CARBONATE DEPOSITS IN ROMANIA. HYDROGEOLOGICAL REGIONAL CLASSIFICATION OF THE KARST.

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Carbonate rocks in Romania outcrop over a total area for which estimate range between 4400 km^2 (limestones and dolomites alone, M. BLEAHU and T. RUSU, 1965) and 5637 km^2 (4602 km^2 limestones and dolomites and 975 km^2 carbonate sandstones and conglomerates, V. SENCU, 1968), being included in geological structures that belong to the Orogene (the Carpathian Orogene and the North-Dobrogea Orogene) and to the Moesian Platform.

The Carpathians Orogene consists of the deformed units (which outcrops in the Carpathians and the Apuseni Mountains) and post-tectonic elements (foredeep, molassic depressions, post-tectonic covers and alpine subsequent magmatites) which bound the folded units (M. SĂNDULESCU, 1984).

Dividing the karstic areas into regions with common specific characteristics has been subject of various classification (M. KOMATINA, 1975, M. HERAK, 1977, A. SARIN, 1984).

In Romania, till now, the karst regions classifications are based upon lithological, structural and morphological criterions. M. BLEAHU et al. (1976) distinguished five types of karst: lower karst plateaus, high karst plateaus, high calcareous ridges, lower calcareous bars and isolated calcareous massives. T. ORGHIDAN et al. (1984) differentiate: crest karst, plateau karst and calcareous bars karst, while C. GORAN (1993) proposed three genetic classes of karst relief: platforms, calcareous bars and isolated massifs.

The karstification and generation of the karst systems is subjected to the same hydrochemical and hydrodynamic laws, irrespective of the tectonic structure, of the lithologic constitution and of the topographic setting in which the carbonate deposits occur. The structural and topographic setting produce only specificities in the manner in which these systems are emplaced and evolve, a distinction of the karst areas based on these features being useful in terms of a regional hydrogeological approach (I. ORĂŞEANU, 1993).

The variety of the structural and topographic settings in which carbonate rocks develop is directly mirrored by the groundwater recharge, flow and discharge pattern, which has resulted in differentiating, in hydrogeological terms, between four karst types: the mountain karst (the karst of Carpathian Orogene), the peneplane karst (the karst of North Dobrogea Orogene); the platform karst (the karst of Moesian Platform) and the bedding karst (the karst of Carpathian post-tectonic covers), (Fig. 1).

1. The mountain karst (the karst of Carpathian Orogene)

Within the Carpathian Orogene folded units, carbonate deposits outcrop over an area of about 4435 km^2 (2625 km^2 sedimentary Mesozoic limestones and dolomites, 835 km^2 crystalline limestones and dolomites and 975 km^2 carbonate sandstones and conglomerates V. SENCU, 1968). They are included in complicated geological structures, strongly folded and fractured, that are frequently involved in great overthrust nappes systems. The orogenic movements resulted in uplifting these deposits at heigh altitude, thus creating large elevation drops, hence a strong hydraulic gradient, which together with their intense fracturing favored intense karst development processes.

Carbonate rocks are distributed over the entire extent area of the Carpathian Mountains deformed

units, but they generally occur on small and scattered surfaces. Important areas covered by these deposits are met especially in the western half of the Southern Carpathians and in Apuseni Mountains.

Surface stream courses in the Carpathian Orogene karst areas frequently display a temporary flow character, water losses in their bed and presence of underground flow being often simultaneous, thus emphasizing the complex character of the relationships between the surface and underground flow.

Karst systems display various development stages, from an incipient organization stage of the underground flow, to the occurrence of a single conduit. Karst systems are both of unitary and of binary type, the weight of the non-karst catchment areas in the constitution of the latter being often very important. The groundwater average transit velocity is often rather large, tracer tests documenting values of 2-100 m/hour. Underground residence time of the water is relatively small, while springs flow rates and water physical-chemical parameters exhibit a large variation in time over one hydrological year span. In terms of landforms, karst areas in the Carpathian Orogene display various features (mountains topography, high and low plateaus, limestone bars), that at their turn result in a certain specificity of the previously mentioned parameters. The average flow rates of the main springs do not exceed 2 m^3/s as mean annual discharge.

2. The peneplane karst (the karst of North Dobrogea Orogene)

Carbonate deposits in Tulcea area of North Dobrogea Orogene, consisting of Triassic limestone and dolomite extending over an area of 149 km^2 (M. BLEAHU and Th. RUSU, 1965), are involved in complicated geological structures, similar to the previous type. The flat topography of this area however induces a small water table gradient of the groundwater accumulations located within theses deposits and a small groundwater transit velocity. The area has a deficient rainfall regime (400-500 mm/year). The average flow rates of the main springs do not exceed 10 l/s. The main karst water flow is directed east-southeast, toward Razelm lake, the structure plunging axially in that direction (M. PASCU, 1983).

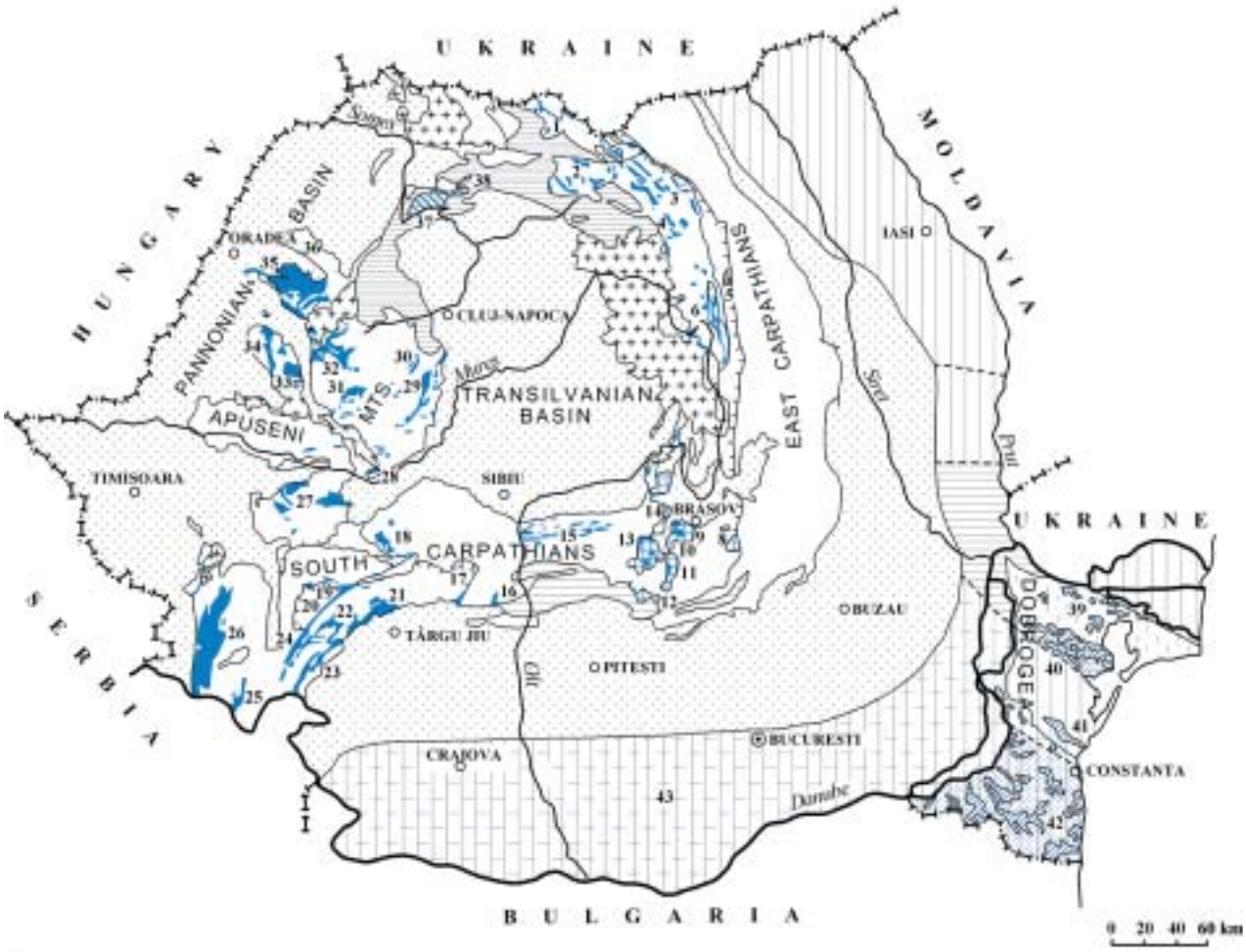
3. The platform karst (the karst of Moesian Platform)

Within the carbonate series of the platform areas, that display significant thicknesses and virtually horizontal structures, slightly or not at all folded, yet concerned by important systems of vertical faults, there are located important aquifers displaying very small hydraulic gradient and very slow groundwater transit.

The northern part of the Moesian Platform, developed in the Romanian Plain and in South Dobrogea, includes in its geological layout a stack of Malm-Barremian limestones, up to 1500 m thick. These rocks outcrop over restricted areas in the southern part of the Romanian Plain (on the Danube border, at Giurgiu), yet they cover extended areas south of the Danube, in Bulgaria. The carbonate complex in the Romanian Plain extends over a 30,800 km^2 area; it progressively sinks northward, beneath younger deposits, reaching a 2000 m depth in the Bucharest city area, where aquifer reservoir has a thermal character (F. ZAMFIRESCU et al. 1994). To the east, the Malm-Barremian limestones gently rises, to outcrop again on the Danube river border, at Hârşova and in South Dobrogea. The Malm-Barremian karst aquifer in the Romanian Plain is investigated and exploited over very small areas, in Giurgiu district (P. CRĂCIUN et al., 2000, A. ŢENU et al., 2000).

In South Dobrogea, the Malm-Barremian limestones is covered to a large extent by successions of Cretaceous-Neogene deposits, among which a conspicuous, hydrogeological significant position, is occupied by the Sarmatian limestones. Carbonate deposits in South Dobrogea occupy a 4500 km^2 area, being yet covered by loess. They outcrop over small areas, restricted to the main valleys pathways and to the Black Sea shore.

In South Dobrogea, the flat topography generates in the two karst aquifers that overlie one another, the Malm-Barremian and the Sarmatian one, small hydraulic gradients, that impose very small transit velocities, estimated to 2.6-5.4 m/year for the first aquifer and to 0.8 m/year for the second one (F. D. DAVIDESCU, A. ŢENU, ANA SLĂVESCU, 1991). These aquifers have been investigated in detail and they are extensively exploited, representing the only water supply source in this whole area (N. PITU, 1980, V. MOLDOVEANU, 1999).



GEOTECTONIC MAJOR UNITS

Carpathians Orogene
a - Orogenic formations;
Post-tectonic elements
b - Foredeep and molassic depressions;
c - Post-tectonic covers;
d - Subsequent alpine magmatites

North-Dobrogea Orogene
a - Orogenic formations;
b - Post-tectonic covers

Platforms

HYDROGEOLOGICAL KARST TYPES

Mountain karst
(The karst of Carpathians Orogene)
a - Limestones and dolomites
b - Calcareous sandstones and conglomerates

Peneplane karst
(The karst of North-Dobrogea Orogene)

Platform karst
(The karst of Moesian Platform)
a - Limestones in outcrops
b - Limestones covered by loesses
c - Limestones covered by Pre-Quaternary deposits

Bedding karst
(The karst of Carpathian post-tectonic covers)

KEY OF THE SITE

1 - Maramureş Mts.
2 - Rodna Mts.
3 - Rarău Mts.
4 - Giurgeu Mts.
5 - Ceahlău Mts.
6 - Hăghimaş Mts.
7 - Perşani Mts.
8 - Ciucaş Mts.
9 - Piatra Mare Mts.
10 - Postăvaru Mts.
11 - Bucegi Mts.
12 - Leaota Mts.
13 - Piatra Craiului Mts.
14 - Codlea area
15 - Făgăraş Mts.
16 - Buila-Vânturariţa Mts.
17 - Lotru and Căpăţânii Mts.
18 - Sebeş Mts.
19 - Retezat Mts.
20 - Cerna-Jiu passage
21 - Vâlcan Mts.
22 - Mehedinţi Mts.
23 - Mehedinţi Plateau
24 - Cernei Mts.
25 - Almăj Mts.
26 - Banat Mts.
27 - Poiana Ruscă Mts.
28 - Rapolt zone
29 - Trascău Mts.
30 - Gilău Mts.
31 - Poieni Plateau (Metaliferi Mts.)
32 - Bihor Mts.
33 - Vaşcău Plateau (Moma Mts.)
34 - Codru Mts.
35 - Pădurea Craiului Mts.
36 - Rez Mts.
37 - Someşan Plateau
38 - Preluca Mts.
39 - Tulcea Mts.
40- Babadag basin
41 - Casimcea area
42 - South - Dobrogea
43 - Moesian Platform

Figure 1. Distribution of the hydrogeological karst types in Romania
(Structural map after M. SĂNDULESCU, 1984)

Babadag basin is the post-tectonic cover of the North Dobrogea Orogene, that through its evolution and geological layout (placed on a stable basement, of large thickness and tabular structure), and through the hydrogeological behavior of the Cretaceous karst aquifer, provide it with hydrogeological features typical to the platform karst. The basin, consisting prevalently of limestones and sandy limestones of Cretaceous age, with its thickness reaching 1000 m, has the configuration of a syncline structure, of 732 km^2 area, out of which limestones outcrops occupy 332 km^2 (GH. & RĂDIŢA BANDRABUR, present volume). It strikes north-northwest-south-southeast, plunging eastward, beneath Razelm lake and the Black Sea. The karst aquifer has a small hydraulic gradient, which imposes a slow groundwater transit to the east, where it probably discharges through undersea outlets.

4. The bedding karst (the karst of Carpathian post-tectonic covers)

The sediments of the Carpathian Orogene post-tectonic covers have been deposited in unsteady basement (intermittent subsidence) basins, and they consist of alternating rocks of various lithologic constitutions, in which carbonate rocks are frequent and may often reach thicknesses of several tens of meters, outcropping over an area of about 540 km^2. They have a monocline, slightly inclined structure and are slightly concerned by major tectonic features.

Such a setting occurs on the north-western border of the Transylvanian Basin, where within the Eocene and Oligocene deposits series there occur two, 20 and 30-60 m thick limestone horizons, separated by alternating, 40-70 m thick marl and gypsum layers. In this area, an outstanding physiographic unit is the Someşan Plateau, that exhibits in terms of landforms an evolved, both surface and underground karst topography.

Aquifers hosted in beded limestones have reduced resources, their recharge being supported mainly by surface runoff from noncarbonate terrains. The spring discharge are reduced and display large seasonal fluctuation. There are many karst systems with small area and a high degree of organization.

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