HYDROCHEMICAL FACIES OF LAKE (AND SEA) WATERS

By G. A. MAXIMOVICH

(*Communicated by A. A. Grigoriev, Member of the Academy, 28. VIII. 1944)*

Lakes are an important variety of the hydrosphere. Their area makes up about 1.8 per cent of the dry land, or 2 682 000 km^2, and the volume of water in them is 250 000 km^3. This constitutes 0.75 per cent of the area of the ocean and only about 0.02 per cent of its volume.

The hydrochemistry of lakes is of great interest. The amount of mineral substances dissolved in the lakes varies from $6 \cdot 10^{-5}$ to 37.15 per cent, that is the concentration of the lake waters varies $6.19 \cdot 10^6$ times ([2],[8],[7]).

The water filling the lake bath is not uniform in composition. Aside from silt waters, which should be classed among underground waters, the lakes always contain no less than two varieties – bottom and surface, or basic waters. Their gas and mineral composition is different.

The fact that the composition of the prevailing substances dissolved in lake (or sea) water varies according to area and depth, made the author suggest the conception of the hydrochemical facies of lakes (and seas).

A hydrochemical facies of a lake (and sea) is such a portion of the basin, whose waters are characterized by definite hydrochemical conditions due to the prevalence of definite substances dissolved in them (ions, colloids). The concentration and mineral composition of waters within each facies may vary, but the predominance of a given substance characterizing it is maintained.

Like in river waters ([4]), the hydrochemical facies of lake (and sea) waters is determined from three components predominant by weight; they receive their names in the order of their decreasing value.

The hydrochemical facies are united into groups or formations, according to the first predominant dissolved component. From 588 analyses of waters of 209 lakes (and seas) taken from the literature ([2],[8],[5–7]), the author separated out 43 hydrochemical facies, according to the concentration of their waters. They are given in the table.

The lake (and sea) waters may be grouped into five hydrochemical formations: the siliceous, hydrocarbonate, sulphate, sodium and chloride one.

The distribution of the hydrochemical facies of lake waters over the Earth surface is characterized by a latitudinal and altitudinal zoning. The following zones may be distinguished:

1. Sone of the predominance of silica and hydrocarbonate-silica hydrochemical facies of tropical and subtropical lakes.

2–3. Zones of the predominance of sulphate, sodium, chloride, hydrocarbonate-sodium and hydrocarbonate-potassium hydrochemical facies of lakes of the northern and the southern hemisphere, confined to the desert-steppe zones.

4–5. Zones of the predominance of hydrocarbonate-calcium hydrochemical facies of lake waters of the temperate climatic zone of the northern and the southern hemisphere.

6. Mountain (vertical) zone of the predominance of silica and hydrocarbonate-silica hydrochemical facies of lake waters. The waters of black and brown lakes of near-polar and tropical regions ([2]), rich in organic matter, belong to the silica-carbonate (SiO_2-C) and hydrocarbonate-carbonate-silica (HCO_3-C-SiO_2) facies.

The hydrochemical facies of lake waters is a typical complex of predominating solutes pointing to definite climatic and, accordingly, geochemical (weathering), soil, hydrogeological and hydrobiological conditions under which lake waters acquired their concentration and composition.

The local lithological, hydrological and hydrogeological conditions, as well as the activity of man, may cause the appearance of azonal hydrochemical facies of lakes. Zonal facies are predominant, however.

The development of readily soluble rocks causes the appearance of azonal hydrochemical facies. The karst lakes of the Kungur region, inclusive of the underground lakes in the Glacial cave ([3]), within the zone of the predominance of hydrocarbonate-calcium facies, are characterized by azonal sulphate-calcium-hydrocarbonate facies. Thus, to this facies in the Kazan region should be referred lake Goluboye (Blue), and in the region of the town of Penza, lake Vad.

Lake Winnipeg, located within the zone of the predominance of hydrocarbonate-calcium waters of the northern hemisphere, is fed by the Red River. This river is fed in the zone of sulphate and chloride facies, and the lake near the point of discharge of the river belongs ([7]): in July, to the azonal SO_4-HCO_3-Ca facies; in June, to the Na-HCO_2-SO_4 facies; in August and October, to the transitionary HCO_3-SO_4-Ca facies, and in September only, to the zonal HCO_3-Ca-SO_4 facies. Further off the mouth of the river, the lake is characterized during the year by the zonal HCO_3-Ca-SO_4, or the transitionary HCO_3-SO_4-Ca facies. Azonal phenomena are also observed ([1]) in such cases where a considerable role in the supply of the lakes is played by mineral springs.

The hydrochemical facies change with time and space. With a change in the climatic conditions the boundaries of the zones of hydrochemical facies are shifted. The hydrochemical facies of lake waters at the point of discharge of rivers into the lakes may vary in the course of the year, according to the condition of the river waters supplied. The activity of man may also bring about changes in the hydrochemical facies of a lake by controlling water supply from rivers. Such phenomena have been recorded for Lake Utah ([6]).

The hydrochemical facies of lake waters change both according to the area of lakes (and seas), and along the vertical. Thus, the lakes may be monofacial and polyfacial. The former type is more common to lakes than to rivers, and chiefly to small lakes. The polyfacial type is common to more concentrated lakes, into which discharge rivers fed from another hydrochemical zone.

Hydrochemical Facies of Lakes (and Seas)

Groups of facies (formations)	Facies*	Mineralization in 0.0001%	Number: Of lakes	Number: Of analyses	Lakes (and seas)
Siliceous	Si-H-Na	80–118	2	2	Yellowstone and Crater Lake (Oregon), USA.
Hydrocarbonate	H-Si-Ca	73	1	1	Lake Tahoe (Cal.)
	H-Ca-Si	16–118	6	34	Lake Superior, Lake Huron, Lake Michigan, Minetonka Lake, Rangeley (Main), Chempeks, Alps
	H-Ca-S	14–272	22	51	Baikal, Kuzher, V. Muzhinskoe, S. Muzhinskoe, Babit (Latvia), Erie, Mushid (USA), Winnipeg, Red Lake (Canada), Zurich, Lac Leman, Taney, Amaldigen (Alps), Konigssee, Walchensee, Schliersee, Chiemsee, Küchelsee, Tegernsee (Germany)
	H-Ca-M	106–178	6	7	Lake of Pskov, Angernsee (Latvia), Würmsee (Germany), Lake of Annecy (France). Lago di Garda (Italy), Mille Lacs (USA)
	H-Ca-Ch	137–155	5	5	Surok, Kozhelaier, East Yalchevskoe, Halstedsee (Germany), Okeecho-bee (Florida)
	H-Ca-Na	39–294	9	9	Okunevoe, Surok, Kuzher, Urdur, M. Muzhinskoe, Kozhlaier, Puzhanier, Yalchevskoe (main), Baikal (USSR)
	H-Na-M	315	1	1	Kisykul
	H-Na-Si	379	1	1	Silver Lake (Oregon)
	H-S-Ca	160–512	3	10	Plattensee (Hungary), Winnipeg, Red Lake (Canada)
	H-Ch-S	304.344	1	1	Svinoe (Budenovsk)
	H-Ch-Na	49–3374	7	7	Onega Lake, Mayen, Uruskul, Kainkul, Karagaikul, North Kalinovskoe, B. Chebachie (USSR)
	H-Na-Ca	2966	2	o	Gusinoe, Moses Lake (Washington)
	H-Na-K	51.700	1	1	Filan (Nebraska)
	H-Na-S	484–5704	7	7	M. Tzagan-nor, B. Kuzherskoe, Gudzhirnoye (lakes of Oregon and Washington)
	H-K-Na	27300–71200	3	3	Lakes of Nebraska
	H-K-S	53.600	1	1	Fleid (Nebraska)
	H-Na-Cl	135–103470	5	5	Victoria-Nyanza, Natron Lake (Egypt), Kaldy, Kezlikul (N. Kazakhstan), Good-noon (British Columbia)
Total 17 facies		14–103470	81	146	
Sulphates	S-H-Si	654	1	1	Big Stone Lake (Minnesota)
	S-H-Ca	224–306	2	2	Utah Lake (Utah), Winnipeg (Canada)
	S-Ca-H	122–2335	5	9	Nouar, Rietom (Alps), Vad (near Penza), Goluboye (Tataria), Kungur (in a cave)
	S-Ca-M	2373	1	1	Rietom (Alps)
	S-Ca-Na	4446	1	1	Chichankanab (Yukatan)
	S-Ch-Na	1165–40626	4	8	Tagar (Siberia), Pilenkino (Azov), Algren-sor, Utah (Utah)
	S-Na-H	48360–353700	2	4	Gudzhirnoe, Beloe (Siberia)
	S-Na-Ch	11278–145500	15	16	Pilenkino (Azov), Gudhirganskoe, Turpanye, Obrochnaya lestchad, lakes of Abagan, Wyoming, North Dakota, Canada, Rumania
	S-Na-M	6708	1	1	Wyoming
	S-M-Ch	193500	1	1	Muskoka (Canada)
Total 10 facies		122–353700	33	44	
Sodium	Na-H-S	Per cent 1.85–11.97	1 5	1 5	Winnipeg (Canada), azonal Lakes of Peru, Nebrasca, Washington, Wyoming, California
	Na-H-Cl	0.09–5.12	5	7	Boga-Khan-Nor, Verkhn. Beloe (Siberia), lakes of Oregon and California
	Na-S-H	0.63	1	1	Riszanda (Hungary)
	Na-S-Ch	0.49–0.61	2	2	Selenga, Tulare Lake (California)
	Na-Ch-S	0.25–1.51	2	3	Kirenskoe (Siberia), Walker Lake (Nevada)
	Na-Ch-H	1.05–21.37	5	9	Van, Harney Lake, Albert Lake (Oregon), California lakes
Total 6 facies		0.09–21.37	21	28	
Chloride	Ch-Ca-Na	0.366	1	1	I Charkhal (N. Kazakhstan)
	Ch-H-Na	5.336	1	1	Chebarkul (USSR)
	Ch-Na-H	0.09–21.14	8	10	Maloe Chebachie, May-Balyk (N. Kazakhstan) Lakes of Nevada, India, South Africa
	Ch-S-N a	0.039–28.9	6	8	Aral, Tinetzkoe, B.Manych, Kirghizia, Rybnoe Charkhal (N. Kazakhstan)
	Ch-Na-S	1.11–31.0	39	316	Atlantic Ocean, Indian Ocean, Arctic Ocean White Sea, Baltic Sea, Ireland, Black, Medi terranean, Red, China Seas. Lakes: Kuku-Nor of Iran, the Caspian, Kara-Bugaz, Iletzkoe Tagarskoe, Alatyr, B. Leshchad, Selenga Lomovoe, B. Balpash, Balpash, Basaybar Moldybay-sor,Chuiruk-sor, Taykonur, Bish-tuz B. rielenoe (Utah), Chile, Argentine, Africa India
	Ch-S-M	–	1	1	Kara-Bugaz
	Ch-Na-M	4.6–37.15	13	19	Khanskoe, B. and M. Jarovoe, B. and M. Kalkamak, Kammertauz, Ekibastuz, Altybai-sor Dead Sea, Sivash, Inder, Lakes of Rumania Australia
	Ch-M-Na	19.26–26.5	2	9	Dead Sea, Elton
	Ch-M-Ca	25.99	1	1	Dead Sed, 300 m (Palestine)
Total 9 facies		0.09–37.15	72	366	
Total 43 facies		14.10^{-4}–37.15	209	586	

* Si – siliceous, H – hydrocarbonate, Na – sodium, Ca – calcium, S – sulphate, M – magnesium, Ch – chloride, К – potassium facies.

The waters of seas and oceans belong to the chloride-sodium-sulphate facies. This monofacial character of the World ocean (the slightly mineralized Baltic Sea and the highly concentrated Red Sea included), alternating with transitional facies at the points of river discharge, is due to the fact that the concentration of the waters of the Ocean varies within a rather narrow range (0.7–6.15 per cent). This concentration is characterized by the chloride-sodium-sulphate facies.

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REFERENCES

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