Theoretical and Applied Karstology, 2 (1985), pp. 211—216

PARTIAL CAPTURES AND DIFFLUENCE SURFACES. EXEMPLES FROM THE NORTHERN KARST AREA OF PĂDUREA CRAIULUI MOUNTAINS

BY

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Starting from the examples furnished by the Pădurea Craiului Mourtains karst, methodological considerations needed for drawing up the hydrogeological balance of karstic areas lead the author to define the concept of karstic basin diffluence and the notion of diffluence surface, with specification of their role and place in the structure of the hydrogeological karstic systems.

Hydrogeological investigations carried out in the northern part of the karstic area of Pădurea Craiului Mountains showed major developing capture phenomena, that induce a diversion in the epigean hydrographic network of karstic terrains. In this case the task of the surface drainage is taken over by underground drainage.

Thus, Luncilor valley, which is the upper section of Mișid brook, is affected by losses along the channel through the alluvium of the streambed on two section. The phenomenon is visible especially during draught periods, when the whole course of the valley is swept away by diffuse infiltrations. The tracings performed [1] indicated that waters of this sinking brook appear on the Brătcanilor outlet, situated to the east, in the hydrographic basin of Brătcuța brook.

Mniera valley crosses south-north wards the karstic area under study down to the swallet cave of Potriva, where it sinks, its water emerging on the border of Borod basin, in the spring of Aștileu. In its median section, not far from the Cornet, Mniera valley spans a strongly alluviated portion, where hydrometric gauging indicated heavy infiltrations in the riverbed which, during draght periods, may reach some 75% of the brook upstream this capture area (30 l/sec.). These partial losses are directed by underground path out of the hydrographic basin of the Mniera brook, toward the spring of Moara Jurji [2].

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[1] The tracing was performed in september 19, 1982, in cooperation with Jurkiewicz and Gaspar, under of diffuse total loss downstream Moanei cave. The exit of the tracern used, In-EDTT and Rhodamine B, was recorded after 60 hours at Brătcanilor spring, situated 5200 m away and 289 m downward.

[2] In December 19, 1982, the diffuse partial loss from Cornet was traced with Rhodamine B. The exit of the tracer through the checking section from Moara Jurjii spring developed in two stages, two and four days after injection. The aerial distance between the two points is 1700 m, for a heigh difference of 80 m.

Since the heavy discharge of the spring from Aștileu could not be exclusively ascribed to the supply due to Mniera brook and to the diffuse infiltration on the nearby karstic plateau, our attention turned to the upper course of Topa brook, a tributary of Crișul Negru. Hydrogeological investigations identified several karstic capture areas, associated here too with strongly alluviated stream sections on the Topa brook and on some of its tributaries ,the losses in drought periods being total on Poienii and Topa valleys and partial on Pestiș valley (Fig. 1). The tracings with In-EDTA performed in cooperation with E. Gaspar established the slow transit of this waters to the spring of Aștileu, under the watershed of the hydrographic basins of Crișul Negru and Crișul Repede [3].

In terms of hydrography, this type of capture by which the waters infiltrated in a hydrographic basin are recovered subsequently to an underground travel, in another hydrographic basin. was designated by Bleahu (1957) as heterohydrographic capture, in distinction of cohydrographic captures, by which the water sunk in a certain hydrographic basin emerges in the same basin after an underground flow, and of the endohydrographic captures, which affect a closed hydrographic basin, and to which hydrogeologists usually refer to as total captures [4].

The cohydrographic and heterohydrographic captures are partial losses in the bed of surface stream, initially due to reduced diffuse seepage. They gradually modify the surface course regime from perennial to temporary and are morphologically marked by strong accumulation of alluvia in the capture area, following the alluvia depositon induced by the reduction of the liquid flow. Once the surface course penetrates entirely in the underground, when an antithetic

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[3] The partial loss from Pestiș valley was traced with 17,1 g In-EDTA in July 4, 1983, the samples being collected continuously at Aștileu spring. Since the tracer had not appeared at the spring during the elapsed time interval, in October 15, 1983 a new tracing was performed with 20 g In-EDTA in the total loss from Poienii valley. The passage of the tracer was recorded at Astileu sprirg starting from October 20, 1983 through April 24, 1984. During thus time interval, computations relying on the recorded flow showed that 25 g In-EDTA has been recovered, hence, a larger quantity than any of those injected in each of the swallets, clearly indicating the flow of the waters of both of them toward this spring. The aerial distance between the loss from Pestis valley and Aștileu spring is 11350 m, while than from the loss in Poienii valley is 8650 m, the level differences being of 82 m and 133 m, respectively.

We suppose that the tracer quantity than had not been recovered was carried away by a deep flow which contributes to the supply of the hydrothermal structures from Oradea-Felix-1 Mai area, situated more than 20 km away to the west. This statement is supported by the hydrogeological water-budget drawn up for the karstic area of Pădurea Craiului Mountains, which shows only a partial flow toward the Aștileu spring of the water infiltrated on the Topa valley-Aștileu spring diffluence surface. This area actually behaves as a "polydiffluence surface".

[4] Underground connections between the endohydrographic captures and springs shown in Fig. 1 were carried out by Rusu in the 1966—1974 time intedval (Rusu, 1981) and by Orășeanu in cooperation with Gaștar (Tomii swallet-Izbîndiș spring, Recea swallet-Vîntului Cave, Barc swallet-Roșia spring, Fîntînele swallet-Toplicioarei spring, Peșteruța swallet-Dămișenilor spring) and with Iurkiewicz (Sîncuta swallet-Peștera cu Apă le la Bulz) in the 1980—1983 period.

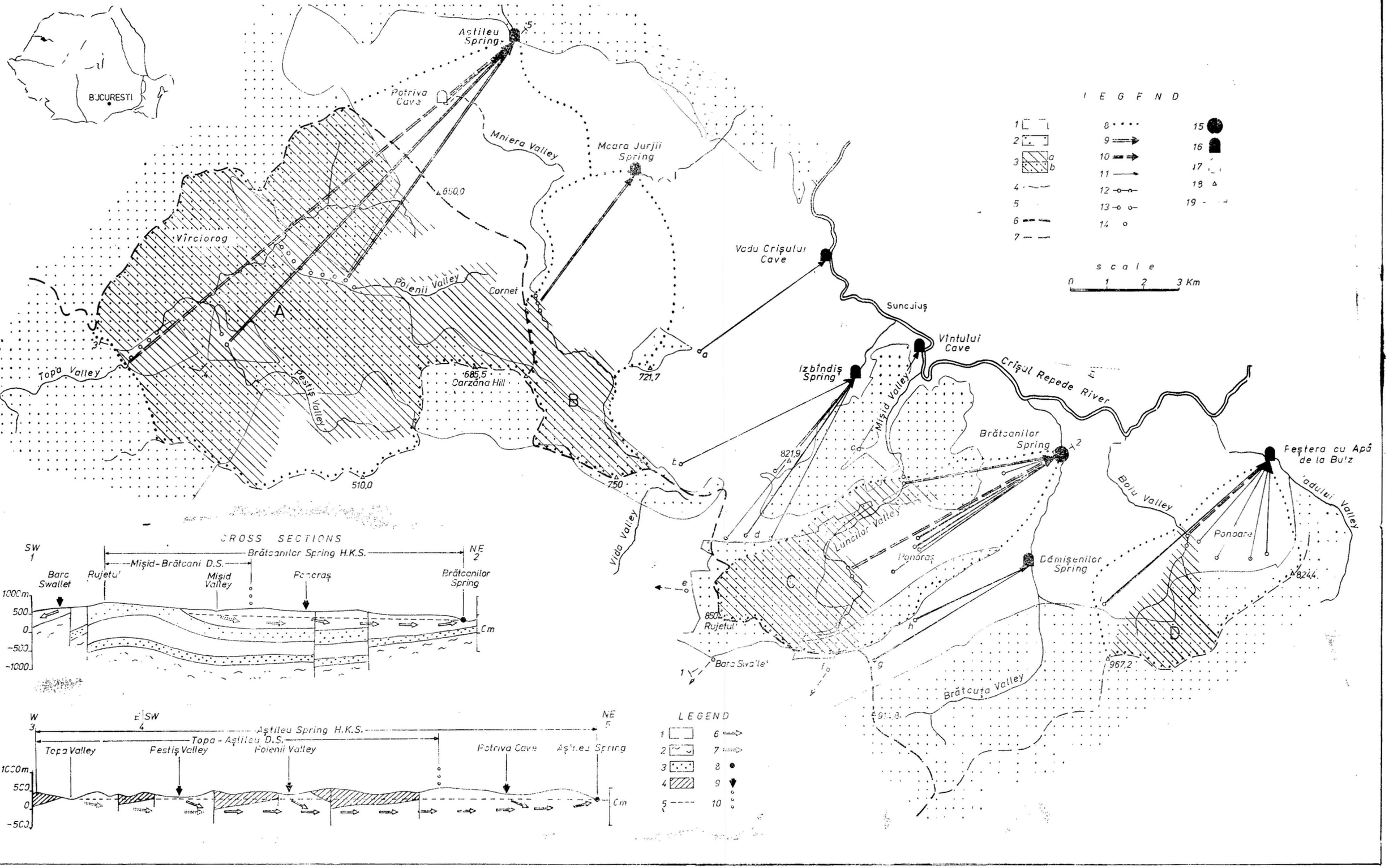

Fig. 1. Partial captures and diffluence surfaces from the northern karst area of Pădurea Craiului Mountains. A — Topa valley—Aștileu spring diffluence surface; B — Mniera valley—Moara Jurjii spring diffluence surface; C — Mișid valley—Brătcanilor spring diffluence surface; D — Boiu valley—Peștera cu Apă de la Bulz diffluence surface; a — Bătrînului cave; b — Tomii swallet; c — Recea swallet; d — Swallets of Cărmăzan; e — Prislop swallet; f — Fîntînele swallet; g — Peșteruța swallet; h — Toaia swallet. Legend: 1 — Karstifiable rocks (Limestones and dolomites); 2 — Nonkarstifiable rocks (quartz sandstones, cristalline rocks, marls, sands, gravels); 3 — Diffluence surface (a — on karstifiable rokcs; b — on norkarstifiable rokcs); 4 — Perennial river; 5 — Temporary river; 6 — Superficial watershed between Crișul Repede and Crișul Negru river; 7 — Superficial watershed between books; 8 — Supposed limit of hydrogeological karstic sistems; 9 — Underground connection between partial captures (heterohydrographic captures) and springs established by budget method; 11 — Underground connection between total captures (endohydrographic captures) and springs established by tracing method; 12 — Perennial partial capture (perennial heterohydrographic capture); 13 — Partial capture (Heterohydrographic capture) actions temporarily as a total capture; 14 — Perennial total capture (endohydrographic capture); 11 — Karstic spring; 16 — Outflow cave; 17 — Inflow cave; 18 — hill; 19 — Direction of cross section. Captions for cross section: 1 — Limestones and dolomites; 2 — Cristalline rokcs; 3 — Quartz sandstones; 4 — Ecleja marls; 5 — Supposed piezometric level; 6 — Flow direction of underground waters established by tracers; 7 — Supposed direction of underground waters flow; 8 — Karstic spring; 9 — Tracer release location; 10 — Superficial watershed: H.K.S. — Hydrogeological karst system; D. S. — Diffluence surface.

tep may often appear, the capture undergoes a further development stage and becomes an endohydrographic capture. i.e. a total loss.

The distinction between the cohydrographic and heterohydrographic captures is no doubt almost arbitrary, depending on the

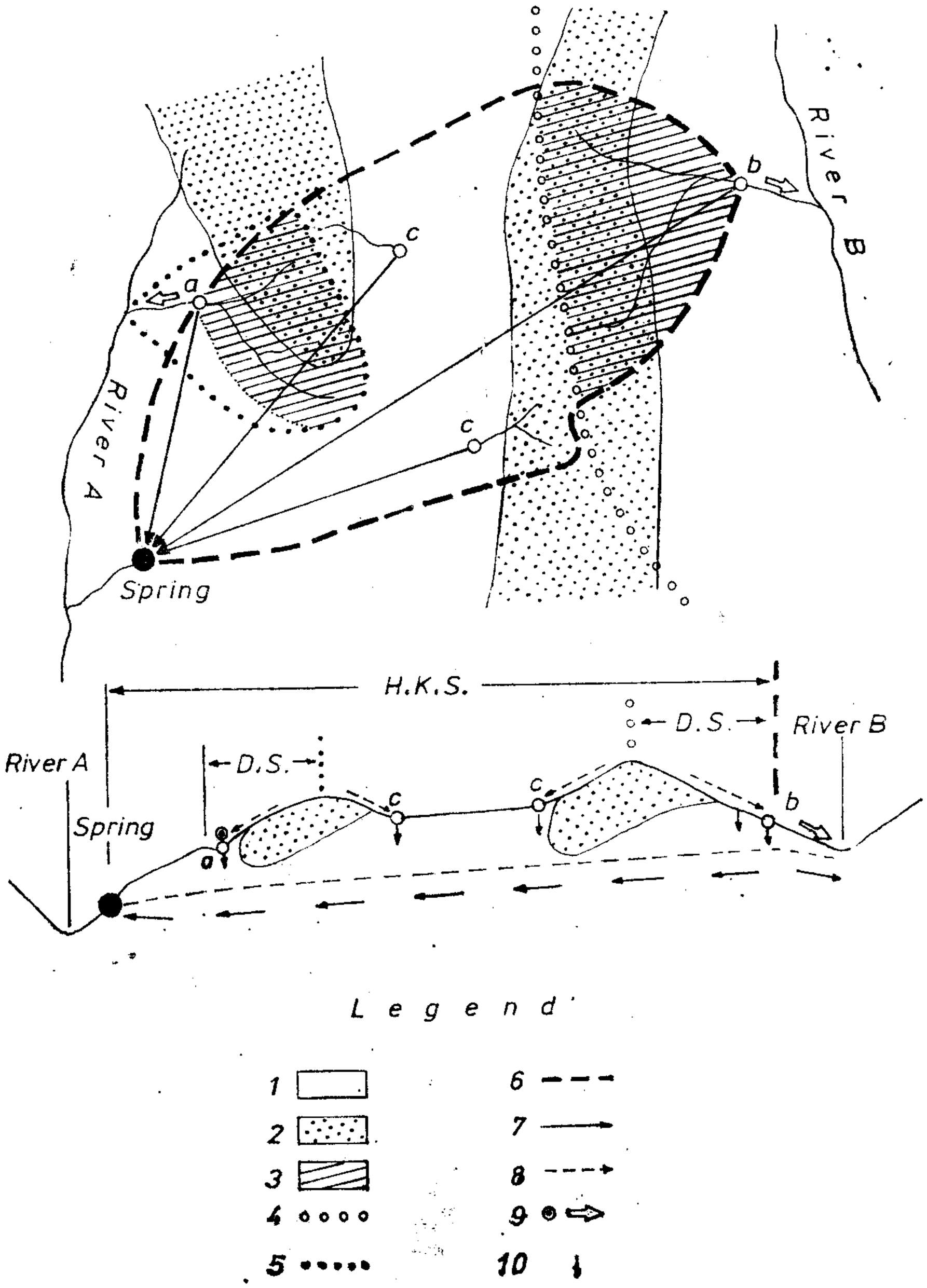

Fig. 2. Partial captures and position of the diffluence surfaces. a — Cohydrographic partial capture ; b — Heterohydrographic partial capture ; c — Endohydrographic (total) capture ; H.K.S. — Hydrogeological karst system ; D.S. — Diffluence surface ; 1 — Karstifiable rocks ; 2 — Nonkarstifiable rock ; 3 — Diffluence surface ; 4 — Superficial watershed between rivers ; 5 — Superficial watershed between brooks ; 6 — Limit of hydrogeological karst system ; 7 — Underground flow direction ; 8 — Efficient rain ; 9 — Output from the system ; 10 — Infiltrations.

scale on which the analysis is performed and is principally serviceable in solving the problems arisen by the hydrogeological waters budget on the karstic areas. Thus, the capture of the upper Mișid course by Brătcanilor spring may by considered as cohydrographic if the analysis is performed the scale of the whole basin of the Crișul Repede river, or as heterohydrographic if it is performed the scale of the Mountains of Pădurea Craiului.

In order to draw up the water budget of a karstic area one must establish the catchment areas of the main sources which stretch also in the area upstream of the partial captures of the hydrographic basins and which contribute, by means of the infiltrated fraction to the recharge of those sources.

For a pertinent hydrogeological particularization, the hydrographic basin area upstream the partial capture was designated as diffluence surface, while the concept of karstic basin diffluence was suggested for the phenomenon itself (Orășeanu, Iurkiewicz, 1982).

The karstic basin diffluence is a process divinding the available water quantity of a hydrographic basin [5], as a consequence of partial capture, into an infiltrated fraction supplying an underground flow directed outside the hydrographic basin of origin and a fraction that flows permanently or temporarily along the river channel downstream the partal capture.

In addition to the water of the partial capture, the underground flow directed toward another hydrographic basin may be also supplied by the infiltrations on the karstic terrains situated within the diffluence surface. However, the diffluence surface does not include the karstic areas devoid of epirogen drainage (the karstic plateau) and it may be located on karstic terrains alone, or, on terrains consisting of both karstic and nonkarstic deposits.

The existence of the karstic basin diffluence, in the diffluence surface is an incipient stage in the hydrogeological evolution of hydrographic basin currently subjected to capture by an external source. The notion of karstic diffluence is dynamic in both time and space. The diffluence surface migrate because of the extension of the capture area of a certain source, indicating the direction and degree of development of the hydrogeological karst system [6].

The diffluence surfaces are fully incorporated in the hydrogeological karst system to the supply of which they contribute by the infiltrated fraction. Estimation of the water volumes with furnished to the supply of the system is performed, according to hydrologic criteria, by installing a discharge gauge station downstream the partial capture. The gauged discharge is considered as an output of the system tending to diminish constantly in time.

The hydrogeological karst system includes both the karstic terrains, displaying a karstic-like undergrond water circulation, as well

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[5] The available water quantity of a hydrographic basin is that left for the runoff and infiltration, i.e. after substracting the evapotranspiration from the precipitation on the basin surface.

[6] Term introduced by Mijatović (1981).

as the non-karstic terrains, the flow of which contributes entirely or partially by the karstic basin diffluence phenomena, to the supply of the same spring or group of springs being interconnected, during a given time interval.

The data concerning the hydrogeological features of the diffluence surfaces in Pădurea Craiului Mountains[7] and the effective infiltration to the runoff ratio on these surfaces will be the object of another study of these mountains.

The overall hydrogeological picture of the Pădurea Craiului Mountains is characterized by the presence of a unitary karstic aquifer in which there is a deep circulation from the east to the west overlay by numerous underground „superficial" (epidermic) ones which discharge at the periphery of the massif, by sources with overflow meaning, the water excess resulting from the rainfall on its surface and which can't be involved in deep circulation.

The karst waters with deep circulation, while moving westwards are thermalized as a consequence of the hyperthermol regime of the area adjacent to the Pannonian Basin and are partially discharged by the sources in the Felix-Oradea-1 Mai zone, which is part of the vast karstic aquifer.

In this complex circulation, the phenomena of karstic basin diffluence points out the relations between the hydrographic basins and „superficial" underground circulation, against the background of a regional diffluence which distributes the available amount of water for runoff and infiltration of the Pădurea Craiului Mountains karstic zone between the deep circulaton on the one hand and the superficial underground circulation and the runoff out of the masif, on the other hand.

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[7] Besides the three diffluence surfaces mentioned here (Mișid valley-Brătcanilor spring, Mniera valley-Miara Jurjii spring, Topa valley-Aștileu spring), in the northern part of Pădurea Craiului Mountains, a foruth one Boiu valley-Peștera cu Apă de la Bulz exists (Orășeanu, Jurkiewicz, 1982).

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CAPTĂRI PARȚIALE ȘI SUPRAFEȚE DE DIFLUENȚĂ EXEMPLE DIN ZONA CARSTICĂ NORDICĂ A MUNȚILOR PĂDUREA CRAIULUI

Rezumat

Cercetările hidrogeologice efectuate în partea nordică a zonei carstice a Munților Pădurea Craiului au evidențiat prezența unor captări carstice majore, în plină desfășurare, care conduc la dezorganizarea rețelei hidrografice superficiale. Acestea sînt reprezentate de captările carstice parțiale prin care apele unor bazine hidrografice sînt transferate pe căi subterane spre surse situate în afara acestor bazine.

Astfel cursul superior al văii Mișidului alimentează parțial izbucul Brătcanilor, valea Mniera este drenată parțial de izbucul de la Moara Jurjii, apele superficiale din bazinul superior al pîrîului Topa sînt captate parțial de către izbucul Aștileu pe sub cumpăna hidrografică dintre rîurile Crișul Negru și Crișul Repede, iar cele ale pîrîului Boiu se regăsesc în parte în cursul subteran care apare din Peștera cu Apă le la Bulz.

Plecînd de la aceste constatări, din considerente metodologice ridicate de întocmirea bilanțului hidrogeologic al zonelor carstice, se defnește conceptul de difluență carstică de bazin și noțiunea de suprafață de difluență, făcîndu-se totodată precizări asupra rolului și locului acesteia în cadrul sistemelor hidrogeologice carstice.

Manuscript received 3rd August, 1985

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