sensibly diminished value, along the direction of the Moma Nappe structure up to the Moneasa valley (Apostol et al., 1975).

Four boreholes were drilled between 1972—1975 with a view to investigating the area from a hydrogeological point of view and they assessed the structure of the hydrothermal reservoir at depth. In the summer of 1987 the S_6 hydrogeological well, located on the Scărița valley, started being drilled.

Well S_2 (No. 4663) was drilled in 1972 nearby the subthermal spring on the Megheș valley and traversed carbonate deposits along the entire depth (i.e. 604 m). The measurements conducted during drillings indicated the presence of waters with increased temperatures (30°C) in the upper part of the karst aquiferous complex and with lower temperatures (24°C) in its lower part (Vasilescu, Avramescu, 1972 [5]).

Hydrogeological testings performed in borehole F_3 showed that throughout the entire depth (i.e. 197 m) it traversed deposits devoid of water of Moma Nappe, for which reason it was cemented.

The well S_4 (No. 4664) was located directly on the Permian deposits of the Moma Nappe, which it traversed along a thickness of 78 m; to a depth of 520 m it penetrated limestones and dolomits highly karstified and then, down to the bottom (i.e. 836.4 m), Werfenian quartzitic sandstones, a succession belonging to the Finiş Nappe.

The pumping tests conducted during drilling operations on the well S_4 indicated a sensible drop in the temperature of depth waters and a decline of the specific discharge/tested interval thickness ratio because of the reduction of the intensity of fissuration and of the size of the karst channels. Furthemore, it was noted that the discharge capacity of the intervals tested below 500 m, mainly including quartzitic sandstones, dropped substantially (fig. 10).

Wel S_5 (well No. 4666) traversed a succession including Permian schists, sandstones and basaltes belonging to the Moma Nappe (0—275

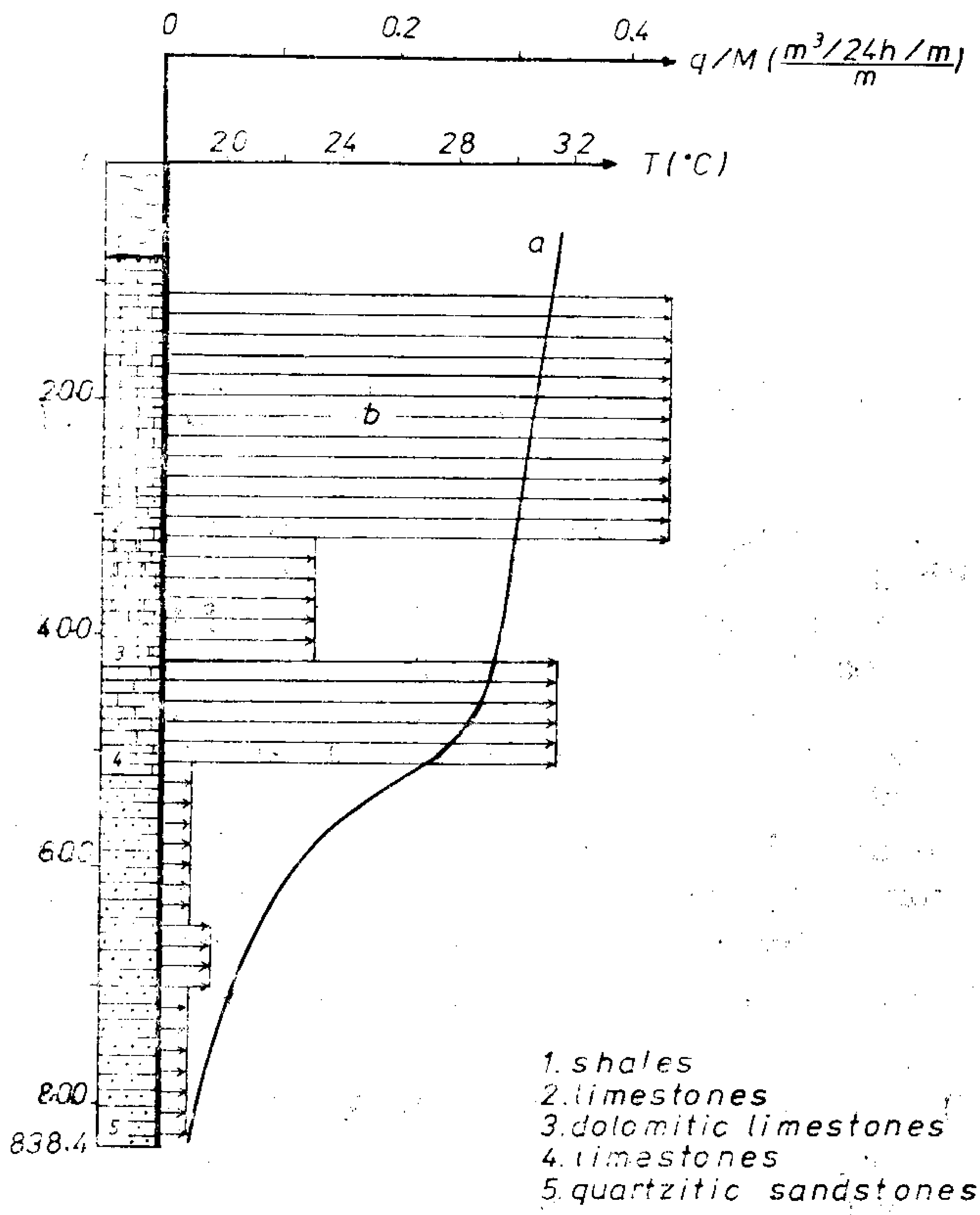


Fig. 10. The variation of temperature (a) and of specific discharge / tested interval thickness ratio (b) of the S_4 well.

[5] VASILESCU G., AVRAMESCU N. (1972), *Hydrogeological report*, I.F.L.G.S. Bucureşti.

m), and then penetrated Triassic karstified limestones (275—340 m) and Werfenian quartzitic sandstones (340—424.6 m) belonging to the Finiș Nappe. The waters intercepted in Triassic limestones boast an artesian discharge of 7 l/sec. of water with a temperature of 17°C at a dynamic level situated 1.5 m above the ground. The hydrostatic level was of +23 m (Pîrvu, 1975 [6]). Present temperature of water is 14°C.

Besides the aforesaid thermal-waters sources, we should also refer to a spring, situated on the left-hand bank of the Moneasa river (fig. 1, p), under the embankment of a former narrow railway, near the stadium. It boast an average discharge of 0.1 l/sec. and a mean temperature of 17.5°C, values that registered great variations during rainy periods.

Others subthermal springs are situated in the upstream part of Băilor brook : spring a (14,2°C, 7,0 l/sec), spring b (10,2°C, 4,0 l/sec) and spring c (14,5°C, 3,5 l/sec). Tămăduirii spring (15—24°C, 0,3 l/sec) situated on the left-hand bank of the Megheș brook (fig. 2, f) is temporary flooded.

6. PUMPING TESTS

With a view to complementing hydrogeological image of area with data concerning the hydrodynamics parameters of the karst aquiferous complex wherein the thermal-water is located, pumping tests were performed in 1977 [7]. Water in the well S_5 was pumped at a constant discharge ($Q = 11.5$ l/sec, drawdown $s = 46.6$ m) for 120 hours and the variation of the water level in well S_1, S_2 and S_4 was observed during both pumping and in recovery. Furtermore, during the exploitation of well S_1 by the balneal spa ($Q = 2.45$ l/sec. at a dynamic level of 0.14 m above the ground) the variation of the piezometric level in well S_4 was noted.

The results obtained through pumping tests were processed and placed on a diagrams. With them as a basis, the transmissivity and the storage capacity (effective porosity) of the karst aquiferous complex were calculated. The results obtained, which are noted on the block-diagram in figure 11, bespeak a great variation, alond different directions, of the hydrodynamic features of the complex. This anisotropy is due to the bank-stratification of the limestones and dolomites, as well as to their different fissuration degree.

Thus, higher values of transmissivity and storage coefficient were obtained for the directions between wells S_1—S_5 and S_4—S_5, which correspond to the area of maximum crumbling of limestones and dolomites as a result of the Moma Nappe overthrust and to the direction of stratification of the carbonate deposits and, equally, superpose over the main direction of fissuring of these deposits.

Lower values were obtained for the S_4—S_1 direction, owing to its orientation which is perpendicular on the direction of stratification of

[6] PÎRVU MARIA (1975), *Hydrogeological report*, I.F.L.G.S. București.
[7] ORĂȘEANU I. (1977), *Hydrogeological report*, I.P.G.G. București.

the carbonate deposits and to their lower fissuration degree as an outcome of their more distant position as to the Moma Nappe overthrust plane.

The interference between these wells, which constantly discharge waters with different temperatures (S_5 — 14°C, S_1 — 24°C, S_2 — 28,5°C and S_4 — 32.5C), corroborated with the results of tracer labellings, which highlighted the relationship between cold karst waters and thermal waters, attests to the presence of a unique hydrogeological karst system of great expanse, boasting an extremely heterogeneous distribution of temperatures, caused by local lateral contributions in karst water of high temperatures in its southernmost part (fig. 12).

The thermal waters in Moneasa area are results of mixing between cold karst waters and karstic waters of deep circulation that rise in

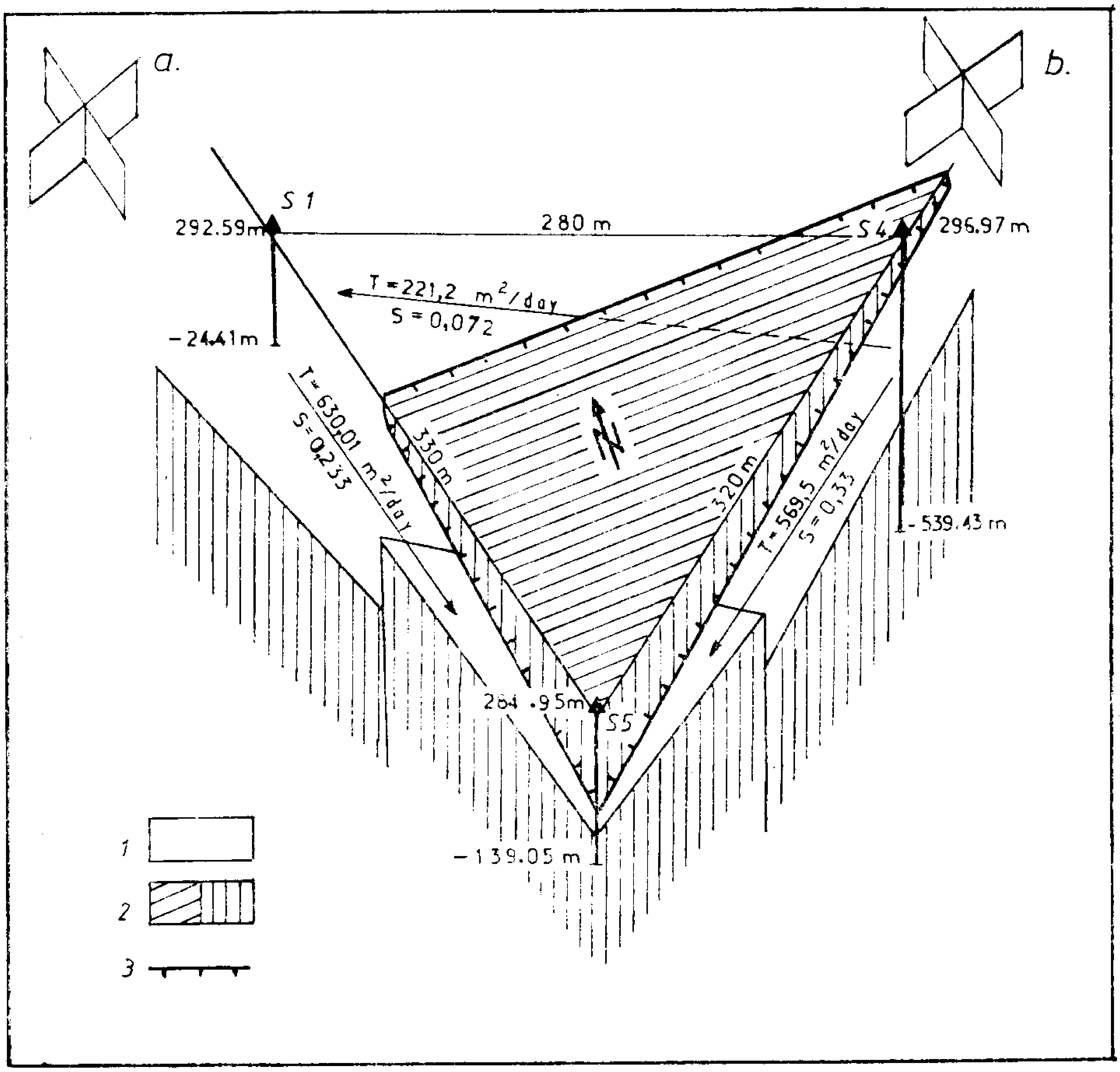


Fig. 11. Block-diagram with pumping tests results. 1 — Karstifiable rocks ; 2 — Nonkarstifiable rocks ; 3 — Overthrust front ; a, b — Main direction of rocks fissuring at Grota Ursului spring (a) and in left-hand slope of Megheş brook, near S_2 well (b).

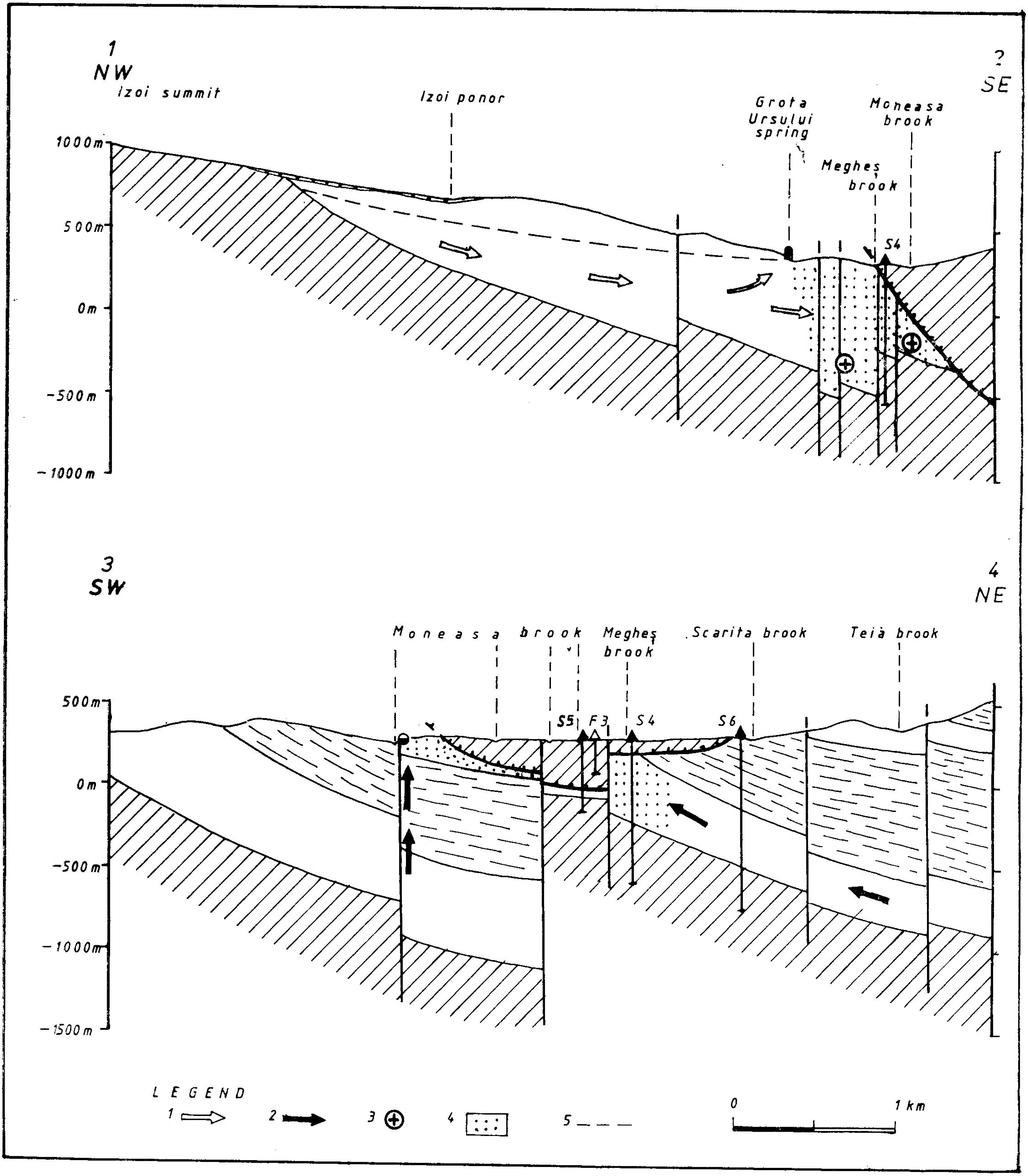


Fig. 12. Hydrogeological cross-sections in Moneasa area. 1 — Direction of cold karst waters flow ; 2 — Direction of hot karst waters flow ; 3 — Lateral contributions in hot karst waters ; 4 — Mixing zone between hot and cold karst waters ; 5 — Approximate position of water table. Others signs as in fig. 1.

temperature because of the relatively high heat flow in this area (80 mW/m^2). The area is not for from the Pannonian Basin, which is recognized fort its hyperthermal regime, more than 90 mW/m^2 (Veliciu, Opran, 1983).

As to the position of the convection cell responsible for the hydrothermal reservoir in the Moneasa area, there are two variants which we consider as possible.

The first variant (fig. 13 a) implies infiltration of cold karst waters from the Brătcoaia (and, possibili Tinoasa or Huta) area to the east, in the direction of the sinking of the limy deposits and, further on, their movement to the south, with the water temperature going up owing to a high flow. In their movement to the south the thermalized waters are barred by the impermeable deposits of the Moma Nappe ; they follow a rapidly ascending direction to the west, along the network of fissures and fractures generated in the carbonate deposits by he overthrust of the aforesaid nappe. Close to the surface these waters blend with the cold waters of the hydrogeological karst system in their movement to the discharge area in Grota Ursului.

The second variant (fig. 13 b) implies a contribution of thermalized waters from the south-west originating in the waters infiltrated in the

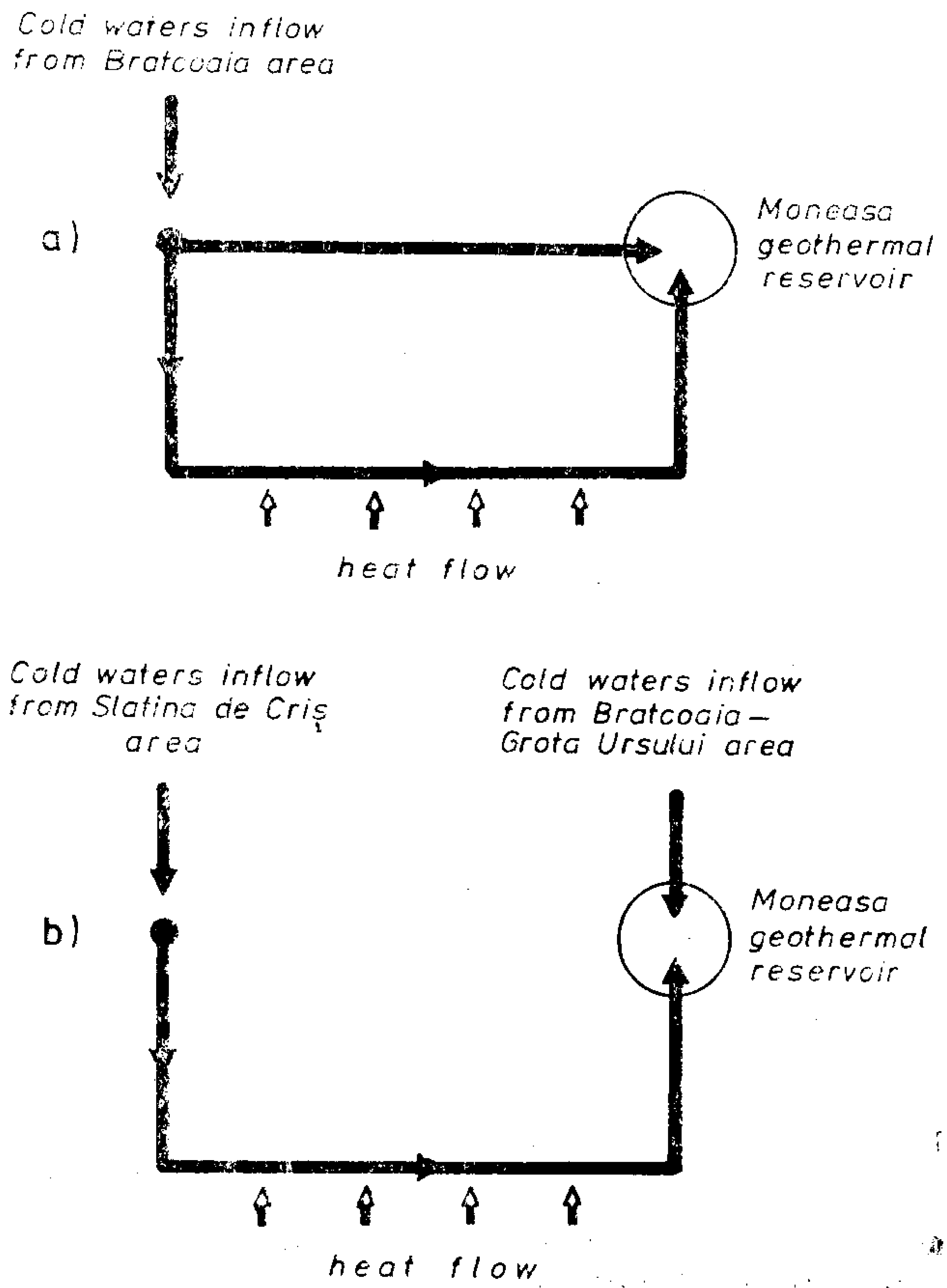


Fig. 13. Convection cells in Moneasa area.

calcareous interfluve at Moneasa and the localities of Slatina de Criş and Dezna, the latter being known owing to its underground thermal waters [8]. Before emerging to the surface in the Moneasa area, these waters get colder partially, which is a result of their blend with the cold waters of the Grota Ursului hydrogeological karst system.

7. HYDROGEOLOGICAL BALANCE OF THE MONEASA AREA

With a view to establishing the expanse of the hydrogeological karst system which discharges its waters to the south in the Moneasa spa area, both through the cold-water spring of Grota Ursului and through the thermal-water springs and wells, we drew up the overall balance of surface and underground water resources.

The area includes the hydrographic basin of the Megheş, Băilor and Pietros brooks and the Tinoasa—Izoi basin whose link with the exurgences in the Megheş and Băilor brooks' basins was proved through tracer labellings. The endorheic basin of Brătcoaia was not included in the balance as it is only partially drained by the sources in the Moneasa valley basin, its contribution to the supply of these sources being only indirect, as resulting from the obtained budget.

The overall balance was drown up for the whole basin and for each separate hydrographic basin with a view to establishing the supply or drainage relationships between them. To work it out, the hydro-meteorological measurements performed at the Moneasa station by Palfy et al. [9] in the Octobebr 1, 1975 — September 30, 1976 hydrologic year were taken as a basis.

Precipitations were assessed with the help of a isohyet map drawn up by interpolating the values of precipitations registered in the aforesaid hydrologic year at the meteorologic stations at Izoi (altitude 700 m), Boroaia (350 m) and Rănuşa (225 m), situated 4 km south-west of Moneasa.

Evapotranspiration was computed with the help of Turc's formula, where the mean annual temperature was assessed according to the map containing the air isotherms, worked out by interpolating the values of the mean annual air temperature measured at the Izoi and at the Moneasa.

Runoff was estimated according to the mean daily discharges measured in the gauging cross sections on the Megheş and Pietros brooks.

The emergences of underground waters (springs) are represented by the contributions of the cold and themal waters on the Băilor brook, assessed through the hydrometric measurements performed in the No. 2 gauging cross section on the Băilor brook.

Catchings of water for domestic use and for the supply of the local swimming pool are represented by the amounts of water taken from

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[8] **In 1978 IFLGS drilled a hydrogeological borehole at Dezna, a locality situated roughly 6 kms south of Moneasa. Along the entire depht (897 m) it traversed carbonate deposits mainly. The well discharges 3.5 l/sec. bicarbonate calcic magnesian water with a temperature of 38.5° (VĂLENAŞ E., FASOLA V., *Hydrogeological report,* IFLGS Bucureşti).**

[9] **See footnote 4.**

Table 3

Hydrogeological balance of Moneasa area (Hydrographic basins of Megheş. Băilor and Pietros brooks) October 1975 — September 1976 hydrologic year

Elements	U.M.	Hydrograph. basin of Megheş brook	Hydrograph basin of Băilor brook	Hydrograph basin of Pietros brook	Tinoasa-Izoi endorheic basin	Total area
Surface	km^2	6,9	1,38	1,65	4,5	14,43
Mean altitude above sea level	m	587,0	505,0	531,0	775,0	653,0
Mean annual air temperature	°C	7,4	7,8	7,7	6,7	7,1
IMPUT						
— Mean annual rainfall	mm	1.079,4	992,8	1.020,0	1.124,5	1.077,6
	$x10^3$ cu.m	7.448,0	1.370,0	1.683,0	5.060,0	15.561,0
OUTPUT						
— Evapotranspiration	mm	461,3	465,0	447,5	446,2	453,7
	$x10^3$ cu.m	3.183,0	615,0	738,0	2 008,0	6.544,0
— Runoff	$x10^3$ cu.m	2.336,0	—	763,0	—	3.099,0
— Emergences	$x10^3$ cu.m	—	5.313,0 [1]	—	—	5.313,0
— Catching of water for domestic use	$x10^3$ cu.m	34,0 [2]	33,0 [3] 209,0 [4]	—	—	276,0
— Output from hydrogeological karst system downstream of the gauging cross sections	$x10^3$ cu.m	101,0 [5]	208,0 [6]	—	—	309,0
Total OUTPUT	$x10^3$ cu.m	5.654,0	6.378,0	1.501,0	2 008,0	15.541,0
Variation of water resources ±dW = IMPUT — OUTPUT	$x10^3$ cu.m	1.794,0	—5.008,0	182,0	3.052,0	20,0

[1] Emergences in Băilor brook measured in the No. 2, gauging cross section;
[2] The S_2 well;
[3] Grota Ursului spring catchment;
[4] The spring 1 and 2 caught for domestic use;
[5] The S_4 well;
[6] The S_5 well.

the Grota Ursului spring and spring 1, spring 2 and well S_2 thermal sources.

Exist from the hydrogeological karst system draining in the surface flow downstream of the monitoring sections are represented by the waters discharged by wells S_4 and S_5 which were not in use in the period the balance was drawn up.

The balance that could be drown shows – in the error interval of five per cent, which is acceptable in hydrometric measurements — a fine concordance between the inlets and outlets estimated for the entire area taken into consideration. It also points to a serious lack of concordance between the areas of the hydrographic and hydrogeologic basins in the zone under study (see tables 3 and 4).

The tracer labellings that have been performed render this image more intricate, in the sense that the area taken into consideration features both inlets from he Brătcoaia depresion and outlets through the Megheş—Piatra cu Lapte diffluence surface. The values of those contributions are probably equal and cannot be sensed in balance calculations.

On the other hand, this situation is relevant for the difficulties encountered in the hydrogeological research of a karst area, and highlights the need for an approach through several methods.

8. WATER CHEMISM

The chemism of the cold and thermal waters at Moneasa is calcic-magnesian with low mineralization (Table 5). Overall mineralization declines in the case of the springs on the Băilor brook as temperature rises (fig. 13) and a direct relationship may be noted between the

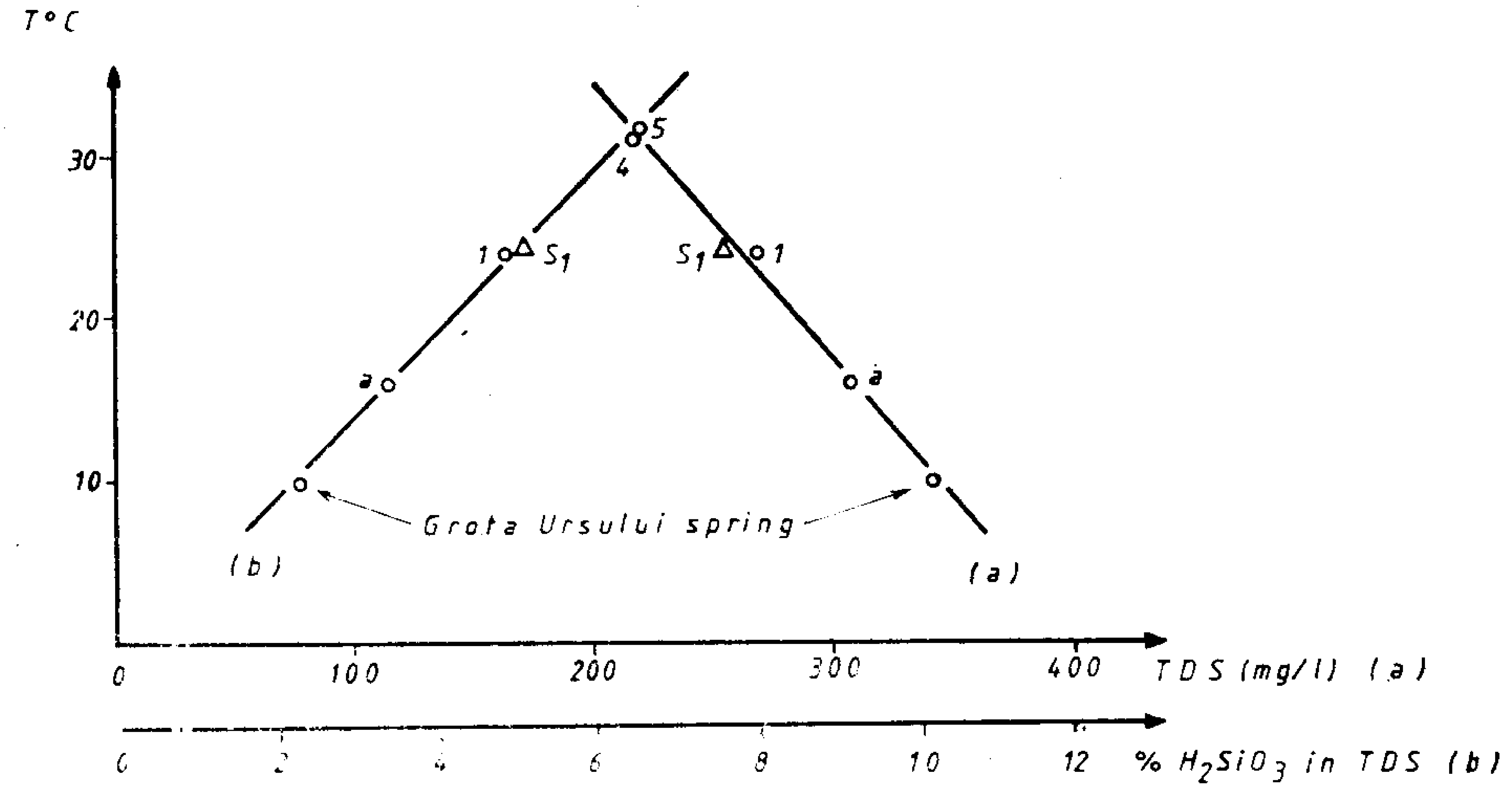

Fig. 14. The relation between TDS(a), % H_2SiO_3(b) and temperature of sources in Băilor brook.

Table 5

Variation range of chemical composition for the waters sampled in Moneasa area in *1970—1977* time interval (mg/l)

Sources	n	TDS x	T(°C)	Cl−	SO_4^{--}	HCO_3^-	Na^+	K^+	Ca^{++}	Mg^{++}	Fe^{++}	CO_2	H_2SiO_3
Thermal spring No. 1	7	228 3	24.0	3.5		146.4	1.7	1.2	25 6	13.1		8.8	10.3
		348.1		7.1	15.3	219 6	21.0	3.1	40.0	17.0	0.1	17.6	12 9
Thermal spring No. 2	3	242.6	24.0	7.1	5 7	158.6	1.4		32.1	14.5	0.1	8.8	12 9
		246.3		7.0	7.6	159.6	4.7		33.6	14 6	0.1	8.8	12 9
Thermal spring No. 4	5	214.5	31.0	13.5		134.2	0.1	2.0	18.4	12.2	0.1	8.8	12 9
		269.8		14.2	15.3	170.8	11.5	2.6	36.4	15.0	0.2	13.2	23.3
Thermal spring No. 5	6	217.6	31.2	3.5		134.2	1.2	2.3	15.2	11.4	0.1	4.4	12 9
		252.3		14 2	17.2	170.8	10.9	2.6	28.0	22.4	0 3	8.8	18.1
Subthermal spring "a"	3	291.5	13.4	7.0		207.0	2.1		36.8	18.5	0.1	8.8	7.7
		356.1	14.9	14.2	9.6	231.8	15.9		44.1	18.7	0.1	17.6	10.5
Subthermal spring "e"	1	240.2	24.5	7.0	3.8	158.6	1.3		33.6	14.1	0.1	8.8	12 9
Tămăduirii spring	2	319.6	15 0	7.0	5.7	207.4	5.0		44.0	13 1	0.1	8.8	12 9
		329.6	24 0	7.1	11.5	219.6	10.4		52.9	14.8	0.1	13.2	15.5
Spring near the stadium	3	205.2	14.0	7.1		128.1	3.7	1.2	28.4	6.3	0.1	—	15.5
		242.2	17.5	14.2	7.7	158.6	10.8	1.2	38.4	10 2	0.1	8.8	20.7
S1 well	5	217.6	24.0	3.5		146.4	0 4	0.5	13.6	12.1	0.1	8.8	10.3
		295 5		7.1	16.3	183.0	11.5	1.7	39 2	23.8	0.2	17.6	12 9
S2 well (4662)	5	231.1	29.0	3.5		146 4	0.8	1.0	20.8	6.3	0.05	8.8	12 9
		254.5		7.1	5.7	170.8	3.1	1.6	44.6	16.0	0.5	17.6	15.5
S4 well (4664)	3	197.8	32.5	7.1	3.8	134.2	7.2	2.1	20.0	12.1	0.1	8.8	15.5
		257.7		7.1	9.6	158.6	17.1	2.4	24.0	12.9	0.2	17.6	18.1
S5 well (4666)	3	182.3	15.9	7.1		109.8	0.1	1.4	18.4	9.4	0.1	8.8	12 9
		195.3		7.1	5.7	122.0	6.8	1.6	20.2	15.5	0.2	8.8	16.1
Grota Ursului spring	5	274.7	7.0	3.4		195.2	1.4		40.0	6.2	0.1	—	3.9
		405.7	9.0	10.6	11.5	286.6	28.3		76.1	24.3	0.1	22.0	12.0

n = number of observations
* = calculated values
Note : Analysis performed in the laboratories of I.P.G.G. Bucharest.

Table 4

Surface of hydrographic and sydrogeologic basins in Moneasa area

		Hydrographic basin km^2	Hydrogeologic basin km^2
1.	Megheş brook	6,9	3,6
2.	Băilor brook	1,38	11,6
3.	Pietros brook	1,65	1,3
4.	Izoi-Tinoasa endorheic basin	4,5	0

H_2SiO_3 content and temperature. In time, the chemical composition of the water of the thermal springs fluctuates substantially, the most significant variation being recorded in the case of the ionic species Na^+ and SO_4^{--}. These variations show that cold karst waters are the origin of the thermal waters at Moneasa.

The No. 1 and 2 thermal springs feature low releases of gases with a composition that is identical to that of atmospheric gas. These releases are generated by the exit from solution of he atmospheric gas dissolved in cold waters as their temperature rises (Table 6).

Table 6

Chemical composition of the gas outflowing from thermal springs

Compound (%)	Thermal spring No. 1	Thermal spring No. 2
CH_4	0.3	7.7
CO_2	0.3	1.0
O_2	20.8	19.1
N_2	77.6	71.2
Ar	0.89	0.82
He	0.0	0 05

Note: Other compounds for which the gases were analyzed, C_2H_6, C_3H_8, C_4H_{10}, H_2 are lacking.

The complet measurements performed by Szabo and Iosif (1967) of the radioactivity of the thermal waters at Moneasa, indicate values ranging from 0,69 to 1.0 nCi, figures which place them far below of 29-nCi, limit which make waters radioactive.

ACKNOLEDGEMENTS

I should like to most warmly thank Francisc Palfy, head of the hydrologic station at Moneasa, for his support in processing the hidro-meteorological data needed to draw up a hydrogeological balance, as well as for our numerius talks on with the hydrology of this area.

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STUDIUL HIDROGEOLOGIC AL ZONEI MONEASA

Rezumat

Cercetările hidrogeologice complexe efectuate în zona Moneasa au evidenţiat prezenţa unui vast sistem hidrogeologic carstic (s.h.c.) în depozitele predominant carbonatice ale Pînzei de Finiş.

Marcările cu trasori şi bilanţul hidrogeologic au precizat extinderea spre nord a s.h.c. pînă în depresiunea de contact litologic Brătcoaia, apele infiltrate prin ponoarele din partea nordică a acestei depresiuni suferind o difluenţă, ele participînd atît la alimentarea izvorului Finişului şi Feredeu situate la nord, cît şi a izbucului Grota Ursului şi a surselor termale de la Moneasa situate la sud.

Izvorul Grota Ursului are un debit mediu de 121.4 l/sec., iar hidrograful debitelor acestei surse în perioadele neinfluenţate este caracterizat prin mai mulţi coeficienţi de secare, reflectînd un mod complex de alimentare, circulaţie, stocare şi descărcare a acumulărilor acvifere.

În partea sudică, la contactul cu depozitele impermeabile ale Pînzei de Moma, apele s.h.c. sînt local termalizate ca urmare a unui aport lateral de ape carstice cu temperatură ridicată. Aceste ape au la origine ape carstice reci antrenate într-o circulaţie profundă, parcurs în care temperatura lor a crescut ca urmare a fluxului termic regional ridicat (80 mW/m^2).

Sursele de ape termale captate sînt reprezentate prin cele 4 izvoare, cu temperaturi de 24—30.8°C, situate pe pîrîul Băilor şi prin 3 sonde ce debitează apă cu temperatui de 24—32.8°C. Debitul cumulat al acesto surse este de 17 l/sec. Caracterul chimic al apelor termale este bicarbonatat calcio-magnezian cu mineralizaţie mică, asemănător apelor carstice reci.

Rezervorul hidrotermal prezintă transmisivităţi de 221.2—630.1 m^2/zi şi coeficienţi de înmagazinare de 0.072—0.33, valorile mai ridicate fiind înregistrate pe direcţia generală nord—sud, corespunzătoare direcţiei principale de fisurare a depozitelor carbonatice şi stratificaţiei acestora.

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