HYDROCHEMICAL FACIES OF THE FLUVIAL WATERS AND THEIR ZONING

By G. A. MAXIMOVICH

(Communicated by A. E. Fersman, Member of the Academy, 4.V111.1942)

Rivers are the main agents of chemical denudation $(1^{14-15}, 1^{19-20})$ which, according to F. W. Clarke, lowers the earth surface by as much as 1 m in 100 000 years, i. e. 0.01 mm a year.

A river is a complicated and very dynamic physical-chemical system, the relationship between its elements being influenced by a variety of factors. Among them are the concentration of substances dissolved; the peculiarities of rocks and soils of the basin drained; the character of fluvial muds and water organisms; the climatic factors controlling the weathering processes; and, not infrequently, the activity of man. The composition and the relationship of dissolved substances change with time undergoing daily $(^2)$, annual $(^{23})$, perennial (Bruckner) and periodical (in the vicinity of industrial establishments) fluctuations.

A particular portion of a river is, however, distinguished by its own specific physical-chemical conditions of formation, concentration and mineral composition of water. Consequently, the water in different parts of a river is of different concentration and chemical composition, both changing within definite limits and persisting through a rather considerable space of time. It is therefore possible to speak of hydrochemical facies of rivers.

The meaning conveyed by the term is that the bed of a river can be divided into separate portions, each characterized by the predominance in its water of some dissolved substance, or set of substances (ions, colloids, etc.). The concentration and mineralogical composition may change within certain limits, but the predominant substances must continue so throughout the portion.

It is generally assumed that the composition of fluvial waters (which are complex solutions consisting of many components) depends on the character of rocks occurring in the river basin ($^{9-12}$, $^{14-16}$). This opinion is encouraged by the practice of evaluating the hydrochemical materials according to Stabler (") and Palmer (¹⁸), whereby such an important factor as concentration is lost sight of. Even Clarke (¹⁵), whose materials have been widely used by the author, overlooked the concentration factor, although he took into consideration the percentage composition of such components as Si0₂, A1₂0₃, Fe₂0₃, which are considered to be colloids according to Palmer and drop out of the calculation when the hydrochemical analyses are expressed domain, but may also complete their number. Besides those mentioned here, there are other possible hydrochemical facies of lower stability (especially sulphate and chloride ones), but we shall not enter into their discussion until more is known about them.

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	1	ryurochen	near i			
Facies		Mineralizati	Nun	iber of	4	
grouns	Facies	on in	rivers	analyses	Rivers	
groups		0.0001%	110015	anaryses		
	Siliceous chloride sodium	17	1	1	The Eger at its source (tributary of the Elbe)	
	Siliceous chloride calcium	17	1	1	The Saale at its source (tributary of the Elbe)	
	Siliceous sulphatic carbonaceous	30	1	1	The Iltz (tributary of the Danube)	
	Siliceous sulphatic carbonaceous	13–47	2	2	The Erlau, source of the Elbe (tributary of the Danube)	
C:1:	0'1' 1 1 1 1	27.07	15	270	The Amazon, Uruguay; the rivers of India, British Guiana and the	
Sinceous	Siliceous hydrocarbonaceous calcium	3/-8/	15	278	Georgia, Oregon, Washington and Carolina states in the USA	
					The Laplata: the rivers of British Guiana and of the Georgia. Carolina.	
	Siliceous (hydro)carbonaceous sodium	16–91	14	254	Virginia states, USA: the source of the Elbe	
	Siliceous hydrocarbonaceous chloride	98	1	1	The Parana river	
	Sinceous nyuroeuroonaceous emoride	13.08	35	538		
Calaium	Calaium aulmhatia hudro aarbana aaau	13-90	1	1	The Oder near Dreelow (during high water)	
Calcium	Ladre and an an and a start of the start of	91	1	1	Dittal Cuinne (and view)	
	Hydrocarbonaceous sinceous lerrous	45	1	1	British Gulana (one river)	
	Hydrocarbonaceous siliceous sodium	57	1	1	Carolina (USA) (one river)	
					The Loire, Garonne, Blue Nile rivers; the tributaries of the Amazon and	
	Hydrocarbonaceous siliceous calcium	37–170	22	456	Danube; the rivers of Sweden and the USA: Oregon, Washington,	
					Alabama, Virginia; Canada	
	Hydrocarbonaceous siliceous sulphatic	46-181	5	75	The rivers of Java, Oregon, Washington and California	
	Hydrocarbonaceous sulphatic siliceous	99-121	2	38	The Pekationgath (Java) and Jokima (Washington)	
					The Seine, Daubs (France); the rivers of Sweden; the Rhine, the Yukon.	
	Hydrocarbonaceous calcium siliceous	125-320	16	274	the Mississippi; the rivers of California, Kansas; Washington, Virginia;	
	y			-	the St. Lawrence River	
	Hydrocarbonaceous sodium siliceous	153-156	2	3	Nevada (1 river) Ana (Oregon)	
	Trydroearbonaecous soundin sinecous	155 150	2	5	Sweden (2 rivers): Alaska (1 river): the Pio Drimero river (Argentina)	
	Hydrocarbonaceous calcium sodium	19–160	5	5	Jreland (1 river), Alaska (1 liver), the Kio Filmero liver (Algentina).	
					The Kome Volce Ture Driveter Denuhe and many of its tributories	
					Vistala Ella Dhina Main Dhana Mana Davida Thanasa Savitanaland	
po "					Vistula, Elbe, Rhine, Main, Rhone, Maas, Dauro, Thames, Switzerland	
car	Hydrocarbonaceous calcium sulphatic	74-422	60	887	(1 river), Nile (the lower course), the Red River, Yukon, Tanaka, Coper	
Ce	5 · · · · · · · · · · · · · · · · · · ·				river, Columbia (1 river); the Lost, Russan, St. Gabriele, St. Anne,	
lyd na					Aiowa, Peder, Cascade, Rock River (Columbia); the Arkansas,	
Ŧ					Mississippi rivers, Illinois, Canada	
	Hydrocarbonaceous calcium chloride	de 31–455 2 2 The Dee (Scotland)	The Dee (Scotland); the Veber (Yuta)			
	Hydrocarbonaceous sodium calcium	27-174	2	4	The White Nile, Klarelf (Sweden)	
	TT	195 207	6	4.1	The Lost river, Red River, Rock River, the City-Creek, the Bair (USA);	
	Hydrocarbonaceous calcium magnium	185-207	0	41	Danube; the Vetluga (USSR)	
		The Mai Saskatchey	The Main, the Saale, Argentina, Canada (Assinoboya and			
					Saskatchewan): Salainese (California): the Mississippi: the tributary of	
	Hydrocarbonaceous sulphate calcium	80–554	20	400	the Colorado: the Kansas: the rivers of the Wisconsin Ajowa	
					Pennsylvania Idaho Nebraska Minnesota N Y states	
	Hydrocarbonaceous sulphate chloride	187	1	1	The N Dving near Archangel	
	Lydrocarbonaccous sulphate enforte	221	1	27	Oregon in the USA (1 river)	
		100, 220	1	37		
	Hydrocarbonaceous sodium sulphate	180-339	2	37	The Valk (Nevada), Owens (California)	
	Hydrocarbonaceous chloride calcium	320-450	4	73	The Om near Omsk, the Colorado (Texas), the West River (Indiana), the	
	· · · · · · · · · · · · · · · · · · ·				Ogden (Yuta)	
		19–554	152	2335		
Sulphatic	Sulphate hydrocarbonaceous siliceous	48	1	38	The Andrioscoggin (USA)	
Sulphate	Sulphate hydrocarbonaceous sodium	112-2842	2	2	The Rio-Frio Chile); the Uil (the arm of the Karasay, Kazakhstan)	
		100 714	10	220	The Chusovaya, the Missouri with its tributaries; the rivers of Nebraska,	
	Sulphate hydrocarbonaceous calcium	180-/14	10	220	New Mexico, California; the Elbe, Vezer; the Nelson (Canada)	
				_	Colorado, Ohio: the Potomac river (the tributary of the Danube): Sweden	
	Sulphate calcium hydrocarbonaceous	81–958	5	76	(1 river)	
	Sulphate calcium sodium	1011_2412	3	38	The Colorado (USA): the Santa Maria (California): the Arkansas	
	Sulphate calcium sodium	651	1	1	The Colorado (OSA), the Santa Maria (Camornia), the Arkansas	
		031	1	1	The Colorado (Algentina) The Kansas, Deese, Die Crande, Colorado, Die Seledille (Argentine)	
	Sulphate chloride sodium	561-14950	8	116	The Kansas, Pecos, Rio-Grande, Colorado, Rio-Saladillo (Argentina),	
					Snellir (Algeria)	
	Sulphate sodium calcium	1136–2134	1	60	The Atrek (Asia); the Arkansas river	
		48-14950	31	951		
	Chloride hydrocarbonaceous sulphate	183	1	36	San Joukhin (California)	
Chlorid	Chloride hydrocarbonaceous sodium	637	1	1	The Bair river (Yuta)	
Chioride	Chloride sodium hydrocarbonaceous	7700	1	1	The Jordan (Palestina)	
	Chloride sulphate sodium	892-9185	3	33	The Brazos (Texas); Rio de Los Papagaios (Argentina): the Jordan (Yuta)	
	A		-		(),	

Hydrochemical Facies of Fluvial Waters

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3 C. R. (Doklady) de l'Acad. des Sci. de l'URSS, 1942 v. XXXVII, No 5-6.

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Faciar		Mineraliza- tion in 0.0001%	Num	ber of	Rivers
groups	Facies		rivers	analyses	
Siliceous	Siliceous chloride sodium » calcium » sulphatic carbonaceous » hydrocarbonaceous calcium	17 17 30 13-47 37-87	1 1 1 2 15	1 1 1 2 278	The Eger at its source (tributary of the Elbe) The Saale at its source (* * * * *) The fitz (tributary of the Danube) The Erlau, source of the Elbe (tributary of the Danube) The Amazon, Uruguay; the rivers of India, British Guiz and the Geogram Organon Washington and Garaling sta
	» (hydro)carbonaceous sodium	16-91	14	254	in the USA The Laplata; the rivers of British Guiana aud of the Georg Carolina, Virginia states, USA; the source of the Elbe
	» hydrocarbonaceous chloride	98	1	1	The Parana river
<u></u>		13—98	35	538	
Calcium	Calcium sulphatic hydrocarbonaceous	91	1	1 1	The Oder near Breslau (during high water)
Hydro- carbo- naceous	Hydrocarbonaceous siliceous ferrous	45 57 37—170	1 1 22	1 1 456	British Guiana (one river) Carolina (USA) (one river) The Loire, Garonne, Blue Nile rivers; the tributaries of Amazon and Danube; the rivers of Sweden and the US Oregon, Washington, Alabama, Virginia; Canada
	 sulphatic siliceous calcium siliceous 	46 - 181 99 - 121 125 - 320	5 2 16	75 38 274	The rivers of Java, Oregon, Washington and California The Pekationgath (Java) and Jokima (Washington) The Seine, Daubs (France); the rivers of Sweden; the Rh the Yukon, the Mississippi; the rivers of California, Kan Washington, Virginia: the St. Lawrence River
	» sodium siliceous » calcium sodium	153-156 19-160	2 5	3 5	Nevada (1 river), Ana (Oregon) Sweden (2 rivers); Alaska (1 river); the Rio Primero r (Argentina) Ireland (1 river)
	» calcium sulphatic	74 - 422	60	887	The Kama, Volga, Tura, Dniester, Danube and many of its butaries, Vistula, Elbe, Rhine, Main, Rhone, Maas, Dau Thames, Switzerland (1 river), Nile (the lower course), Red River, Yukon, Tanaka, Coper river, Columbia (1 riv the Lost, Russan, St. Gabriele, St. Anne, Aiowa, Pec Cascade, Rock River (Columbia); the Arkanšas, Mississi rivers, Illinois, Canada
	Hydrocarbonaceous calcium chloride	31 - 455 27 - 174 185 - 267 80 - 554	2 2 6 20	2 4 41 400	The Dee (Scotland); the Veber (Yuta) The White Nile, Klarelf (Sweden) The Lost piver, Red River, Rock River, the City-Creek, Bair (USA); Danube; the Vetluga (USSR) The Main, the Saale, Arcentina, Canada (Assinoboya and J
	 sulphate chloride. sodium sodium sulphate chloride calcium 	187 221 180-339 320-450	1 1 2 4	1 37 37 73	katchewan); Salainese (California); the Mississippi; the butary of the Colorado; the Kanšas; the rivers of the V consin, Aiowa, Pennsylvania, Idaho, Nebraska, Minnes N. Y. states The N. Dvina near Archangel Oregon in the USA (1 river) The Valk (Nevada), Owens (California) The Om near Omsk, the Colorado (Texas), the West R
	1		152	2335	(Indiana), the Ogden (Yuta)
Sulpha- tic	Sulphate hydrocarbonaceous siliceous	48 112-2842	1 2	38 2	The Andrioscoggin (USA) The Rio-Frio Chile); the Uil (the arm of the Karasay, Kaza
	» » calcium	180-714	10	220	stan) The Chusovaya, the Missouri with its tributaries; the ri of Nebraska, New Mexico, California; the Elbe, Vezer;
	» calcium hydrocarbonaceous.	81—958	5	76	Nelson (Canada) Colorado, Ohio; the Potomac river (the tributary of the Da
	» calcium sodium	1011 - 2412 651 561 - 44050	3 1	38 1 116	The Colorado (USA); the Santa Maria (California); the Arka The Colorado (Argentina) The Kansas Bacos Bio Granda Colorado Bio Salad
	» sodium calcium	501 - 14950 1136 - 2134	8 1	60	(Argentina), Shellif (Algeria) The Atrek (Asia); the Arkansas river
		48-14950	31	951	
Chloride	Chloride hydrocarbonaceous sulphate	183 637 7700	1 1 1	36 1 1	San Joukhin (California) The Bair river (Yuta) The Jordan (Palestina)
	» sulphate sodium	892—9185	3	- 33	The Brazos (Texas); Rio de Los Papagaios (Argentina); Jordan (Yuta)

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