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STUDY OF THE EFFECT OF GLAUCONITE AND VERMICULITE ON THE SALINITY OF THE SOIL OF KARAKALPAKSTAN

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Abstract

The studies were carried out on saline soils that were taken soil samples on the territory of Mamiy, Shumanai district of the Republic of Karakalpakstan to assess the state of soils and salinization and content of water-soluble salts of this site. All soil samples taken are saline, salinization-sulfate-chloride, chloride-sulfate, sulfate. The degree of salinization varies from medium to very strong in all soil profiles. There are also summarized data on the studied components, the most characteristic soil conditions of the surveyed area.
Keywords: *Karakalpakstan, Shumanai, glauconite, vermiculite, soil salinization, dry residue, agronomists, agriculture, water-soluble salts, adsorption, desorption*

Introduction

Today, increasing soil salinity is one of the pressing problems around the world. This is one of the most common processes that leads to land degradation worsening and determining their fertility. In this aspect, the process of draining and drying the bottom of the Aral Sea led to pollution, environmental pollution, soil salinization, salinity, which depends on the areas of gradual salt formation (Turemuratova A.Sh., Reymov K. D., Allaniyazov D. O., 2022).

Research objects and methods

The object of research in this work is the soils of the Shumanai region: the Mamiy section located 70 km from the center of Nukus Karakalpakstan.

Research material and methodology

The water extract of the selected soils was prepared according to the generally accepted method – soil: water in a ratio of 1:5 (Arinushkina E. V., 1970). The content of chlorine ions was determined by sea argentometric methods; calcium and magnesium trilonometric; sulfate by titration; aqueous extract with sulfuric acid solution in the presence of methyl orange indicator; sodium and potassium ions by difference of sum of anions and cations. The results of the analysis of aqueous extracts were expressed in milligram equivalents per 100 g, air-dry soil, the sum of water-soluble salts in percent.

The results of the aqueous draw analysis were monitored for solids.

The degree of salinization of soils was evaluated on a scale (Arinushkina E. V., 1970; Genkel P. A., 1975; Genkel P. A., 1975; Kovda V. A., 1984). The data obtained are presented in table 1.

Figure 1. *Coordinates of samples obtained in the territories of Mamiy, Shumanai district, Karakalpakstan*

1, (42,6009667, 58,9927549) / Kontr 11/98

2, (42,5963145, 58,9856809) / Kontr 11/76

3, (42,5938604, 58,9859182) / Kontr 17/17

4, (42,5940663, 58,9874199) / Kontr 11/73

Research results

Table 1 shows the content of Cl, SO_4^{2-} – and Na^+ ions in the studied samples in the ranges of 0,75–30,00, 9,43–43.55 and 1,48–42,13 mg-eq per 100 g of dry soil, respectively, so that soils from salinization with sulfates and sodium chlorides.

The dry residue in the samples ranges from 0,750 to 4.800 ml, eq. Based on the value of the dry residue of this sample by the degree of salinity, it belongs to the class; weak, weak and highly saline, respectively.

To study the percentage of adsorption of ions with agronomic ore, first prepared aqueous extracts from the 4th sample at ratios of 1:10 (soil: H_2O). Next, a certain amount of agro or was added to the obtained extract, and after 2 days, the ionic composition of the extract was determined, and the adsorption and desorption rates of Cl, SO_4^{2-}, Na^+ ions from the aqueous extract were calculated.

As follows from the analysis of the result of Table 1, the strongest saline soil sample is the 4th sample containing Cl, SO_4^{2-} and Na^+ ions. It is 30,00;43,55 and 42,13 mg, eq per 100 g of dry sample.

Therefore, the 4th sample was used in further studies.

The adsorption capacities of glauconite and heat-treated vermiculite of ions: Cl,

Table 1. *Ion composition of soil samples*

No.	Sample №	Color and transparency of the hood	pH	solid residue		NO$_2^-$	Numerator: mg-eq per 100 g, dry, soil; denominator: % to abs, dry soil											Salinity type
							anions						cations					
				experimental	combed		CO$_3^{2-}$	HCO$_3^-$	Cl$^-$	SO$_4^{2-}$	NO$_3^-$	Sum of mg-eq anions	Ca^{2+}	Mg^{2+}	NH$_4^+$	Na$^+$	Sum of mg-eq cations	
1.	11/98	Transparent				0.01	No	0.80	0.75	9.43	0.02	11.01	7.20	2.00	0.33	1.48	11.01	–C–
		without color	7.10	0.750	0.713	0.001	–	0.049	0.026	0.453	0.001		0.144	0.024	0.006	0.034		weakly
2.	11/76	Transparent				0.02	No	0.60	7.75	18.46	0.15	26.98	9.20	6.40	0.33	11.05	26.98	–C–
		without color	6.90	1.780	1.712	0.001	–	0.073	0.275	0.886	0.009		0.184	0.078	0.006	0.254		average
3.	17/17	Transparent				0.03	No	0.80	3.25	10.12	0.06	14.26	4.80	3.40	0.17	5.89	14.26	–C–
		without color	7.10	0.940	0.905	0.001	–	0.049	0.115	0.485	0.004		0.096	0.041	0.003	0.135		weakly
4.	11/73	Transparent				0.06	No	1.00	30.00	43.55	0.65	75.26	7.80	25.00	0.33	42.13	75.26	–C–
		without color	6.80	4.800	4.662	0.003	–	0.061	1.064	2.090	0.040		0.156	0.304	0.006	0.969		strongly

* *Depth of ignition 0–20 cm*

Table 2. *The influence of temperature on the adsorption capacity of vermiculite and glauconite*

No.	Sample №	Color and transparency of the hood	pH	solid residue		NO$_2^-$	Numerator: mg-eq per 100 g, dry, soil; denominator: % to abs, dry soil										
							anions						cations				
				experimental	combed		CO$_3^{2-}$	HCO$_3^-$	Cl$^-$	SO$_4^{2-}$	NO$_3^-$	Sum of mg-eq anions	Ca^{2+}	Mg^{2+}	NH$_4^+$	Na$^+$	Sum of mg-eq cations
1.	Vermiculite 800° C 11/73	Transparent without color	9.20	4.020	3.837	0.02	0.40	0.30	23.75	35.49	0.64	60.60	20.20	6.60	0.35	33.45	60.60
						0.001	0.012	0.018	0.842	1.704	0.040		0.405	0.080	0.006	0.769	
2.	Vermiculite 600° C 11/73	Transparent without color	6.70	4.700	4.552	0.02	No	1.20	27.50	44.75	0.64	74.11	12.00	23.50	0.25	38.36	74.11
						0.001	—	0.073	0.975	2.148	0.004		0.240	0.286	0.004	0.822	
3.	Vermiculite 400° C 11/73	Transparent without color	7.10	4.600	4.570	0.02	No	1.20	26.25	45.00	0.64	73.11	13.00	22.00	0.25	37.86	73.11
						0.001	—	0.073	0.931	2.160	0.040		0.260	0.267	0.004	0.871	
4.	Vermiculite 11/73	Transparent without color	7.10	4.860	4.737	0.003	No	0.90	27.50	46.38	0.64	75.45	13.80	20.60	0.12	40.93	75.45
						0.001	—	0.055	0.975	2.226	0.040		0.276	0.250	0.002	0.941	
5.	Glauconite 11/73	Transparent without color	6.60	4.560	4.484	0.33	No	1.10	26.25	43.46	0.64	71.78	15.00	21.00	0.12	35.66	71.78
						0.015	—	0.067	0.931	2.086	0.040		0.301	0.255	0.002	0.820	

* *Soil ratio: Agroores 1:1*

SO_4^{2-} and Na^+ of the water extract of the 4th soil sample were studied.

The effects of heat-treated vermiculite temperature, soil: Agro-ore ratio and fraction size were studied.

Calcination temperature The ratio of soil: size fractions of Agro-ore varied from 400 to 800 °C, 5:1–1:3 and 1–7 mm, respectively.

Sieve composition of initial glauconitis and vermiculitis

No.	Name Agro ores	Size fraction, mm					
		– 5 + 3	**– 3 + 2**	**–2 + 1**	**–1 + 0.5**	**– 0.5 + 0.25**	**– 0.25**
1.	Vermiculite	40.97	55.52	2.0	0.9	1.6	0.8
2.	Glauconite	–	–	–	–	33.26	66.74

Tables 2 and 3 show the influence of the temperature of the calcination agro-ore and the adsorption capacity of vermiculite and glauconite.

Table 3. *Degree of sorption and desorption (%) of soluble ions of agro-ore*

The sample number corresponds to the numbers table 2.	anions					cations			
	CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}	NO_3^-	Ca^{2+}	Mg^{2+}	NH_4^+	Na^+
1.	No	–70.00	–20.83	–18.36	–1.53	+158.9	–73.60	+6.06	–20.60
2.	No	+20.00	–8.33	+2.75	–1.53	+53.80	–6.00	–24.24	–8.94
3.	No	+20.00	–12.50	+3.32	–1.53	+66.66	–12.00	–24.24	–10.13
4.	No	–10.00	–8.33	+6.42	–1.53	+76.92	–17.6	–63.63	–2.84
5.	No	+10.00	–12.5	–0.20	–1.50	+92.30	–16.00	–63.63	–15.35

4 (11/73) samples were selected as saline soils; Table 3 shows that the adsorption capacity of glauconite relative Cl and Na^+ ions is greater than the capacity of the original vermiculite. When using glauconite 12,5; 11,15; 3,5% Cl and Na^+ are adsorbed and the ions are finally applied.

Vermiculite and adsorption are 8,33 and 2,84% hard 1,5 and 5,40 tons' times lower, however, with increasing calcination temperature, the adsorption capacity of vermiculite increases from 8,33; 2,84 to 20,83 and 20,60, respectively, relative Cl^- and Na^+ ions.

It is necessary to purify the adsorption capacity of the used Agro-ore relative to NH_4^+ is the same and is equal to 63,63%; with increasing temperature, the heat treatment of the wall of adsorption of NH_4^+ ions decreases, and at 800⁰C it practically stops; the adsorption capacity of NO_3^- ions is not affected by the type and temperature of the Agro-ore calcination and is 1,53%.

As for the SO_4^{2-}, ion, glauconite slightly sorbs, but the original vermiculite is not sorbed, and with increasing calcination temperature, the pore size increases and at 800 °C it becomes adsorbed as Cl^- and Na^+ ions also to the SO_4^{2} and Mg^{2+} ions.

Tables 4 and 5 show the effect of the soil: Agro-ore ratio on the adsorption capacity of Cl^- and Na^+ ions. Based on the results of tables 2 and 3, heat treatment of vermiculite at 800 °C for 30 minutes was used as adsorption.

As the experimental results show in table 5, the influence of the soil: Agro-ore ratio on the adsorption capacity of ions is complex. Therefore, based on the results, we can conclude that the 2 nd experiment is optimal, (soil: Agro-ore ratio = 1,67:1) the degree of adsorption of Cl^- and Na^+ ions assigned under these conditions reaches more than 12 and 14%, respectively.

Table 4. *Change depending on the ratio of soil and agro-ore and the ionic composition of the extract*

No.	ratio Soil: Agro-ore,	Color and transparency of the hood	*pH*	solid residue: experimental	solid residue: combed	NO_2^-	CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}	NO_3^-	Sum of mg-eq anions	Ca^{2+}	Mg^{2+}	NH_4^+	Na^+	Sum of mg-eq cations
							Numerator: mg-eq per 100 g, dry, soil; denominator: % to abs, dry soil (anions)						(cations)				
1.	5:1	Transparent				0.05	No	1.20	30.00	47.41	0.64	79.30	11.20	27.80	0.33	39.97	79.30
		without color	6.00	5.100	4.902	0.002	–	0.073	1.064	2.275	0.040		0.224	0.338	0.006	0.919	
2.	1,67:1	Transparent				0.005	No	1.20	26.25	41.66	0.64	69.80	10.60	23.00	0.33	35.87	69.80
		without color	6.20	4.480	4.328	0.002	–	0.073	0.931	1.999	0.040		0.212	0.279	0.006	0.825	
3.	1:1	Transparent				0.05	No	1.00	28.75	47.49	0.64	77.93	11.40	24.10	0.33	42.10	77.93
		without color	6.20	5.000	4.874	0.002	–	0.061	1.019	2.279	0.040		0.228	0.301	0.006	0.968	
4.	1:2	Transparent				0.06	No	1.00	25.00	37.97	0.64	64.67	9.40	19.60	0.50	34.84	64.67
		without color	6.20	4.180	4.022	0.003	–	0.061	0.886	1.823	0.040		0.188	0.238	0.801	0.015	
5.	1:3	Transparent				0.06		1.00	25.00	37.21	0.64	63.91	11.00	16.00	0.55	36.36	63.91
		without color	6.20	4.080	4.005	0.003		0.061	0.886	1.786	0.040			0.194	0.010	0.836	

Sample 4 (11/73) was selected as saline soils

Table 5. *Changes in the ionic composition of the extract depending on the size of Agro-ore fractions*

No.	Color and transparency of the hood	*pH*	solid residue: experimental	solid residue: combed	NO_2^-	CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}	NO_3^-	Sum of mg-eq anions	Ca^{2+}	Mg^{2+}	NH_4^+	Na^+	Sum of mg-eq cations
						Numerator: mg-eq per 100 g, dry, soil; denominator: % to abs, dry soil (anions)						(cations)				
1.	Transparent	6.35	3.860	3.730	0.02	No	0.90	23.50	34.72	0.65	59.79	12.50	16.00	0.17	31.12	59.79
	without color				0.001	–	0.055	0.833	1.666	0.040		0.251	0.195	0.003	0.715	
2.	Transparent	5.90	3.720	3.616	0.001	No	1.00	23.50	33.18	0.64	58.32	9.50	17.50	0.50	30.83	58.33
	without color				0.001	–	0.061	0.833	1.592	0.040		0.190	0.213	0.009	0.709	
3.	Transparent	6.20	3.860	3.721	0.03	No	1.00	22.50	35.32	0.64	59.49	12.00	16.00	0.35	31.14	59.49
	without color				0.001	–	0.061	0.798	1.695	0.040		0.240	0.195	0.006	0.716	
4.	Transparent	6.00	4.100	3.964	0.01	No	1.20	23.50	37.97	0.64	63.32	9.50	18.00	0.23	35.59	63.32
	without color				0.001	–	0.073	0.833	1.823	0.040		0.190	0.219	0.004	0.818	
5.	Transparent	6.60	4.100	3.948	0.02		1.00	23.00	38.23	0.64	62.89	11.50	17.00	0.50	33.89	62.89
	without color				0.001		0.061	0.816	1.835	0.040		0.230	0.207	0.009	0.779	

Table 6. *Change (%) in the degree of absorption and desorption of ions from the extract depending on the ratio of soil and agricultural ore*

The sample number corresponds to the numbers in table 4	anions					cations			
	CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}	NO_3^-	Ca^{2+}	Mg^{2+}	NH_4^+	Na^+
1.	No	+20.00	0	+8.86	–1.53	+43.58	+11.20	0	–5.12
2.	No	+20.00	–12.5	+4.33	–1.53	+35.89	–8.00	0	–14.85
3.	No	0	–4.16	+9.04	–1.53	+46.15	–3.60	0	–0.07
4.	No	0	–16.66	–12.81	–1.53	+20.51	–21.60	+51.51	–17.30
5.	No	+0	–16.66	–14.55	–1.53	+41.02	–36.00	+66.66	–13.69

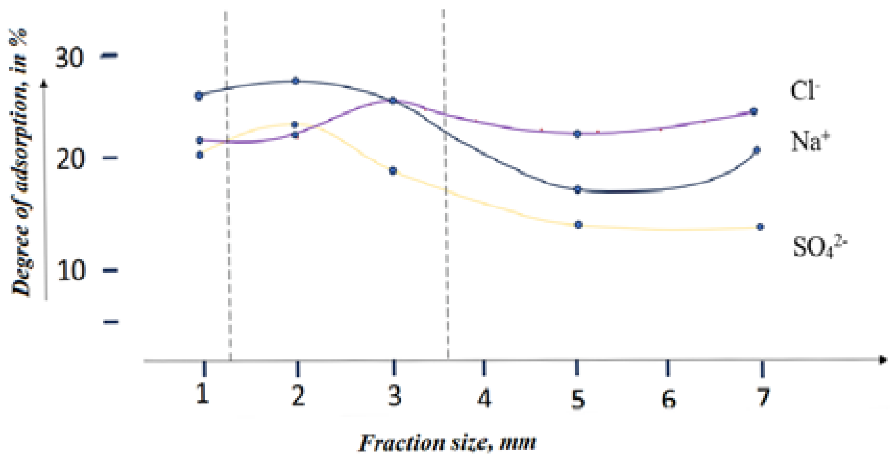
Table 7. *Changes in the degree of absorption and desorption of ions from the extract depending on the size of agro-ore fractions*

The sample number corresponds to the numbers in table 5	anions					cations			
	CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}	NO_3^-	Ca^{2+}	Mg^{2+}	NH_4^+	Na^+
1.	No	–10.00	–21.66	–20.27	0	+60.25	–36.00	– 48.48	–26.13
2.	No	0	–21.66	–23.81	–1.53	+21.79	–30.00	+51.51	–26.82
3.	No	0	–25.00	–18.89	–1.53	+53.84	–36.00	+6.06	–26.08
4.	No	+20.00	–21.66	–12.81	–1.53	+21.79	–28.00	–30.30	–15.52
5.	No	0	–23.33	–12.21	–1.53	+47.43	–32.00	+51.51	–19.55

Tables 5 and 7 show experimental data on studying the effect of fraction size on the adsorption capacity of heat-treated vermiculite for Cl^- and Na^+ ions from the aqueous extract of the 4-th soil (Allaniyazov D. O., 2019; Allaniyazov D. O., Erkaev A. U., 2021; Allaniyazov D. O., Erkayev A. U., Tajibayev T. A., Ochilov S. U., 2023; Allaniyazov D. O., Tazhibaev T. A., Ochilov S. U., 2024; [5–9].

As follows from table 6, at selected intervals of varying the size of fractions 1 = 7 mm, the degree of sorption of Cl^-, SO_4^{2-} and Na^+ ions fluctuates in the ranges of 21,60–24,33; 12,21–23,81 and 15,12–26,82%, respectively.

Figure 2. *Effect of fraction size on the degree of adsorption of ions (Cl, SO_4^{2-}, Na^+) from soil water extract*



In Fig. 2. The nature of changes in the adsorption properties of ions is presented depending on the size of the fractions; the figure shows that in the intervals of 1,25–3,25 mm of fractions the curves, the adsorption capacity of ions intersects and reach a minimum value, therefore the optimal size of vermiculite should be in the intervals of 1,21–3,25 mm.

Conclusions

The studies have shown that all soil samples are saline, characterized by mixed salinity–chloride–sulfate; sulfate, the degree of salinity varies from medium to very strong across all soil profiles.

Based on the results, we can conclude that of all the experiments carried out, the 2nd experiment is the most optimal (soil: Agro-ore ratio = 1,67:1), the degree of adsorption of Cl^- and Na^+ ions assigned under these conditions reaches more than 12 and 14%, respectively.

In addition to combating soil salinity by selecting crops and creating salt-tolerant varieties, in relation to certain types of soil salinization, it is necessary to use techniques that increase the salt tolerance and productivity of cultivated plants on saline soils.

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