CHARACTERISTICS OF WATERS OF UNDERGROUND LAKES

By G. A. MAXIMOVICH and G. G. KOBIAK

(Communicated by A. E. Fersman, Member of the Academy, 30. I. 1941)

Among the diverse Jakes of Ihe Globe, tlie underground variety is the least known. Evenin detailed classifications of lakes they usually are not isolated ([7]). For the most part simply karst lakes are mentioned ([3], [4], [6], [8], [9]). Still less has been studied the composition of the waters of underground lakes. W. I. Vernadsky ([2]) distinguishes among fresh corrosion waters of underground reservoirs (type 176, cavern waters) and underground salt lakes (type 282), referred for some reason to surface wafers. This peculiar variety of lakes, the underground lakes, are however of considerable interest.

Of those known all over the world, the lakes of the Mammoth Gave in America, the lake of the 15.5 m deep Elricli Cave near Nordhausen should be mentioned. In the USSR there is also a number of underground lakes. In particular such lakes are known in the caverns of the Kizel ([1]) and Kungur districts of the Molotov region.

The present paper contains the results of a study of the composition of the water of the Kungur ice-cave lake. The chemical analyses have been made by G. G. Kobiak. Underground lakes in caverns are formed in hollows, in which the water is arrested by the accumulation of argillaceous material. Such conditions exist in the Kungur ice-cave, where 36 underground lakes have been found. From these the most accessible are the lakes in the grottoes Titanic and Coliseum, which are located in the part of the cave usually visited by excursions.

The area of the lake in the grotto Titanic is 750 m^2. Its depth is about 4 m on the average. Tlie maximum depth recorded is about 6 m. The argillaceous layer in this grotto is about 1 m thick. According to the analyses of samples made at an interval of six years (see table, columns 1 and 2), the lake in the grotto Titanic should be referred to mineral (salt) lakes ([2]). The total of mineral constituents is above 2 g/1. Ca and SO_4 predominate in the dissociated part. which is quite natural for a cave in gypsum-anhydrite beds lying among limestones. Mg and HCO_3 are of lesser importance. A considerable SiO_2 (H_2SiO_3) content is noticeable.

A less complete analysis made by the physical-chemical laboratory of the Uralian Institute of Physiotherapy and Medical Hydrology (table, column 3) made in 1935 shows on the whole a similar picture.

The lake in the grotto Coliseum is of a considerably smaller size. The thickness of the clayey layer here is about 0.75 m. The water is also mineralized, the total of mineral constituents being even somewhat higher, 2.3349–2.3360 g/1. The composition of the water varies very little, though the samples were taken at an interval of six years. It is to be considered that the samples have been taken in winter (table, columns 4 and 5). The prevalent constituents here are also Ca and $S0_4$. The lake in the grotto Coliseum is distinguished by a more than double Mg content and a somewhat smaller content of HCO_3, Na and Cl. The latter depends probably on that this lake is being visited much less frequently than that in the grotto Titanic.

Analyses of Underground Lake Waters

	Water of the lake in grotto Titanic			Water from the lake in grotto Coliseum		Water dripping from the cavern in Ethereal grotto
	1	2	3	4	5	6
Specific gravity of water at 20° C	–	1.00206	–	–	1.00237	–
Gram per liter:						
Dry residue of water at 110° C	2.1812	2.1902	–	2.3349	2.3360	1.1734
Dry residue on ignition . .	2.0425	2.0373	–	2.1469	2.1571	1.0766
Loss on ignition	0.1387	0.1529	–	0.1880	0.1789	0.0968
Na	0.0019	0.0021	0.0391	0.0013	0.0015	0.0006
K	0.0001	0.0002	–	traces	0.0001	traces
Ca	0.5672	0.5669	0.4867	0.5456	0.5459	0.2654
Mg	0.0246	0.0244	0.0423	0,0579	0.0580	0.0346
Cl	0.0030	0.0035	0.0035	0.0017	0.0026	traces
SO_4	1.3630	1.3602	1.2970	1.4730	1.4717	0.7220
HCO_3	0.1200	0.1217	–	0.0801	0.0836	0.0546
SiO_2	0.0098	0.0100	–	0.0112	0.0110	0.0078
Al_2O_3	}0.0023	0.0012	–	}0.0021	0.0006	}0.0017
Fe_2O_3		0.0003	–		traces	
Hardness in German units:						
total	85.05	84.96	–	89.70	89.77	45.14
removable	5.52	5.68	–	3.68	3.84	2.51
constant	79.53	79.28	–	86.02	85.93	42.63
Time of sampling	Dec. 1934	April 6, 1940	Oct. 15, * 1935	Dec. 1934	March 29, 1940	Dec. 1934
Analyst	Kobiak	Kobiak	Ovchinnikova	Kobiak	Kobiak	Kobiak

* Date of analysis.

In order to find out the cause of the mineralization of the lake, samples were taken of the water dripping in the Ethereal grotto from an organ pipe (table, column 6). This water is about half as much mineralized. It is to be considered that the water dripping in the Ethereal grotto reaches the cave through large caverns. These caverns are at the surface, while near the grotto there is an organ pipe of a considerable diameter (2 m). Owing to a rather rapid travel from the surface, this water is less mineralized. With a lower rate of travelling along the small hollows and fissures, the degree of mineralization would probably increase.

The fact that the lacustrine water is twice as mineralized as that penetrating along large caverns, may be accounted for by several causes. First, water showing a higher degree of mineralization penetrates into the lakes through small fissures and hollows. Secondly, shores composed of clays and anhydrite contribute to additional mineralization of the lake water at Ihe expense of dissolving of rocks. Some part belongs also lo the evaporation of water from the lake.

The above data show, though on a limited material, that the waters of underground lakes of caverns in gypsum-anhydrite rocks are to he referred lo mineral wafers [salt waters, according to W. I. Vernadsky ([2])]. W. I. Vernadsky refers the corrosional waters of underground basins lo fresh wafers. If is possible that in limestone caverns there are fresh-wafer lakes indeed. This is to be verified.

To the underground salt lakes exemplified by Bakharden in Kopet-dag, should be added waters of underground corrosion lakes in gypsum-anhydrite rocks. The waters of underground lakes in rock-salt ([5]) may probably belong to brines.

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