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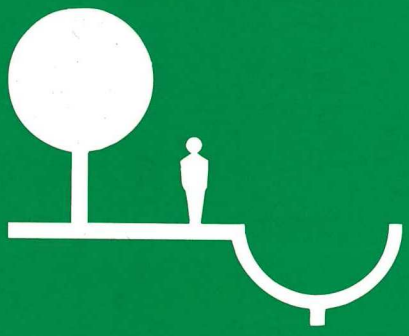

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NEW TRACING EXPERIENCE IN THE SEBES MOUNTAINS - ROMANIA.

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ABSTRACT

G.K.W.: Hydrology, resources, tracing experiments
Geogr. K.W.: Romania, Sebes Mountains

A tracing experience with In - EDTA, which prove the underground connection between Ponorici II Sinkhole and Sipot springs, correlated with discharge-precipitation diagrams and hydrochemical data, complete the image of an important karst water reservoir.

The area is part of the Southern Carpathians and is situated on the western side of the Sureanu montane unit (fig 1).

In the area there are Paleozoic, Mesozoic, Tertiary and Quaternary sedimentary formations that have metamorphic rocks in the basement, which belong to the Getic Nappe.

In the Mesozoic deposits several Jurassic and Cretaceous formations have been separated. We shall present only the carbonate formations.

Limny sandstones, bioclastic limestones, marly limestones and biomicritic rocks (Aalenian - Lower Oxfordian).

This is a predominantly carbonate sequence about 70 m wide, unconformably disposed over the older sedimentary formations and the metamorphic basement of the area (pop, 1985).

Micritic, biomicritic,pelloid and nodular limestones, biolitic limestones (Upper Oxfordian - Tithonian).

These deposits are 100 - 150 m wide and appear on two distinct facies; a) basin - like one represented mainly by micrites and biomicrites and b) a reefal one, represented by red micritic limestones probably corresponding to the Tithonian, which cover the 50-70 m wide reefal massifs limestones. In the lower part these limestones are locally dolomitized.

Urgonian limestones (Upper Jurassic - Lower Aptian).

The metamorphic basement and sedimentary formations are unconformably overlain by an important mass of about 300 m wide limestones. These limestones are largely spread in the area and present a wide variety of carbonate structures bearing biomicrites, biopelmicritites, pelmicrites and their sparitic correspondents.

The bauxite complex (Upper Aptian - Albian).

The Upper Jurassic Lower Cretaceous limestones are discontinuously overlain by the bauxite complex, that appear in the form of some bodies of different dimensions,

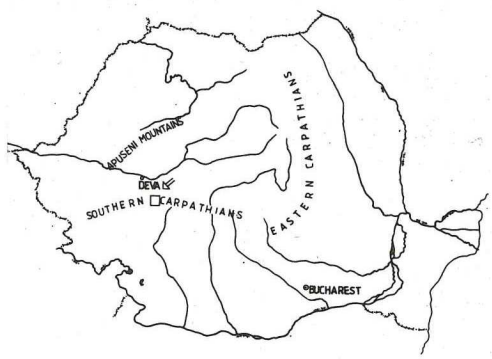


Fig. 1

varying from insignificant appearances to 800/500 m, over 20 m wide lenses.

The bauxite complex is made up of a complex association of hematitic clays and hematitic clay siltites.

GROUNDWATERS IN KARSTIFIED FISSURED ROCKS

About 500 m is the total width of the aquifers situated in Mesozoic limestones.

The crystalline formation (plagiogneisses, gneisses, micaschists)of Precambrian age constitute the impermeable basement for the karstic aquifers in the area.

The Strei valley penetrated the limestone mass, deepening to 400 - 500 m, generating two distinct plateaus: Ponorici Cioclovina - Ohaba Ponor on the right side and Bojita - Tecuri, on the left side. The plateaus margins are made up of vertical cliffs, where the karst phenomena are represented by fossil caves and rockslides (fig.2).

THE PONORICI CIOCLOVINA - OHABA PONOR KARSTIC PLATEAU

The ground waters in this area lie in Aalenian-Lower Oxfordian, Upper Oxfordian - Tithonic and Upper Jurassic - Lower Aptian deposits.

The Upper Jurassic - Lower Aptian limestones show the greatest extent, covering 45 Km^2.

In this area 21 swallets and 14 karstic springs have been pointed out.

The most important discharges are those of the swallets whose waters gather from crystalline formations and vary between 5 - 50 l/s. The waters of the other swallets collected from Mesozoic non-karstified formations, always present discharges under 1 l/s, with two exceptions, the Scarisoara II swallets (1 - 2 l/s)and the Lunca Ohabei swallet (3 - 5 l/s). All the losses are in the Upper Jurassic - Lower Aptian formations and range between altitudes of 800 and 1000 m, are disposed.

THE PONORICI - CIOCLOVINA CU APA KARSTIC SYSTEM

Situated in the northern part of the limestone plateau, the Ponorici - Cioclovina karstic system collect the waters from a surface about 10 km^2.

This hydrogeological basin was partially outline by the surveying activities done in Ponorici Cioclovina cu Apa, Cioclovina Uscata (1) and Valea Stinii caves, later the groundflow image being completed with dye-tracing experiences.

The cave is the third penetration in Romania, whose passages are disposed on 7 km length and 170 m vertical development.

The second important cavity in the system is the Valea Stinii cave, which is 1400

m long. The underground connection between the two caves has been proved by dye-tracing experience. Rhodamine B injected at the downstream end of the Valea Stinii cave has been intercepted in the right main side tributary of the Cioclovina cu Apa cave.

Situated above the main outlet, the third important cave which belong to the system is Cioclovina Uscata Cave, situated above the main outlet. Recently in the cave a small stream has been checked with tracers, but the results were not conclusive, although the surveying data of the underground cavities pointed out their belonging to the same system.

Other two swallets, Trei Piraie (3) and Robului (4) are situated near the Cioclovina resurgence and it is supposed that their waters supply the same collector. It is supposed the same thing about the underground river intercepted in the Triscioare pothole, placed near the above mentioned swallets as well as with the recently discovered swallet formed at the bottom of a suspended doline (2), disposed on the left side of the Ponorolui valley.

The minimum average discharge of the swallets which supply the system is about 30 l/s and represents 40 % of the multi-yearly average discharge rate of the Cioclovina spring (125.1 l/s).

THE SURA MARE KARSTIC SYSTEM

The Sura Mare cave resurgence is situated at the bases of the Ponorici Ohaba Ponor karstic plateau. The main flowing direction, tectonically controlled by a NE - SW fracture contoured a subterranean cavity 6700 m long and + 405 m vertical development. The upstream end of the cave is lying at a 20 m dislevelment under the Fundatura Ponorului sinkhole. The subterranean connection between the main swallet of the system and the resurgence, determined in the past by studies regarding the pulses discharges variations at water inlet-outlet, is now confirmed by the cave survey.

A gauging station situated downstream the confluence between Sura Mare and Cocolbea resurgences recorded a mean annual runoff of 365 l/s, corresponding to a total annual precipitation of 487.9 mm. (fig. 5)

The Sura Mare cave passages, partially have crystalline impermeable rocks on the floor , the flood hydrograph being of a vadose cave stream and tend to be peacked and similar to a surface river.

The storage is strongly influenced by the proportion of the rainfall input that runs off and the lag between the input event and the output response is very short.

The fact that the Fundatura Hobenilor Pothole (6) which is a water inlet belongs to the system was proved by M. Dumitrescu (1967), by a tracing experience with Fluorescein. This test was repeated in 1987 by G. Ponta , with 3.5 kg of Rhodamine B that did not appear in the Sura Mare outlet.

The second experience with tracers was carried out in the underground stream of Dosul Lacsorului pothole. The tracer was intercepted in a sidestream of the Sura Mare cave.

The average discharge of the cave is 150 l/s, while the total average discharge of the swallets id 53 l/s, which represents a percentage of 35 % . Very close to the Sura Mare resurgence it is to notice the presence of a spring on the left side (Gaura Frintoanei) and three springs on the right side. The Gaura Frintoanei cave is an outlet cavity 1200 m long, with average discharge of 2 l/s.

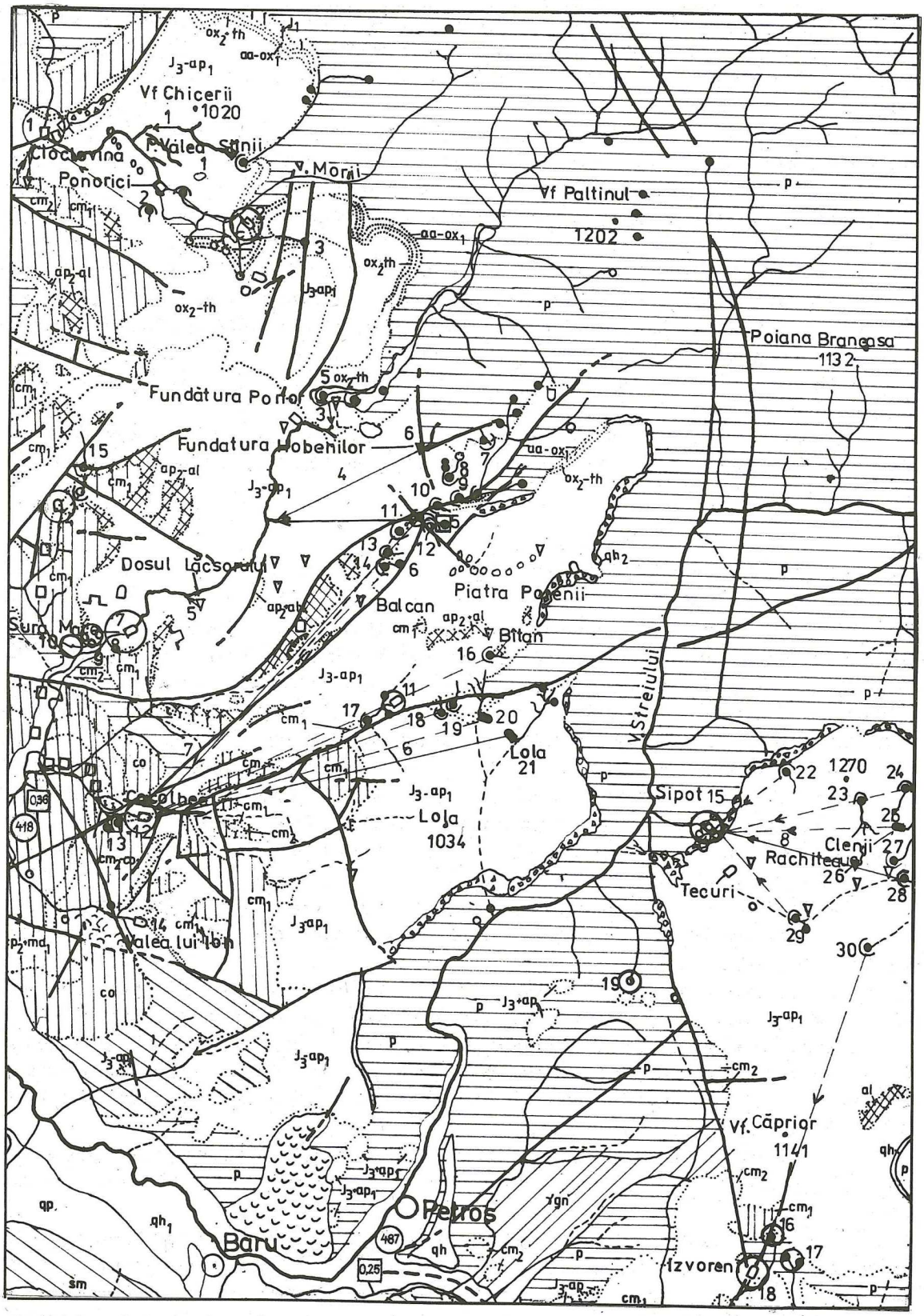
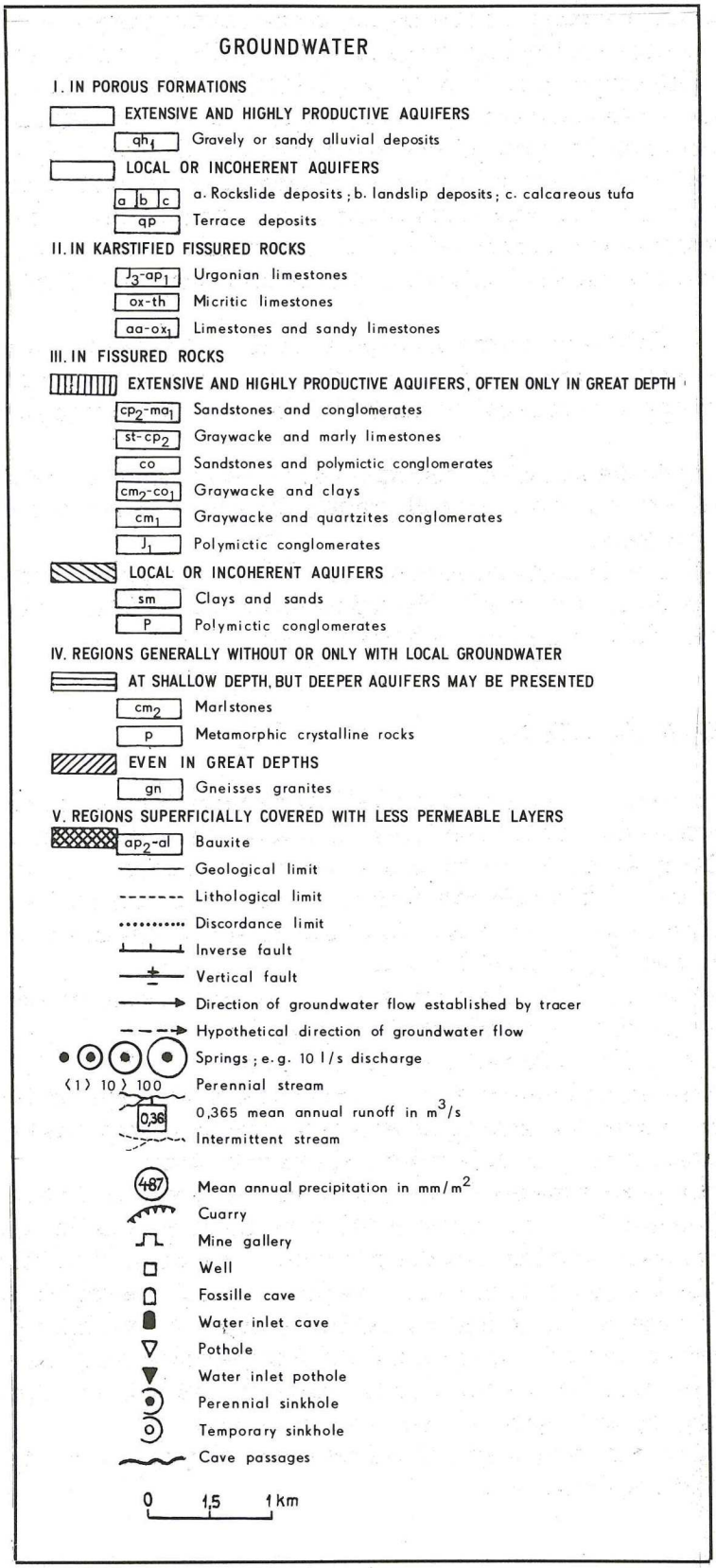


Fig. 2 - Numbers on the map figured near the springs or sinkhole sign



In June , 1988 , 25 g of In-EDTA was injected in Lunca Ohabei Sinkhole to establish the hydrogeological boundary between the basin of Sura Mare and Cocolbea outlet.

The tracer appeared in both springs, in different rate, mainly in the Sura Mare cave. The rainfall from those days are reflected in the general form of the graph. The appearance of the tracer in the Cocolbea spring is determined by a main tectonic fault, and the lag between the two appearances is due to the fact that vadose flow did not exist, the storage of the Cocolbea spring being longer.

300 m downstream of the entrance of the Sura Mare cave, on the right side there are 3 karstic springs (9), disposed on a 15 m distance, having a cumulated discharge of 13 - 15 l/s. The average temperature of these springs is +16° C, while the temperature of the water of the main river is between +5° C and 14° C. According to temperature data it seems to be a separated aquifer bearing subthermal waters.

THE COCOLBEA KARSTIC SYSTEM

The Cocolbea (Sura Mica)resurgence is the main outlet of the southern half of the Cioclovina - Ohaba Ponor karstic

plateau. Situated at the crossing of two major fractures, the resurgence comes out from 125 m long cavity. The multi - yearly average discharge of the cave is 50 l/s and theoretically is supplied by 11 swallets, disposed along the two fractures. The cumulated discharge of these swallets is 10 l/s, which represents the 20% of the resurgence discharge. The swallets are concentrated in two points: Lunca Ohabei and Lola Valley.

The fact that all these swallets belong to the Cocolbea resurgence is hypothetical. Only three experiments with tracers have been carried out, one with fluorescein and two with In - EDTA. The fluorescein and one of the In - EDTA experiments were carried out in the Lola sinkhole while the second in the Lunca Ohabei swallet corresponding to the point named Scarisoara.

In July, 1987, 35 g of In - EDTA was injected in the Lola III sinkhole (21), the furthest from the spring. The results is presented in fig. 3 a, under a curious form of graph. We think that the tracer appearance was controlled by the rainfalls during the experience.

For a better understanding of the situation, the experience was repeated in 1988 with 1 kg of Fluorescein and the result was a normal graph , the tracer being found after 10 days from the injection moment.

The graph is flatter than in the first experience with In - EDTA, that proves that the storage conditions are different between the Cocolbea Spring and Sura Mare. Here, the cave is only about 130 m long, the vadose flow being very short.

THE BOJITA TECURI KARSTIC PLATEAU

The karstic aquifers in this area lie in Upper-Jurassic-Lower Aptian deposits. The plateau is surrounded by vertical walls. At the bases of these walls there are two major springs ,Sipot and Izvoreni. Their waters come from 9 swallets concentrated in the northern half of the limestone area and are disposed 1092m - 1221 m altitudes. The resurgences are situated between 817.4 m and 350 m altitude, which generates a possible development for the karstic aquifer on 400 m wide.

A gauging station situated on the Crivadia river recorded a mean annual runoff of 253 l/s, corresponding to an annual precipitation of 418 mm (fig.5).

The response of a rainfall is rapidly observed on the hydrograph.

The Sipot and Izvoreni resurgences generate two karstic systems whose limits remain only partially known up to now. The geological and cave surveying allow us to suppose that the majority of waters in the plateau are drained towards Sipot.

In November, 1990, a tracing experience with 20 g of In-EDTA was done in the Ponorici II sinkhole (fig.3c). Being only two springs in the area, Izvoreni and Sipot, both of them were under observation. The Sipot outlet presents two springs, both of them and also the cumulated discharge were observed. The tracer was found in both Sipot' springs after 48 hours, the graph presenting two pulses of different amplitude. The experience was done during a rainfall on one side and the storage of the limestone massif is reduced, being possible that after the sumps situated at the entrances of the Sipot caves springs, the main underground stream have a vadose course.

Izvoreni resurgence drains an important area of limestones which was less researched, where new water inlet would be found out.

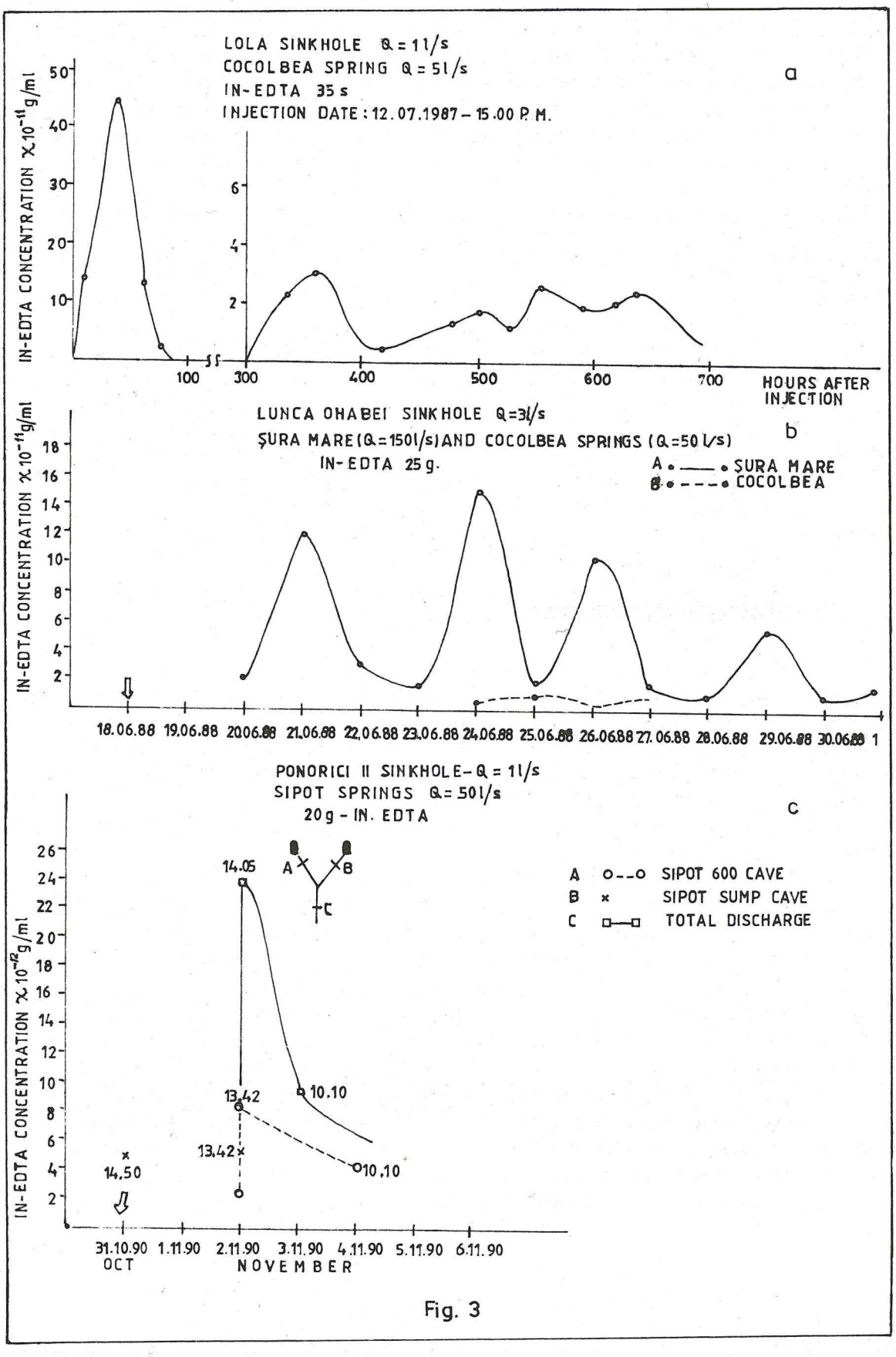


Fig. 3

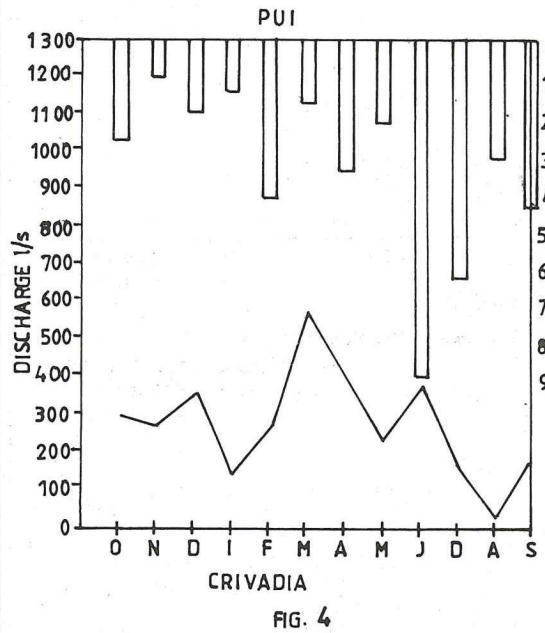


FIG. 4

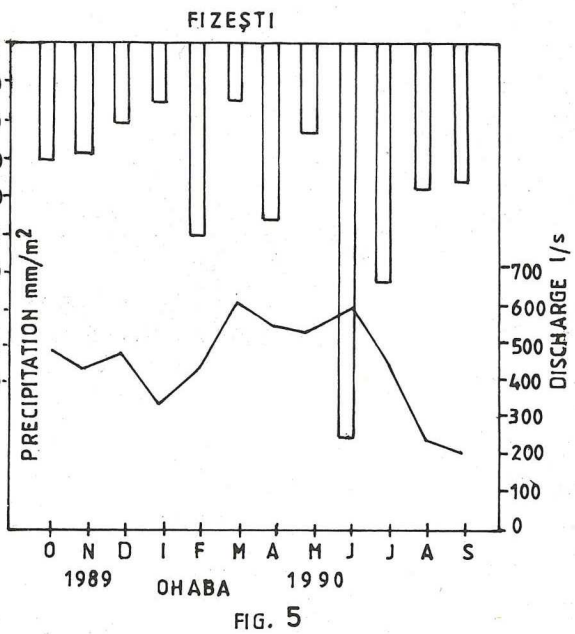


FIG. 5

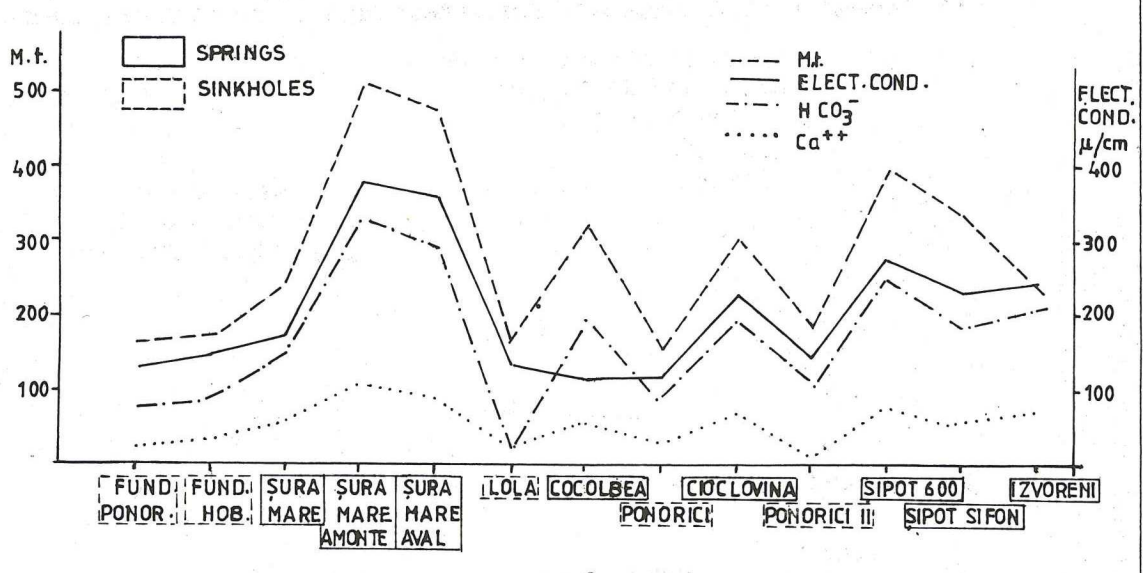


FIG. 6

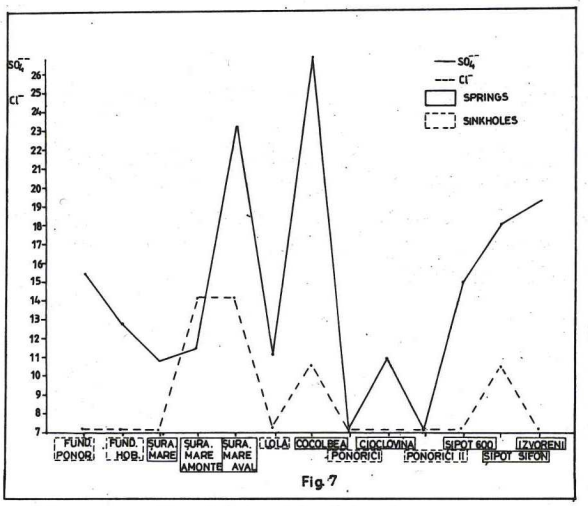


Fig. 7

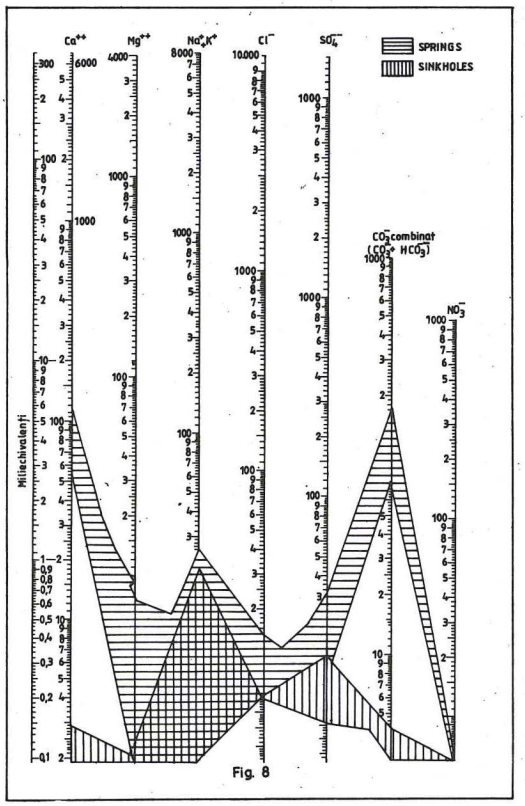


Fig. 8

Tecuri reservoir storage is about 60,000 cm/day.

HYDROCHEMICAL DATA.

From hydrochemical point of view, the matter samples collected in the area (about 50), both from river sinking waters and springs are characterized as waters with little mineralization.

In fig. 7 is presented the variation of SO_4^{--} and Cl^- in different springs and sinkholes. In general both cations are present in low rate, with three exceptions for the SO_4^{--} in Cocolbea springs and the two Sura Mare subthermal springs. The presence of SO_4^{--} demonstrate a longer storage of the water underground and a smaller influence of the rainfall waters.

Also the variation of the Ca^{++} and HCO_3^- correlated with the total mineralization and total conductivity are presented in Fig. 6. There are differences between the sinkhole and the springs. If the surface rivers present the maximun concentration of Na^+ and K^+ anions and SO_4^{--} cations, after crossing the limestone deposits, the characteristics of the waters change, increasing the value of Ca^{++} and HCO_3^- (Fig. 8)

NO_3^- cations are absent from all the samples, the water being unpolluted and apt to be used for water supply.

The Ponorici Cioclovina-Ohaba Ponor reservoir storage is about 35,000 cm/day, while Bojita

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