

OLDER THEORIES ON UNDERGROUND ACCUMULATIONS IN KARST

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The conception about the existence of underground water in karst, about the existence of underground water level (piezometric level) respectively is rather younger than the theory about karst ponors and underground flows.

As the evidence of underground water level – in figurative sense it is underground accumulation too – older authors used karst poljes, periodic lakes respectively. The most famous about such lakes was Cerknica lake on the then Carniola. In our article the ideas on underground accumulations of the three authors as the proof of the theory Cerknica lake, are presented: G. WERNHER (1551), A. KIRCHER (1665) and J.V. VALVASOR (1687, 1689).

In his work *De admirandis Hungariae aquis hypomnematum (1551)* G. WERNHER describes Cerknica lake, mentions fissures and caves through which the water flows off the polje into underground and he describes the underground waters flowing in big distances through the underground caves in the mountains. He says: "One could foresee that some channels lead the underground water from these hidden caves – reservoirs – to the lake. In particular, as it is known, that in the area big mountainous caves exist where the roaring of increasing or decreasing water could be heard; these caves are a sort of lakes which can increase and flood the banks as the rivers and brooks on the surface do". In a sense Wernher's "underground caves-reservoirs" are what call today underground accumulation in the background of Cerknica lake. Unfortunately he did not explain the working of the system neither the connection between the underground reservoirs and Cerknica lake.

Good hundred years later the work of erudite jesuit Athanasius KIRCHER entitled *Mundus subterraneus ... (3rd edition, 1678)* was published. It treats the

underground waters widely, in 5th book entitled "De fluminum origine" in particular.

According to Kircher's theory there are "in dusky guts of the mountains enormous quantities of water" (p. 70). Such underground water body he calls "hydrophylatium". In the Alps there are supposed to be three such "hydrophylatia", one of them in Pennine Alps, these are the mountains in the hinterland of the Adriatic Sea which roughly corresponds to the actual slovene Dinaric karst. The water from the "hydrophylatia" should flow to the surface as the rivers sources, in special cases the superficial waters should joint them. The base for "hydrophylatia" feeding are rain-water and melt-water, seeping to the underground, but the underground channels are important as well which, according to his theory, connect the "hydrophylatia" with sea and through which the sea water flows through the siphons (usually distilled) into land "hydrophylatia" (Fig. 1).

To confirm the conception Kircher cites two examples from the slovene karst. The source of Timavo is an example of direct outflow of the mentioned "hydrophylatia" in the interior of Pennine Alps (below "Timavus mons") into the sea. Incidentally let us say that Kircher writes about the river, which flows 14 miles apart under the village S. Cantiani and disappears in the potholes – these are the actual Škocjanske jame (p. 304). Kircher mentions Cerknica lake on several places, detailed explanation of the function is on the pages 258–262. In this example it is no more theoretical conception about "hydrophylatia" but the explanation of concrete phenomena on the earth surface and in the underground. On one hand he correctly writes that the underground fills by water because of the autumn rain and spring snow melting and rain, that is why the surplus of water flows to the

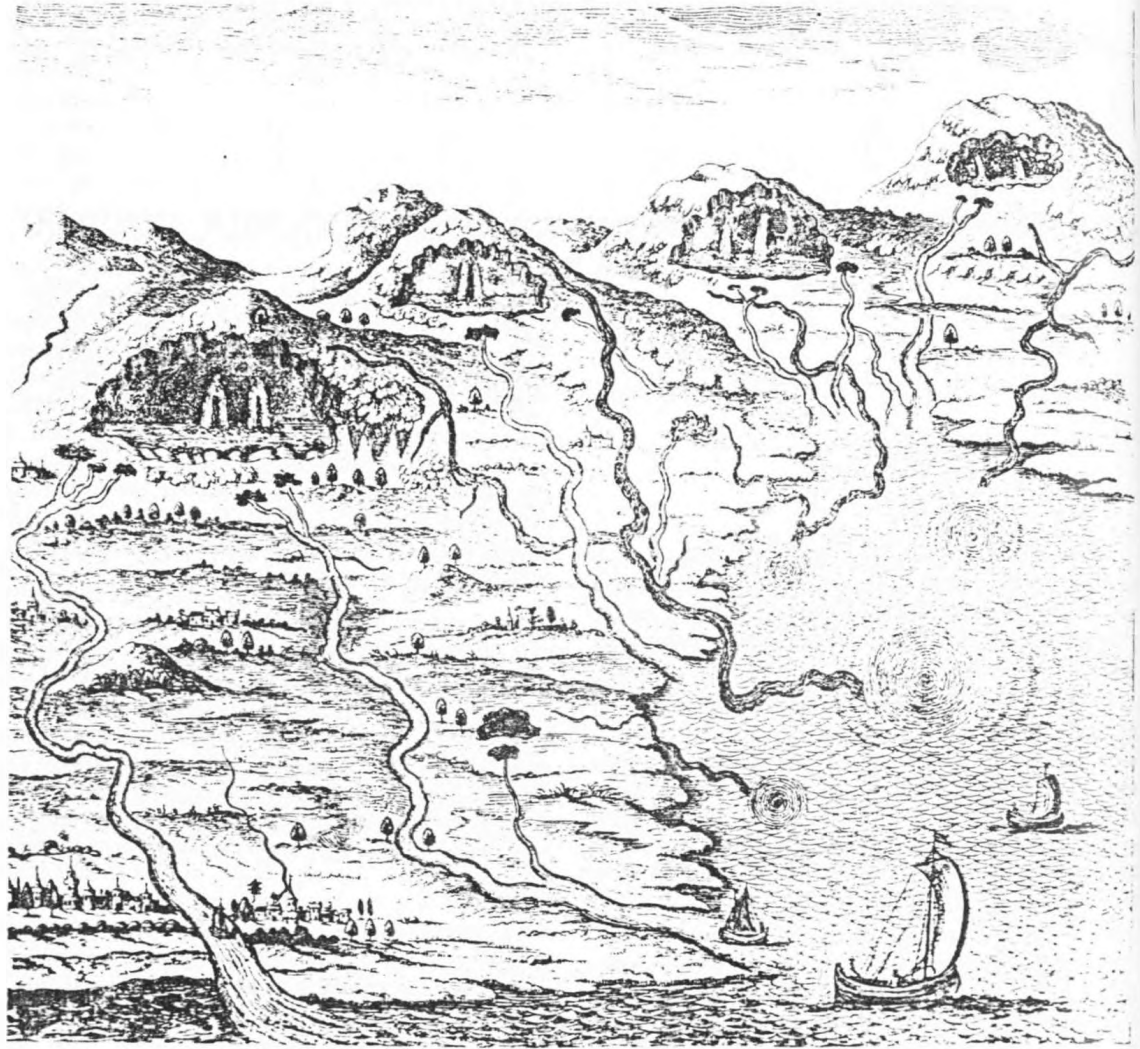


Fig. 1. "Hydrophylatia" inside the mountains, where the rivers take their sources and the connection with the sea (KIRCHER 1678, 254)

surface and floods Cerknica polje. On the other hand his theory about "hydrophylatia" in the interior of Javorniki Mts (Fig. 2) is unnecessary, and even wrong. It states for the siphon through which "hydrophylatia" should flow into the lake and still more for the underground channel through which the "hydrophylatia" should receive the water from the sea. Kircher's work is not only an explanation of Cerknica lake periodicity but an attempt of water budget in the karst world. As geomorphological curiosity let us mention that Kircher does not call Cerknica lake "lake", as most of later writes, but "polje" – "De mirabili Campo in Carniola" (p. 258).

Good ten years after the publication of the third edition of Kircher's work VALVASOR's Die Ehre des

Hertzogthums Crain (1689) was published and two years earlier the detailed description of the Cerknica lake. It could be seen from the Valvasor's bibliography that he knew Kircher's work and even used it by preparing his own. The question remains in which extent he adopted the Kircher's ideas about the underground waters.

At the beginning Valvasor was the most interested in "rarities of the Carniola land" and after him karst waters belong to – "the waters that flow into the earth" as he intitled several chapters in Die Ehre (f.e. XLIX: The water in Central Carniola, flowing into the earth) (RUPEL 1951, 5).

Valvasor saw, knew or supposed that in the bottom of several potholes and caves there is the water. And

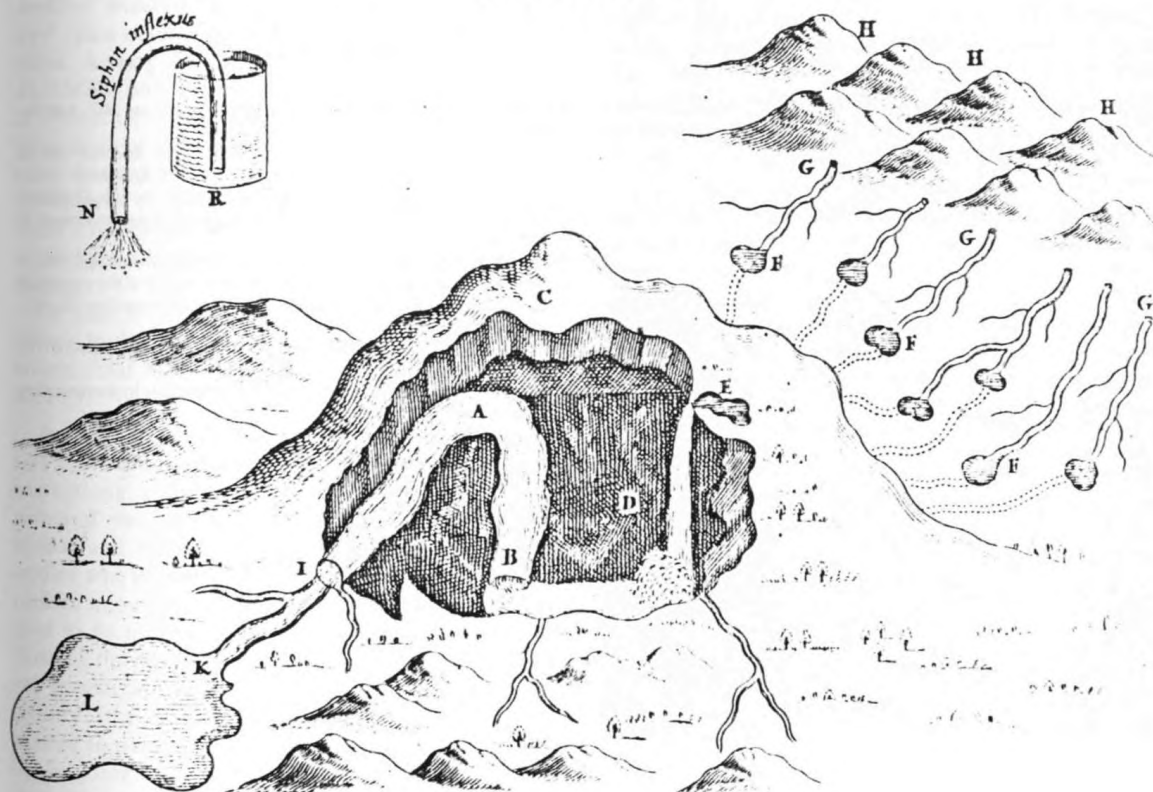
this water seemed to him very important: "Above Kranj, along the path towards Jezerško, there is extremely deep hole in the rocks. If you throw a stone in it, a mist shoot out of it" – accordingly one of weather-making caves. The author finds the explanation for this phenomenon in the underground water: "...I think, that below, in the bottom of that cave, must be a big and deep puddle..." (RUPEL 1951, 29), causing a mist if its surface is disturbed. In connection with weather-making caves, which used to be blessed and later the participants of the procession threw in them a lot of stones and wood, he wonders where disappears all this material and says: "My opinion is that deep beyond there is a river flowing and washing off the accumulated firewood." (RUPEL 1951, 93). One of main reasons why he visited the cave "Sainte Baume" in Provence was just water. He was interested if the water pool in this cave really does not dry up and if one can really take the water out of it without lowering the water table (VALVASOR 1689, 240–241,

491–504). Obviously he knew and visited numerous sinking streams and water caves and he was not unfamiliar with concentrated superficial waters outflow into the underground.

He knew some virtual underground "lakes" in Podpeška jama and in Kompoljska jama. As in these caves he could not cross the water and as he could not illuminate the end of these lakes and also did not hit the opposite wall by the thrown stone, he thought, that the lakes enormous reaching "far in the mountain". As he did not succeed to measure these lakes directly he started indirectly: he levelled the water table in Podpeška jama and the water table in Kompoljska jama and found out that they lie in the same level – it means that this is an uniform lake, although the distance between them is "an hour walk" (VALVASOR 1689, 220, 231).

Considering the narration of local people about the mysterious underground lakes in deep forests of Dinaric plateaus (f. e. Mokrice wood and in Velika

Fig. 2. "Hydrophylatium" inside Javorniki Mountains – explanation for the Cerknica lake intermittence (KIRCHER 1678, 306)



gora of Ribnica) (RUPEL 1951, 42) and Kircher's theory on "hydrophylatia" it is clear that Valvasor believed in conceived underground lakes in karst.

As Valvasor was not such theoretician as Kircher was he did not explain his ideas widely, with exception of one case when he needed the explanation of Cerknica lake drying up. We do not intend to repeat it in detail as Valvasor makes it clear in the pages 685-696 and there are some recent treatises on the subject. I'd like to pay attention to the conception, to his knowledge of "underground accumulation" respectively. Valvasor was not, at least in the case of Cerknica lake, supporter of Kircher's theory about the uniform underground "hydrophylatia" (namely he does not mention it explicitly) but he used for the explanation his own experiences about the "underground lakes" and about the underground siphons.

For the explanation of filling and emptying of Cerknica lake and for temporally different activities of particular springs and ponors, Valvasor invented a complicated system of five underground lakes which are connected among them and with the superficial lake at the same time by usual channels and siphon-shaped channels. Without regard to his opinion about Kircher's "hydrophylatia", Valvasor could not adopt the conception as he knew too much details could not be adjusted with one "underground lake" only.

Beside the superficial Cerknica lake there should be in the underground of "rocky hill" (Javorniki) another five lakes, two big, two small and one very small. Four lakes should be above the level of superficial Cerknica lake, the biggest one 42 feet higher, and one below the level of Cerknica. The number 42 feet he got by levelling the springs. The lakes should be connected among them by channels and siphons, similar to the one he saw in Podpeška jama.

Valvasor did not name these lakes "lake" just symbolically but he really imagined them as lakes similar to the "hydrophylatia" in KIRCHER's book (1678, 254). That these are virtual lakes, it means water bodies with free surface, Valvasor stressed himself as otherwise black ducks, flying from time to time to the surface from some caves, could not live on them.

The conception of the underground accumulations is very old, in modern time one can trace it in 16th century, but, as it could be inferred by the overlooked works, the idea of underground lakes was not elaborated further until the end of 17th century. In the base these theories are namely correct: water bodies in the underground fed by superficial waters do flow under certain conditions and in certain time to the surface. The details of the ideas are wrong, sometimes phantastic (siphon uplift of sea water, life environment for black ducks) which is caused by bad knowledge on karst underground. Also, none of the authors mentioned, do not connect the phenomena he described by special type of the surface - karst namely.

The theories about the ground water in fissured rocks partly developed on the base of mining works in England (SHAW 1979, 127-137) and partly on base of karst water phenomena studies. With pleasure we can conclude that the idea of the underground karst accumulations developed by our scholars or by the scholars studying our karst and contributed a big deal to understanding of karst phenomena.

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REFERENCES

- KIRCHER, A., 1678: *Mundus subterraneus*. III. ed., pp. 507, *Amstelodami*
- KRANJC, M., 1989: Valvasorjevi krasoslovni viri *Simpozij 300 let Valvasorjeve Slave vojvodine Karnijske*, 220-225, Ljubljana
- RUPEL, M., 1951: Valvasorjevo berilo. VII-XXIV, 3-365, Ljubljana
- SHAW, T.R., 1979: The scientific investigation of limestone caves, to 1900. II-XVI, 1-393, *Crymch*
- VALVASOR, J. W., 1687: An Extract of letter written to the Royal Society out of Carniola, being a full and accurate description of the wonderfull Lake of Zirknitz in that Country. *Philosoph. Transactions R. Soc.*, 191, 411-426, London
- VALVASOR, J.W., 1689: Die Ehre des Hertzogthums Crain. I. Th., 1-696, *Laybach*
- WERNHER, G., 1551: De admirandis Hungariae aquis hypomnemation. 20 ff, *Vienna - Aquila*