Atti e Memorie della Comm. Grotte "E. Boegan"	Vol. 25	pp. 113-121	Trieste 1986

GEORGE PONTA *, EMILIAN GASPAR **

NEW TRACING EXPERIENCES WITH IN-EDTA IN THE VASCAU KARSTIC PLATEAU CODRU MOMA MOUNTAINS (ROMANIA)

The Vascau karstic plateau is situated in the western part of Romania, in Codru Moma Mountains (Western Carpathians). Its northern boundary follows the river Briheni, its eastern one the Crisul Negru Valley, to the south the boundary follows the line linking Moma peak and Calugari spring, while to the west it follows Captalanului valley.

Geomorphological data

The morphology reflects the geological structure of the massif. The peaks correspond to the hard formations i.e. rhyolites, Permian basalts and Werfenian quartzites, while the plateau to the carbonate formations. The maximum height of the area is reached at the Momuta peak 930 m, situated in its southern part.

The dominant feature of the morphology is the Vascau plateau, developed at 500-600 m height, showing an impressive karstic topography generated by numerous sinkholes and closed basins. In many sinkholes a few karst lakes occur, as a consequence of the decalcification of impervious clay deposition. In most cases, the sinkholes are alignements, forming sinkholes valleys. These sinkholes are tectonically controlled by fractures. Some of them were identified by geological survey. The alignments brought new data for the tectonic image of the area.

The closed basins are the major exokarstic forms of the Vascau plateau. They are generated by processes of karstic capture of the superficial water flows in various stage of organisation. Some are situated at the contact of the karstificable formations with the nonkarstificable ones, such as Pociovaliste, Recea, Ponoras, others develop exclusively on karstic fields (Fîntîna Ponor).

The karstic capture processes are also responsable for the genesis of dry streambeds (sohodols). The best example of Vascau plateau is the Tarina valley, the water of which enters in the Cîmpeneasca cave, beyond which the streambed is left dry. Initially, Tarina was a direct tributary of the Briheni Valley. The old water course can be noticed beyond the step on which Cîmp village is built along Colesti valley.

To the north the plateau border consist of impervious rocks, in which the steep slopes of Briheni valley are carved. Outside of the plateau the topography is also built on impervious rocks.

The valleys are developped in a radical pattern: to the west Ranusa valley, with its tributaries and Dezna valley and in the south Crocna, Zimbru, Raului and Preotesei.

---

* George Ponta - Institutul de Geologie si Geofizica, Bucuresti

** Emilian Gaspar - Institutul de Fizica si Inginerie Nucleara, Bucuresti

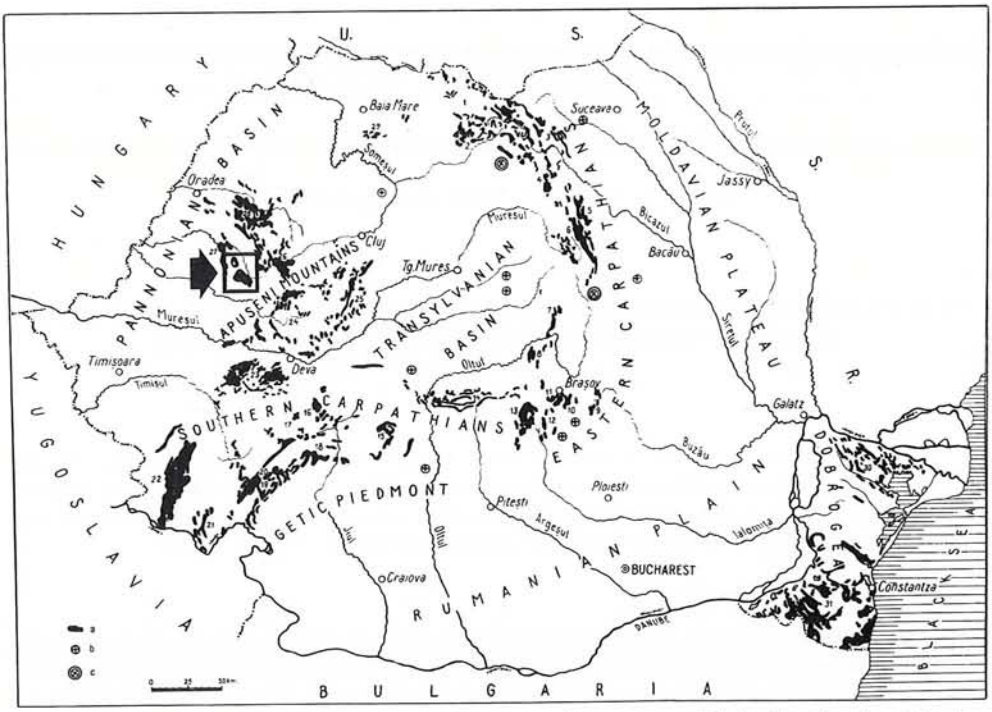

Fig. 1 Distribution of karst-forming rocks in Rumania, a = Limestones and dolomites; b = karst developed on salt and gypsum; c = volcanic rock karst; 1 = Maramuresh Mountains; 2 = Rodna Mountains; 3 = Rarau Massif; 4 = Giurgeu Mountains; 5 = Ceahlau Massif; 6 = Haghimash Massif; 7 = Virghish Valley Basin; 8 = Pershani Mountains; 9 = Ciucash Massif; 10 = Piatra Mare Massif; 11 = Postavarul Massif; 12 = Bucegi Mountains; 13 = Piatra Craiului Massif; 14 = Fagarash Mountains; 15 = Lotru and Capatzina Mountains; 16 = Sebesh Mountains (Luncani Platform); 17 = Retezat Mountains; 18 = Vulcan Mountains; 19 = Mehedintzi Plateau; 20 = Mehedintzi Mountains; 21 = Almaj Mountains; 22 = western side of the Banat Mountains; 23 = Poiana Rusca Mountains; 24 = Metaliferi Mountains; 25 = Trascau Mountains; 26 = Bihor Mountains; 27 = Codru-Moma Mountains; 28 = Padurea Craiului Mountains; 29 = Preluca Massif; 30 = northern Dobrogea; 31 = southern Dobrogea.

Only the Tarina valley has a long subaerial course developped on carbonate rocks and disappears in Cîmpeneasca cave after flowing along almost 5 km. It is worth mentioning that in 1984 the major part of the discharge flew underground through a sink situated 3 km upstream the Cîmpeneasca cave, able to receive 90% of the river discharge.

Vascau plateau has only a few permanent waters, most of them being lost in swallets after a short subaerial course, at the contact of the impervious rocks with the limestone plateau.

Climatic data

The mean annual temperature is 8°C, while the annual mean of rainfall is 1100 mm.

Geological and hydrogeological features

Codru Moma Mts. have a typical overthrust nappe structure, including in their constitution the Nappes of Finis, Dieva, Moma, Vascau, Colesti. They belong to the Codru Nappes system.

They consist of sedimentary Permian-Mezozoic formations intrusted by igneous rocks originated in the permian, mesozoic and neogene eruptions. The neogene magmatic rocks and the neogene sedimentary deposits crop outside them.

Carbonate formations hydrogeology

Carbonate formations, having Moma nappe in their bed, are:

— the carbonate formations of Moma nappe, including black dolomites, dolomitic limestones, grey limestones and reef limestones;

— the carbonate formations of the Vascau nappe, including dolomitic limestones, white dolomites, limestones and black shales at its upper part;

— the carbonate formations of Colesti nappe, including reef limestones, lopherites and red shales.

The carbonate formations of Colesti nappe

The carbonate formations included in this series outcrop on an area of 20,75 km². The whole area is occupied by limestones.

Within this formations the following hydrogeological elements were identified:

Swallets	Q l/s	Springs	Q l/s
Cîmpeneasca	15	Boiu	300-200
Fîntîna Ghita	1	Colesti	8
		P. Colesti	1
		La Fîntîni	2
		Valea Popii	5
		Deliman	1
		Fîntîna Ghita	1
		Fîntîna Oache	0,5
		Ograda Motii	1
Total	16		318,5-218,5

The cumulated yield of the swallets from this formations is 5,02-7,32% of the cumulated resurgences yield.

In the following table we included the characters of the carbonate rocks, separated in respect to the nappes.

The carbonate formations of Vascau nappe

The carbonate formations included in this series outcrop on an area of 32,375 km². 90% of this area is occupied by dolomitic limestones and white dolomites.

Within this formation the following hydrogeological elements were identified:

Swallets	Q l/s	Springs	Q l/s
Haiuga lui Sandor	1,5	Sfaras	1,5
Fîntîna ponor	0,2	Tarau	1
Surii	3	Surii	4

Swallets	Q l/s	Springs	Q l/s
		Tisa	60
		Cascada	1
		Moara Dracului	1
		Sopoteasa	25
		Fîntîna ponor	0,2
		Banisoara	0,5
		Pastravarie	20
		Fîntîna drum	0,04
Total	4,7		114,24

The cumulated yield of the swallets of this formations is 4,1% of the resurgences yield.

The carbonate formations of Moma nappe

The carbonate formations included in this series outcrop on an area of 38.50 km². 80% of this surface is occupied by black dolomites and dolomitic limestones.

Within this formation, the following hydrogeological elements were identified:

Swallets	Q l/s	Springs	Q l/s
Iliei	4	Crisciorel	5
Recea	4	Teplita	25
Ponoras	5	Calugari	2
Sfaras	0,2	Valea Seaca	45
Banisoara	0,5	Raschirata	25
Pociovaliste	1	Izbucas	3
Arînda	0,2	Fumuri	3
Pastailor	0,2	Sfaras	0,2
Valea Dan	1	Sat ponoare	1
Valea Ponoare	5	Negru	1
Zoampa	2		
Pesterelii	3		
Iliei II	1		
Total	27,1		110,2

The cumulated yield of the swallets from this formation is 24% of the resurgence yields.

Nappe	Surf. km²	Q_t swallets l/s	Q_t springs l/s	Q specific springs	Q specific swallets	Type rock
Colesti	20,75	16,0	318,5-218,5	15,3-10,5	0,77	limestones
Vascau	32,37	4,7	114,2	3,5	0,14	dolomites
Moma	38,50	24,1	110,2	2,8	0,62	dolomites
Total	91,62	44,8	542,9-442,9	5,9-4,8	0,48	

The specific yield (Q_s) was calculated for spings and swallets ($Q_s = Q/S$ t) - the total yield divided by the surface). It can be noticed that the yielding capability of the dolomites formations in reduced in respect to that fo the limestones. The limestones have a greater capability of transfer than that storage.

The three carbonate series belonging to different tectonic units act as a single karst system in the areas of the karstic drainage network (the unsaturated zone).

The zone of the karstic drainage network	The absorption zone The vertical transfer zone The horizontal flow zone	The unsatured zone
		The saturated zone

Beneath the limit between the unsaturated and saturated zone, it is possible that the three series should act separately, as independent aquiferous series, the impervious screen being provided by the overthrust plane.

In this case the following correspondence may be assumed:

Colesti nappe — the upper aquifer series
Vascau nappe — the intermediate aquifer series
Moma nappe — the lowes aquifer series.

The hypothesis that the water bearing formations of Moma nappe are separated by a screen from that of Vascau nappe is supported by the occurence of the Fîntîna Banisoarei spring (Q = l l/s) and Fîntîna din Drum spring (l l/s) at the contact fo the carbonate formations of the two nappes.

The Vascau nappe is separated from Colesti nappe by a tectonic screen, whose impermeability is improved by the toarcian shales film, existing at the upper part of Vascau nappe. This shale film outcropping on a reduced area in the northen part of the plateu should continue beneath the Colesti nappe.

For the moment, the existence of the three independent aquifers is only supposed, the problemes are to be solved in the future.

Vascau plateau is a karstic system divided into subsystems. Part of these subsystems had been checked out with tracers by I. Oraseanu-I.P.G.G. Bucharest., while others are only assumed and will be checked out in the future.

The major karstic subsystem is that of Boiu spring. This is the spring with the largest yield of the area (Q = 200-300 l/s).

The first hydrogeological investigation of the Boiu karstic spring was performed by Mihutia on 1904 (G. HALASI, 1979), using dusty coal as a tracer. He proved a hydrogeological interconnection between Cîmpeneasca Cave and Boiu spring.

In the last years, the Boiu spring was investigated with flourescent tracers (Rhodamine B) and radioactive tracers (Na ^{131}I and NH_4 ^{82}Br) by I. Oraseanu on 1979.

During a multitracing experiment in this zone, the two radioactive tracers, ^{131}I (Recea swallet) and ^{82}Br (Iliei swallet) appeared in Boiu spring simultaneously. The tracers were concentrated on ion exchange filters and measured using a low background gamma spectrometry with a Ge(Li) detector.

Thus, the swallowhole under Iliei peak was labelled with ^{82}Br and Recea sinkhole with ^{131}I. The transfer curves obtained in Boiu spring are presented in Fig. 2 and 3, (GASPAR et AL, 1984).

The last labelling in view to establish the recharge area of Boiu spring was performed using In-EDTA as a tracer. In our opinion, In-EDTA (like Dy-EDTA) is the best tracer for karst investigations and was successfully used by authors (SIMION et AL, 1985).

To remove In, the samples OR water are co-precipitated with bismuth hydroxide: then, the water containing the precipitate is filtered under pressure through a nuclear membrane filter. After drying at a room temperature, the precipitate is removed from the filter and then warm-encapsulated in polyethylene sheets.

The capsules containing the precipitate in the form of In hydroxide powder are activated through neutron irradiation with the help of a pneumatic tube in the nuclear reactor, together with the reference sample and the intensity of 417 KeV radiation is measured.

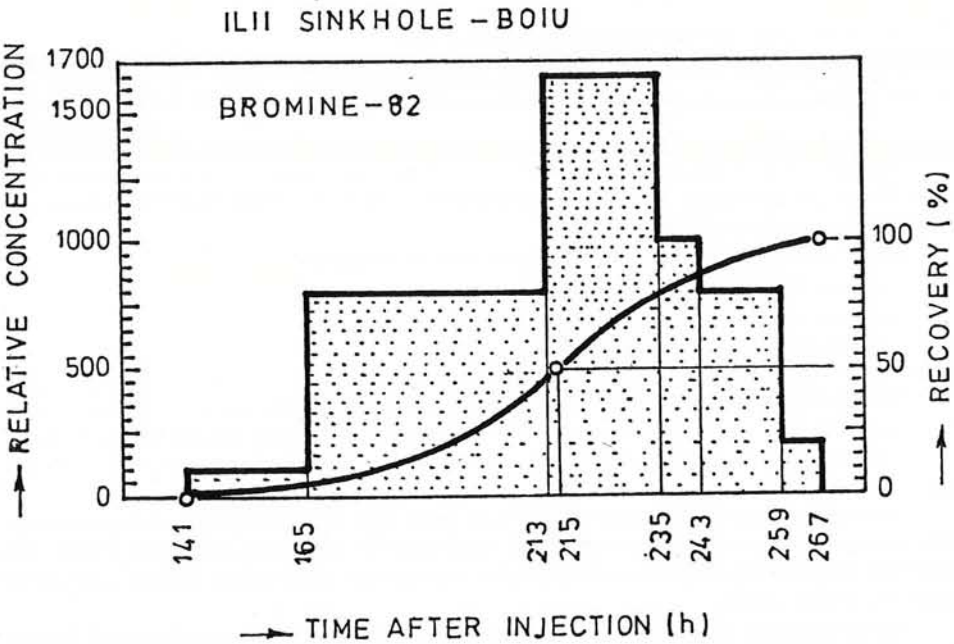
ILII SINKHOLE - BOIU
BROMINE-82
RELATIVE CONCENTRATION
1700
1500
1000
500
0
RECOVERY (%)
100
50
0
141
165
213
215
235
243
259
267
TIME AFTER INJECTION (h)

Fig. 2

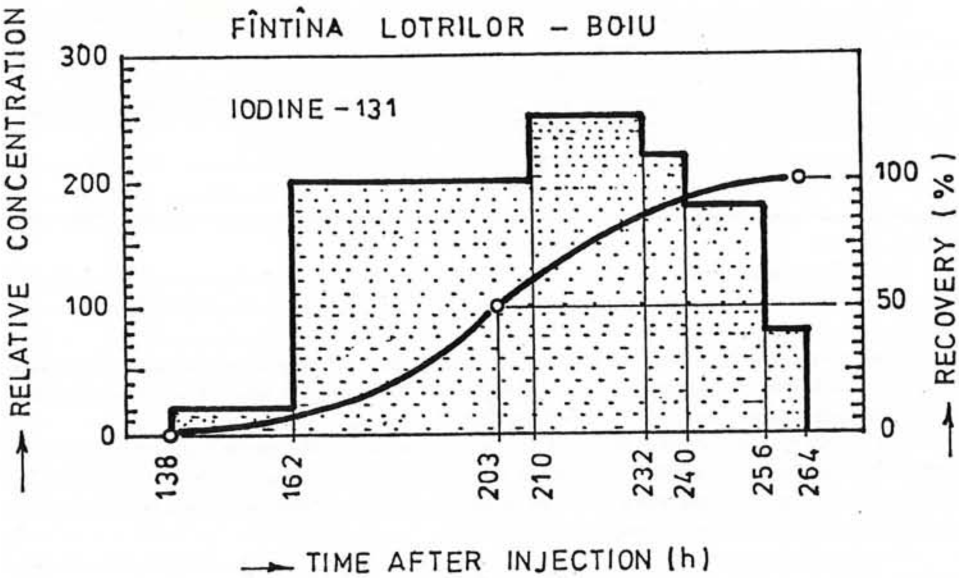
FÎNTÎNA LOTRILOR - BOIU
IODINE-131
RELATIVE CONCENTRATION
300
200
100
0
RECOVERY (%)
100
50
0
138
162
203
210
232
240
256
264
TIME AFTER INJECTION (h)

Fig. 3

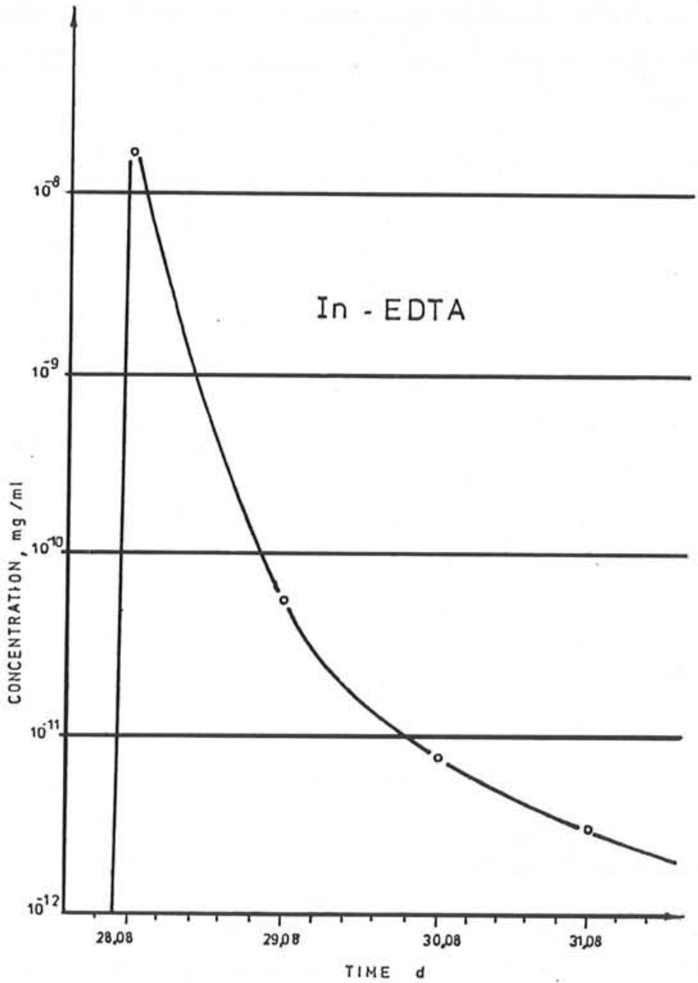

Fig. 4

In our experiment, the Pesterelii Valley swallowhole was labelled with In-EDTA and the tracer appeared after a short transit in Boiu spring. The transfer curve (in concentration vs. time) is presented in Fig. 4. This curve show a pressure and a plug flow, because the experiment was performed during a flood event.

Recea swallet can also contribute with a part of their water to the springs of Valea Seaca-Raschirata, while the recently activated swallet in Tarina valley streambed 3 km upstream of Cîmpeneasca cave may feed the spring from Păstrăvărie trout-hatchery.

The spring from Păstrăvărie trout-hatchery may be fed by the swallet from Valea Dan and Iliei II, which had not been checked out with tracers. The swallet of Zoampa seems to provide the waters for Crisciorel spring.

The subsystem Ponoare Valley-Toplita spring is well defined and acts as a single system. It was checked out with tracers by I. Oraseanu, 1979.

The subsystem Ponoras-Raschirata, Seaca valley is for the moment being assumed, but the geological and structural data support its probability.

The Arînda-Fumuri subsystem is situated in the western section of the plateau. It is a supposed drainage direction.

The Pociovaliste-Tisa subsystem is situated to the north of the plateau. The name of the subsystem is given by the major swallet. The hydrogeological catchment area of Tisa spring includes also the carbonatic rocks situated beneath the toarcian shales. The alternating shale and limestone layers allowed springs with yields of less than 1 l/s to occur, which subsequently sink in diffused swallets are at the contact with the limestones. The swallet of Haiuga lui Sandor was traced, proving to be linked with Tisei spring.

Surii swallet is generated by the alternating shale-limestone layers, and it supplies the spring near Surii cave, as well as the swallets supplying Sopoteasa spring.

To conclude it may be stated that Vascau karst system includes several subsystems, the drainage directions of which interfere (karstic diffluences). As a consequence of this fact Vascau plateau has a hydrogeological network in an early stage of organization. This assertion is supported by the ratio 4,83% of the swallets contribution to springs yields. The resurgences are mainly supplied by the percolation and endokarstic condensation waters. Another consequence of the incipient stage of organization of the network is the existence of many endokarstic phaenomena, of small dimensions, most of them vertical in shape, with development up to 1,5 km.

References

BLEAHU M., 1978. *Muntii Codru-Coma.* Edit. Sport-Turism.

BLEAHU M., PANIN S., TOMESCU C., STEFAN A., ISTRATE GH., STEFANESCU M., 1979. *Harta geologica Vascau, 1:50000.* Institutul de Geologie si Geofizica Bucuresti.

COCEAN P., RUSU T., 1984. *Les plateaux karstiques des Monts Codru Moma,* Trav. Inst. Speol. "E. Racovita", t. XXIII, p. 81-88, Bucharest.

GASPAR E., FARCASIU O., STANESCU P., SPIRIDON S., 1984. *Nuclear methods for karst hydrology investigation, in: Theoretical and Applied Karstology.* 1, Bucharest.

GORAN C., 1981. *Catalogul sistematic al pesterilor din Romania.*

GROH L., HEREDI Z., TULUCAN T., HONIGES O., 1976. *Fenomene carstice în platoul Vascau.* Caietul CSER, 4, p. 82-100.

GROH L., HALASI G., HONIGES O., 1978. *Zonele carstice Briheni-Colesti (M. Codru-Moma).* Bul. CSER 5, p. 123.

HALASI G., 1977. *Avenul Iliei.* Buletin CCSS, 1, p. 24.

HALASI G., 1979. *Morfologia pesterii Cîmpeneasca (M. Codru Moma).* Nymphaea VII, p. 265-272, Oradea.

MITROFAN H., 1984. *Contribution of a Resistivity Survey to karstic aquifers discontinuity investigation.* Trav. Inst. Speol. "E. Ravocita" t. XXIII, p. 67-73, Bucharest.

ORASEANU I., ORASEANU N., TER N., 1978. *Raport asupra studiilor hidrogeologice pentru stabilirea potentialului de ape potabile si termale din carstul Muntilor Moma, perimetrul Moneasa, Zimbru, Criscior, Vascau, Briheni, jud. Arad, Bihor.* Raport I.P.G.G. Bucuresti.

SIMION G., PONTA G., GASPAR E., 1985. *The dynamics of underground waters from Baile Herculane, Cerna Valley, Romania.* Ann. Soc. Geol. Belg, 108.

Atti e Memorie della Comm. Grotte "E. Boegan"
Vol. 25
Trieste 1986

HYDROGEOLOGICAL MAP OF THE VASCAU KARSTIC PLATEAU

(Geology acc. to. M Bleahu et al 1979)

G.PONTA

1985

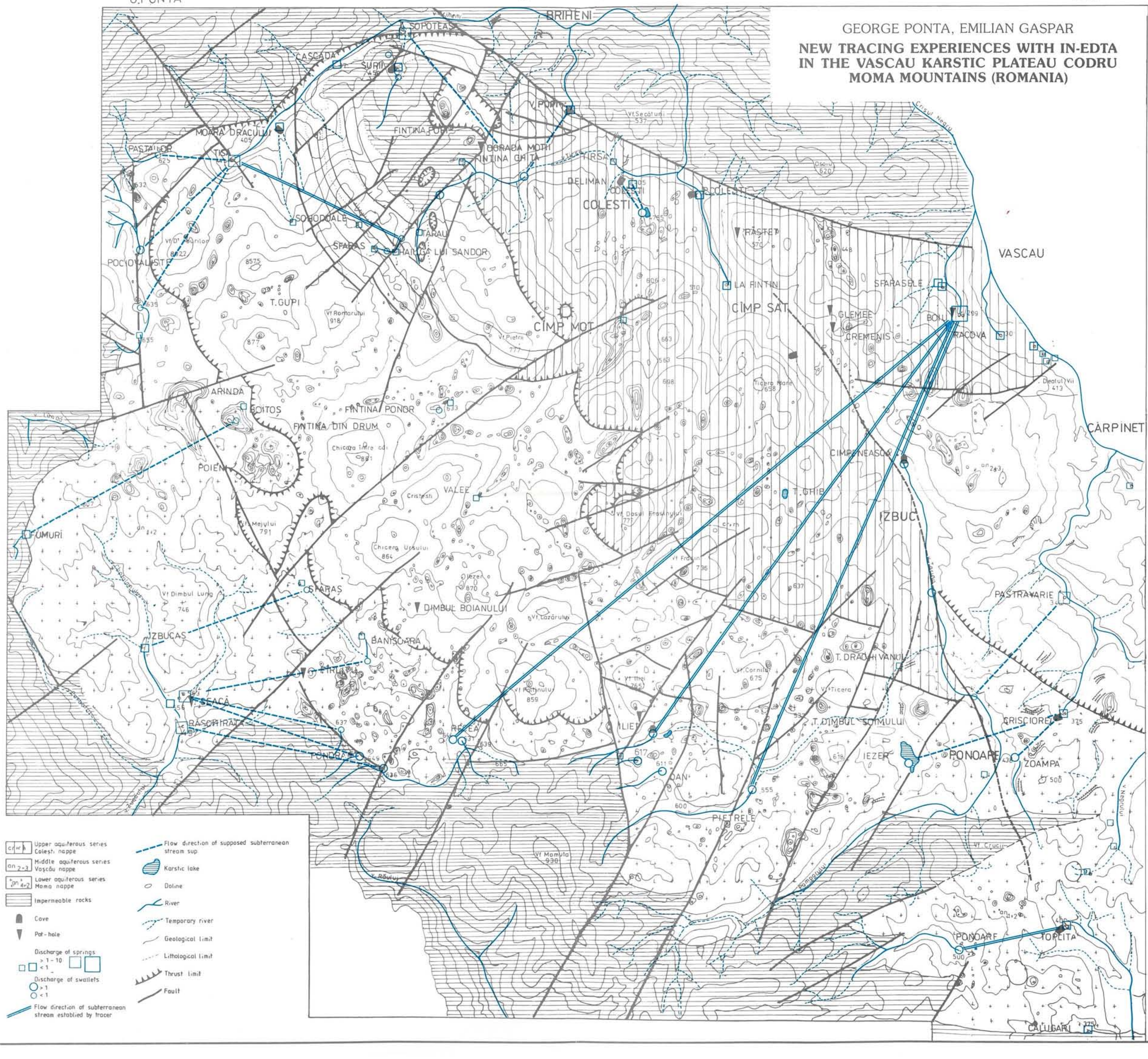

Table 1

Tracing experiences results

SWALLETS					SPRINGS			TECHNICAL DATA				
N.	Swallets	Altit.	Data	Authors	Springs	Distance km	Denivl. m	Time h	Speed m/h	Q swallet l/s	Q spring l/s	Tracer
1.	Iliei	579	1978	I. Oraseanu E. Gaspar N. Terteleac G. Ponta	Boiu-300	5,9	279	252	26,25	10	300	Brom 82
2.	Recea	631	1978	"	Boiu-300	7,6	331	216	26	1,5	300	Iod 131
3.	Haiuga lui Sandor	675	1978	"	Tisa-450	2,15	225	150	14,41	2	110	Iod 131
4.	Cîmpeneasca	406	1978	"	Boiu-300	1,7	106	10	171	12	300	5 kg Rhodam. B
5.	V. Ponoare		1978	I. Oraseanu	Toplita	1,25	99	20	63	30		
6.	V. Pesterelli	555	1985	G. Ponta E. Gaspar.	Boiu-300	5,94	255	12	495	5	300	40 g In-EDTA

RISULTATI DI NUOVE ESPERIENZE DI TRACCIAMENTO CON IN-EDTA NEL COMPLESSO CARSICO DI VASCAU NELLA CATENA DEI MONTI DI CODRU MOMA (Romania)

RIASSUNTO

In un'area la cui complessa morfologia riflette abbastanza bene le caratteristiche litologiche, con rilievi prevalentemente ubicati in corrispondenza di rioliti e di basalti ed un articolato tavolato in cui affiorano diverse formazioni calcaree, numerose ed interessanti sono le forme carsiche superficiali e quelle ipogee. Fra le prime predominano le valli cieche, fra le seconde gli inghiottitoi. Complesso è il reticolo idrogeologico sotterraneo, che drena acque alimentanti numerose sorgenti, alcune delle quali utilizzate a scopi di emungimento civile.

I 1100 mm di precipitazione annuale media vengono in buona parte catturati in volumi rocciosi costituiti da formazioni carbonatico-dolomitiche diverse per litologia ed affioranti con caratteristiche tettoniche variabili. Il regime idrico, e lo sviluppo del carsismo ipogeo, risultano decisamente legati alle condizioni litologiche, strutturali e stratigrafiche delle tre aree in cui si è diviso da punto di vista geologico il tavolato di Vascau.

Numerose prove con traccianti effettuate in tempi successivi (con sostanze coloranti ma anche con sostanze radioattive) hanno provato che le principali sorgenti sono alimentate da reticoli ipogei singolarmente articolati ma interdipendenti e comunicanti fra loro almeno verso le zone di risorgiva. Infatti le singole e numerose direzioni di deflusso sono convergenti in alcune sorgenti o gruppi di sorgenti.

Il regime idrico alle sorgenti indica inoltre come i reticoli ipogei siano ancora in fase giovanile, con fenomeni carsici prevalentemente verticali e relativa diffusione delle acque di base.

(a cura di Franco Cucchi)