Nature and Science

Websites:
http://www.sciencepub.net/nature
http://www.sciencepub.net

Emails:
naturesciencej@gmail.com
editor@sciencepub.net

MARSLAND PRESS
Multidisciplinary Academic Journal Publisher

THE RESULTS OF THE RESEARCH ON THE INFLUENCE OF FILTRATION ON THE COMPOSITION, STRUCTURE AND PROPERTIES OF SALINE CLAY GROUNDS

Prof. B. Rakhmanov. (Samarkand State University).

ABSTRACT. This article describes in the process of leaching changes, the structure and properties of grounds during the dissolution of easily and moderately soluble salts.
[Prof. B. Rakhmanov. **THE RESULTS OF THE RESEARCH ON THE INFLUENCE OF FILTRATIO N ON THE COMPOSITION, STRUCTURE AND PROPERTIES OF SALINE CLAY GROUNDS.***Nat Sci* 2022;20(6):12-22]. ISSN 1545-0740 (print); ISSN 2375-7167 (online). http://www.sciencepub.net/nature. 3. doi:10.7537/marsnsj200622.03.

Key words: leaching, soaking, structure, texture, easily soluble, moderately soluble and sparingly soluble salts.

Changes in the composition of grounds in the process of leaching are associated with changes in their salt complex, primarily with a change in the amount of easily and medium-soluble salts. According to chemical analyses, in the complex of readily soluble salts decreases the content of Na+, Ce^-, $NCO3^-$, but the amount of $Ca2^+$ ions, SO_4^{2}- in some cases even increases, which is associated with the dissolution of gypsum, the transition of salt in ionic form. The amount of gypsum leached for different duration of the experiment and its type (diffusion, filtration) ranged from 8 to 40% of the initial content of $CaSO_4$ 2 H_2O in the ground.

In the process of leaching of salts and their removal from the ground, their micro-aggregate composition changed, mainly due to the reduction of the dusty fraction of 0.01-0.05 mm and an increase in finer fractions. This, in turn, led to an increase in plasticity parameters. The plasticity number increased by 2-3%, which in some cases changed the classification name of the ground. The mineral composition of the studied grounds did not change during leaching.

Leaching of the salt complex of clay grounds affects primarily the structure, which is the main reason for changes in the physical and mechanical properties of grounds.

Fig. 1. Microstructure of loam (vd I-Sh) well 7, Chapt.4.65-4.95 after leaching at P = 0.4 MPa.

Dissolved gypsum crystals increase the porosity of the ground by forming a void around them. In some cases, corroded gypsum crystals practically do not adjust with the surrounding clay matrix (Fig. 1), sometimes undissolved "bridges" remain between them. In addition to changes in the morphology of gypsum crystals, other microstructural changes of clay grounds are also noted. Clay "jackets" on the surface of dust grains are partially eroded, which remained on the grains in the form of individual curved flakes. There is also a deepening and expansion of micropores to a size of 30 microns, the formation of microcracks on some sections of the samples, representing, apparently, filtration passages. The microstructure becomes more homogeneous, less aggregated.

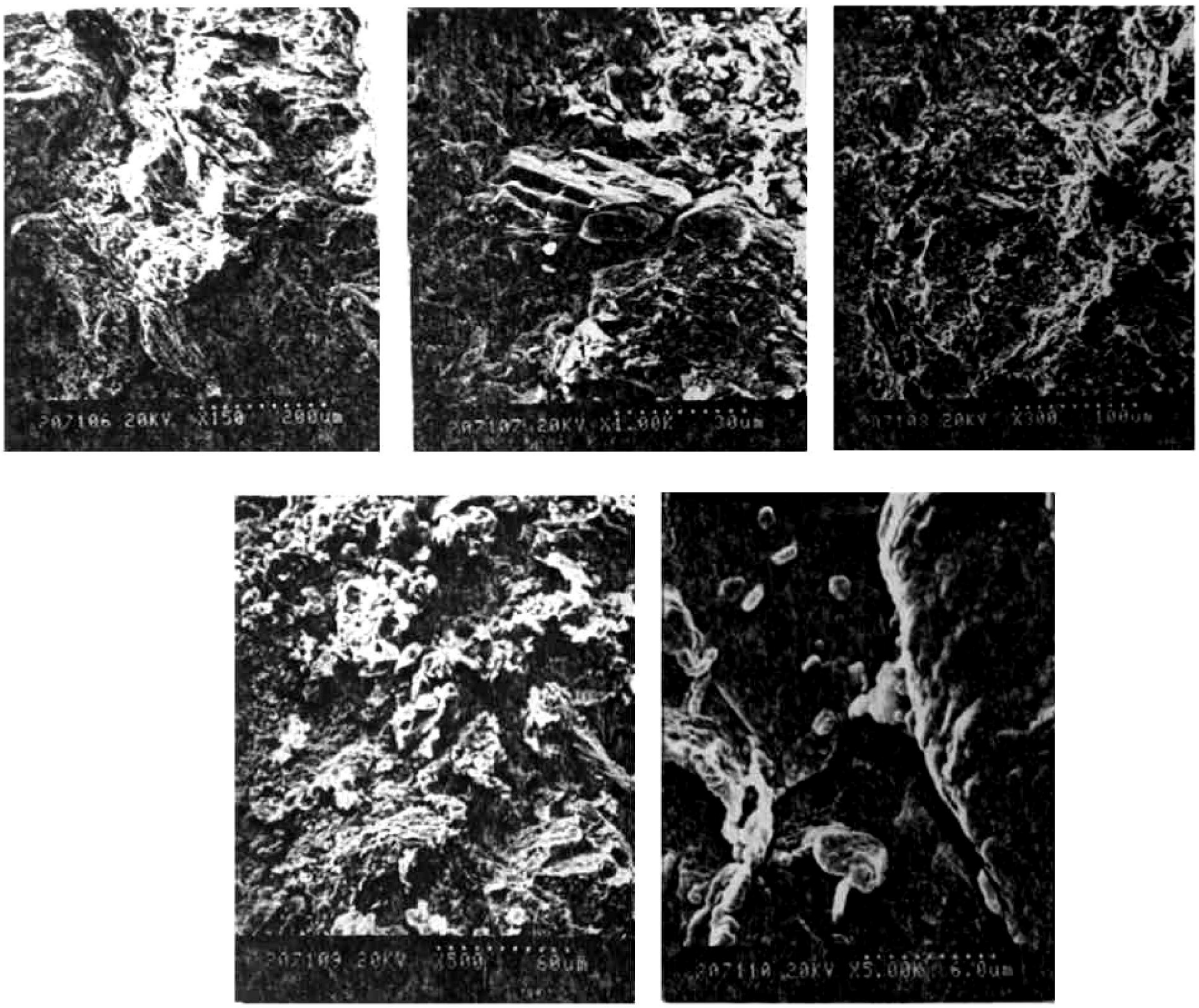

Fig. 2. Microstructure of loam (vd I-Sh) of well 7 Chapt.13,9-14,2 filter leaching.

The microstructure changes particularly significantly during filtration leaching, when the dispersal process is much more intense (Fig. 2). Here is already more evident a change not only in the gypsum grains, but also in the clay matrix itself, it becomes more homogeneous, increases the dispersity, porosity.

On the other hand, there are samples whose microstructure is almost identical to the original. They are characterized only by some increase in voids around the gypsum crystals, while their surface and the condition of the clay matrix remain unchanged. This obviously indicates that under natural conditions the growth of gypsum crystals is not observed, and there is either equilibrium in the system gypsum-pore solution, or there is some shift in the equilibrium towards the pore solution (gypsum dissolution). Such structures are characteristic of Quaternary and Neogene marine sediments.

When considering the microstructural features of clay grounds before and after leaching, differences in the surface state of gypsum crystals appear to be the most significant. If the initial microstructure of gypsum is characterized by a distinct layering and part of a good cut, then as a result of settlement the surface of microcrystals becomes smoother, corroded, "lapped". It is characterized by the formation of micro-sores and caverns of various shapes (elongated, isometric) up to 5 microns in size. In some images, the dissolved gypsum crystals still retain some layering. However, the chipping becomes less clear.

In conclusion, it should be noted that changes in the microstructure of clay grounds can lead to an increase in compressibility of clay gr, reducing the strength, mainly due to a decrease in cohesion. The magnitude and intensity of the effect of leaching on the microstructure and, consequently, on the physical and mechanical properties of grounds will be determined in the greatest degree of dissolution of gypsum.

As noted above changes in the deformation properties of saline grounds during their leaching, the leaching of grounds was carried out in two modes: diffusion and filtration. In essence, these regimes differ only in the rate of salt removal, but the nature of the effect on the properties of grounds remains the same and depends on the degree of leaching.

The analysis of the effect of diffusion leaching on the deformability of grounds was based on the assessment of changes in the compression curve and the parameters describing it during leaching. Fig. 3-7 shows curves ε=f(p) for different ground conditions: natural deposition, after water saturation, after a certain degree of leaching β, taking into account the additional sedimentation at the maximum degree of leaching (β=0.8). All curves, except for the last one, were obtained experimentally $\varepsilon = f(p)$) for β=0,8 was estimated by the formula proposed by Petrukhin V.P.

$$\varepsilon = \varepsilon_p + \varepsilon_s f \qquad (1)$$

$$\varepsilon_s f = kd_0 \frac{\rho_d}{\rho_{гипс}} \beta \qquad (2)$$

Where: ε_p - the relative strain of grounds under load ρ;

d_0 – initial content of gypsum; $\rho_{\_gypsum}$ - its density;

β – leaching degree;

ρ_d – ground skeleton density;

k – coefficient depending on the content of gypsum, d_0 and the magnitude of the external load;

The nature of the compression curves and the data presented in Table 1 suggest that the general strain modulus of grounds (vd $_{I-III}$)) decreases during leaching (Fig. 8)

The change in the strain modulus depends on the initial content of gypsum in the ground and the degree of its leaching (Figs. 8 and 9). At β=0.1-0.2 for $d_0 = 1 - 5$ %the strain modulus decreases by 10-13 % (Fig. 8, curves 1, 2, 4) at β=0.4 for $d_0 > 25$ % (Fig. 8, curve 5) E_0 decreases 5 times. As the limit values of the degree of leaching (β→0,8) are reached, the modulus of general deformation of grounds with $d_0 = 1 - 5$ %reaches 28-54 % (on average 42 %) of its initial value, and at higher initial gypsum content 〖 ($d_0 > 25$ %) E_0 decreases by an order.

It should be noted that the decrease in $E_0$is due to an increase in the pore object of the ground due to salt removal, which has the greatest effect on the compressibility of the ground during leaching 〖($\varepsilon_s f$) with increasing load (10-14).

According to the ratio of curves 3 and 5 in Fig. 6, where the experimental deposit exceeds the calculated one for the same degree of leaching in 1.5 - 3 times for different loads.

As applied to the KNPP site conditions, the obtained data can be presented in the form of isolines of additional suffosion sediments at different degrees of ground leaching.

As an example, Fig. 15-16 shows such schemes corresponding to the limiting conditions of gypsum leaching β=0.8 from the ground from depths (4.0 - 8.0 m), at different loads acting on the base (ρ=0.1 MPa,ρ=0.4 MPa). Such schemes can serve as a basis for predicting additional sediments when conditions favorable for leaching occur. The obtained data give a characteristic of the change in the compressibility of the ground at a certain moment of the experiment for some degree of ground leaching, without characterizing the kinetics of the process in any way. However, to solve prediction problems, it is necessary to estimate the rate of salt removal and the share of the salt complex in the dissolution process. According to some studies, full removal of salts, particularly gypsum during leaching of grounds is impossible, experimentally it is possible to achieve only β=0.8. At the same time, solid salts in grounds can be shielded by organics and other compounds, which also reduces the proportion of their surface interacting with water.

According to laboratory studies of the leaching process of clay grounds, the intensity of diffusive leaching with $\bar{c}$ g/l varies from 0.16 g/l to 0.104 g/l and averages 0.058 g/l. The value $\bar{c}$ depends on the stress state of the ground subjected to leaching (Fig. 17) as can be seen, the graph of the dependence with $\bar{c} = f(\rho)$ has a minimum. Large value of leaching intensity at ρ=0.1 MPa is associated with the greatest change in ground structure during its interaction with water, which for all the studied grounds was accompanied by swelling. Its value $\varepsilon_н$ was everywhere the highest for ρ=0.1 MPa.

With filtration leaching, the intensity of the process increases from 0.49 to 0.94 g/l to an average of 0.69 g/l.

It is known that the solubility of gypsum is 2.41 g/l, and its dissolution rate is $1{,}2 \cdot 10^{-2}$ ^(-2) mmol/cm^2 sec, and by the ratio of these values with $\bar{c}$ we can indirectly judge what percentage of gypsum is involved in dissolution. Thus, the gypsum dissolution rate under diffusion leaching conditions is $2{,}9 \cdot 10^{-4}$ mmol/cm^2 sec, and under filtration $-3{,}5 \cdot 10^{-3}$ mmol/cm^2 sec. Consequently, in the first case 2.4 % of the gypsum surface area is subjected to dissolution and in the second case 29.2 %. Thus, the increase in leaching intensity at filtration compared to diffusive mass transfer is due to both the increase in dissolution rate and the fact that a large volume is involved in dissolution.

The share of gypsum subjected to dissolution depends, in addition, on its specific content (Fig. 18).

Thus, leaching of clay grounds of KNPP foundation significantly affects their deformability. This influence increases with rising content of solid salts in the ground, the degree of leaching and external load on the ground within the limits we investigated.

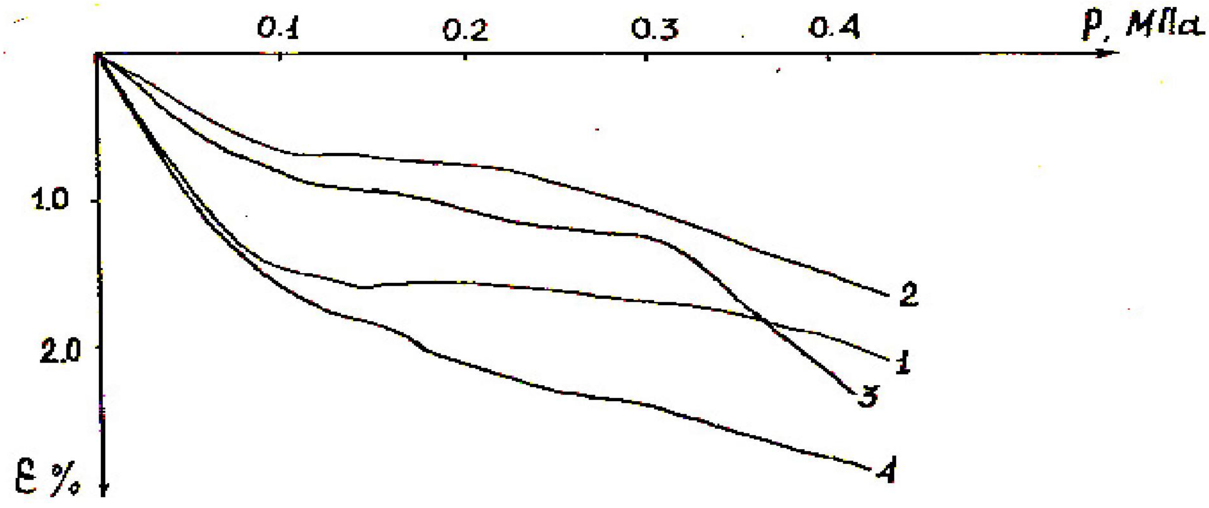

Fig. 3. Compression curves of loam vd I-III in different states:
1-natural composition;
2-after water saturation;
3-after leaching;
4-calculated for β=0.8 (well 7. Chapt. 4.65-4.95)

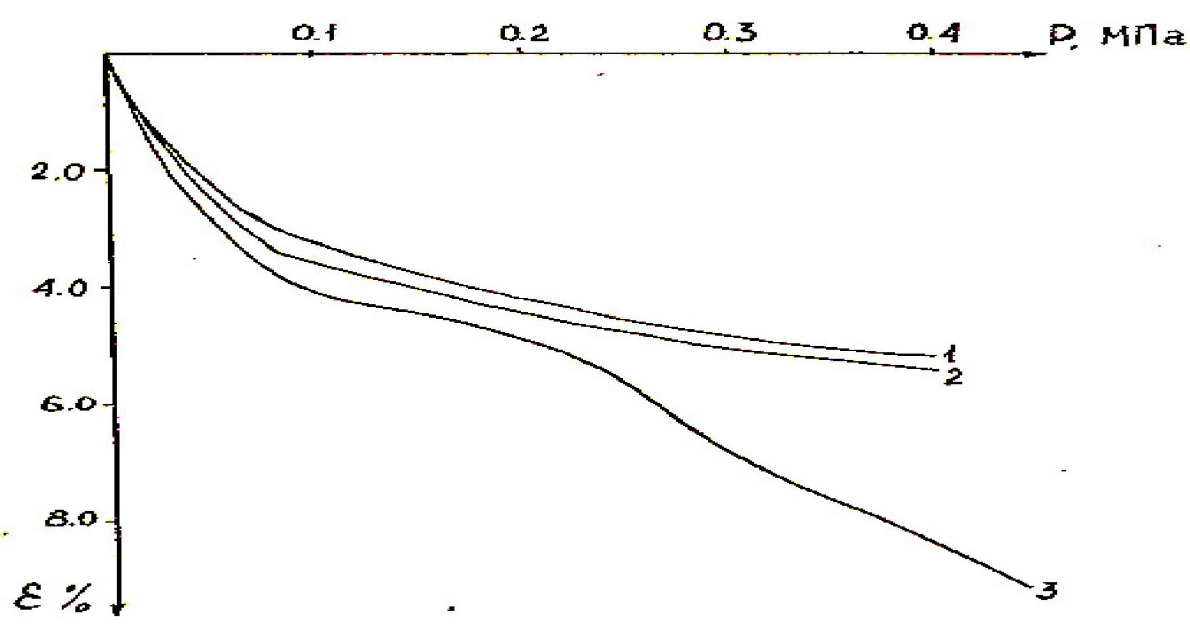

Fig. 4. Compression curves of loam vd I-III (well 7. Chapt. 18, 5-19.0) in different states:
1-natural composition;
2-after water saturation;
3-calculated for β=0.8

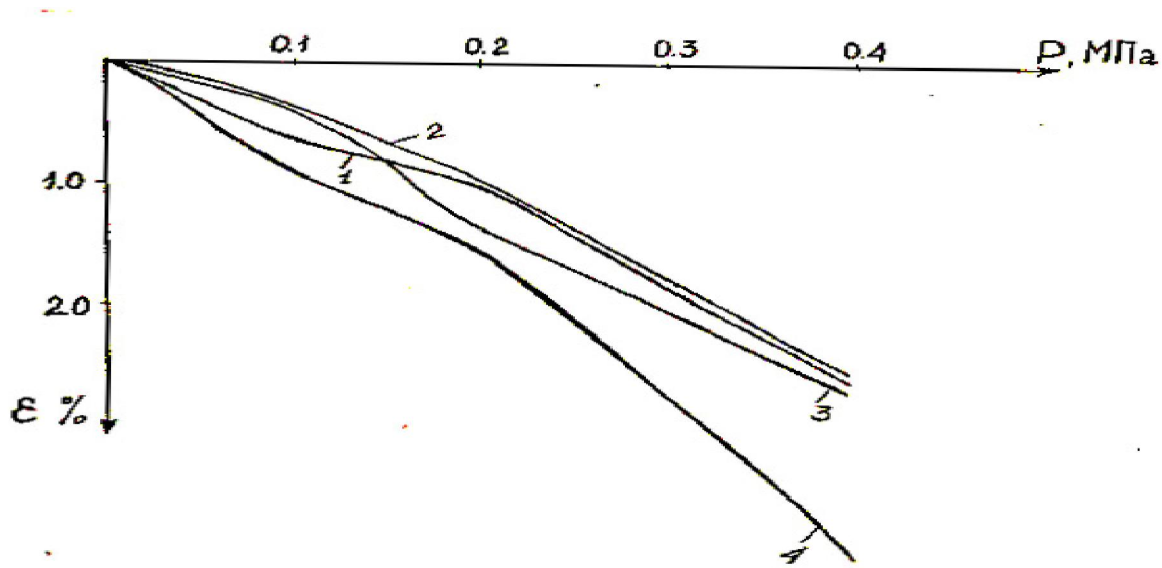

Fig. 5. Compressive compressibility of loam vd I-III in different states:
1-natural compaction;
2-after water saturation;
3-after leaching;
4-calculated for β=0.8 (well 1, Chl. 9.95-10.25)

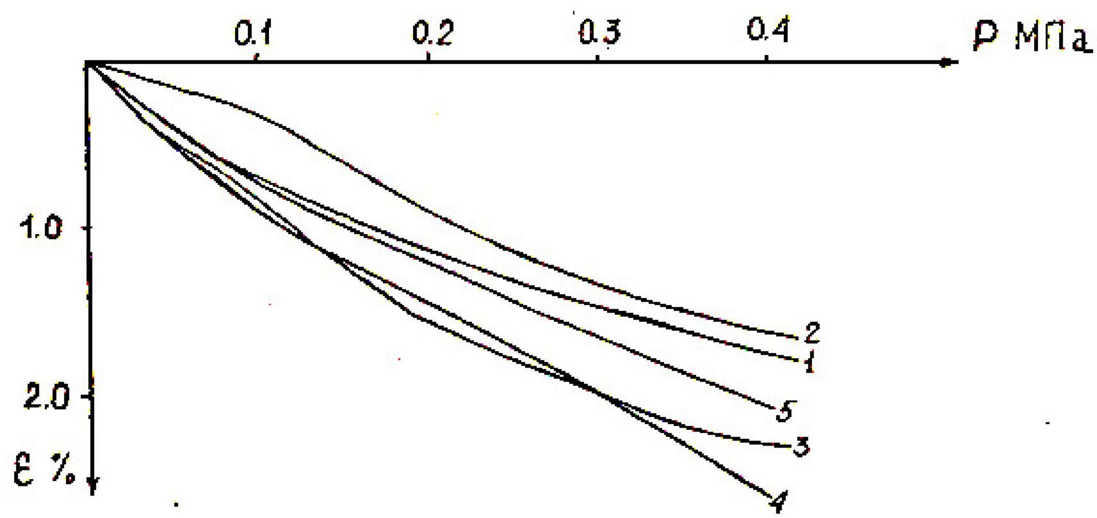

Fig. 6. Compression curves of loam vd I-III in different states:
1-natural composition;
2-after water saturation;
3-after leaching;
4-calculated for β=0.18 (well 1, Chapt.9,3-9,6)
4-calculated for β=0.2

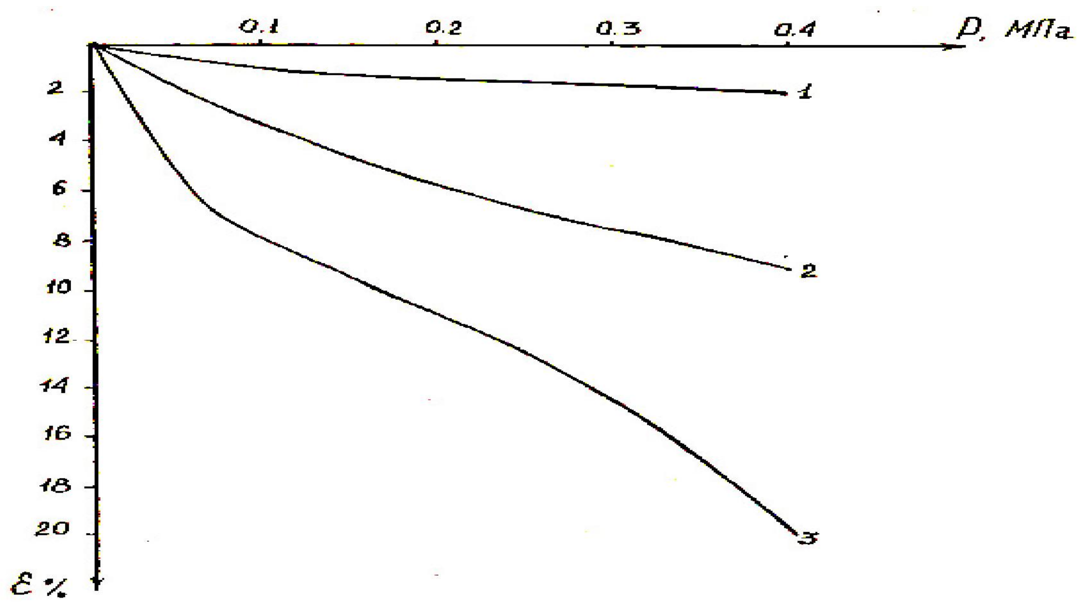

Fig. 7. Compression curves of loam (vd I-III) (well 7, Chapt. 13-9-14,2) in various states:
1-natural composition;
2-after leaching, β=0.38
3-calculated for β=0.8

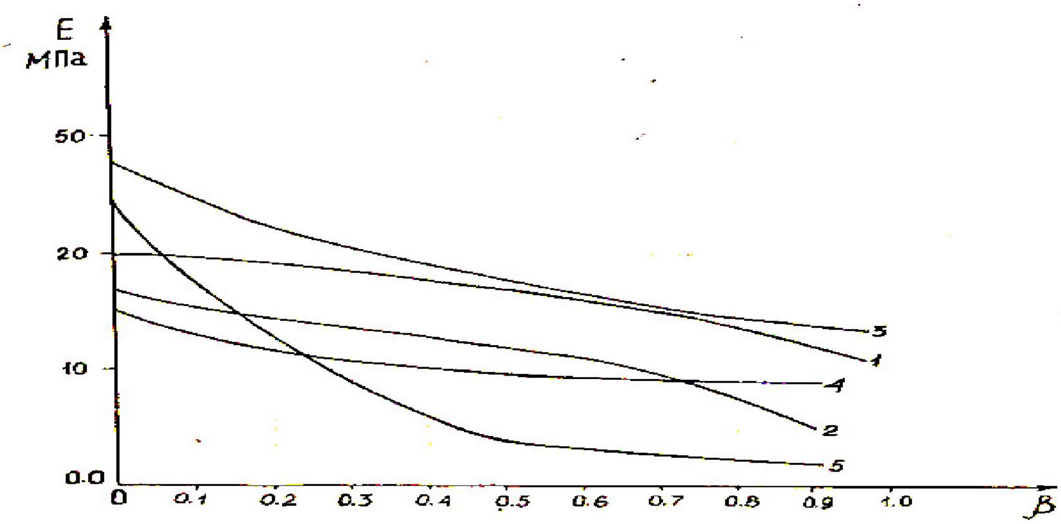

Fig. 8. Changes in the general strain moduli of grounds depending on the degree of ground leaching
1-square. 7, Chapt. 4,65-4,95
2-square. 7, Chapt. 18,9-19,0
3-square. 1, ch. 9.3-9.6
4-square. 1, ch. 9.95-10.2
5-square. 7, ch. 13.9-14.2
loams vd I-III KNPP

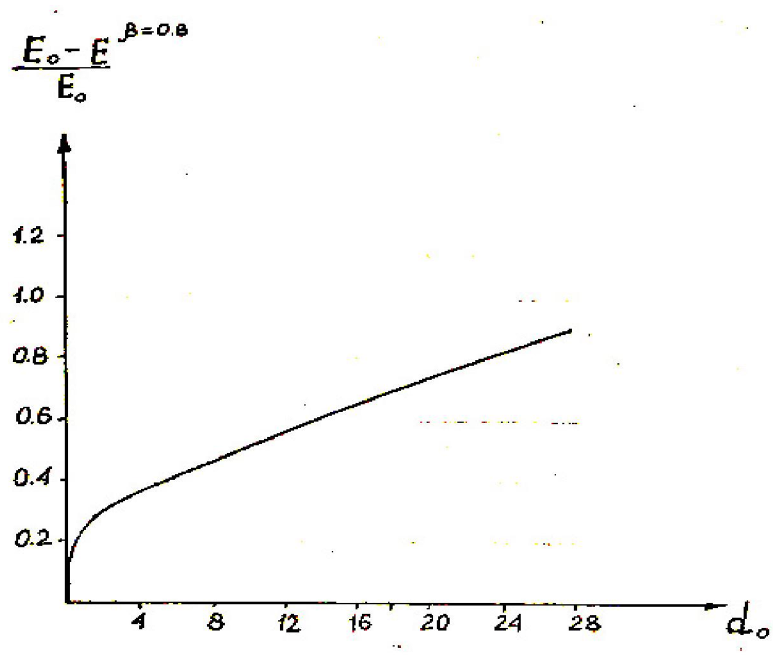

Fig. 9. The dependence of change in the modulus of total strain of grounds during leaching up to β=0,8 on the specific content of gypsum in grounds

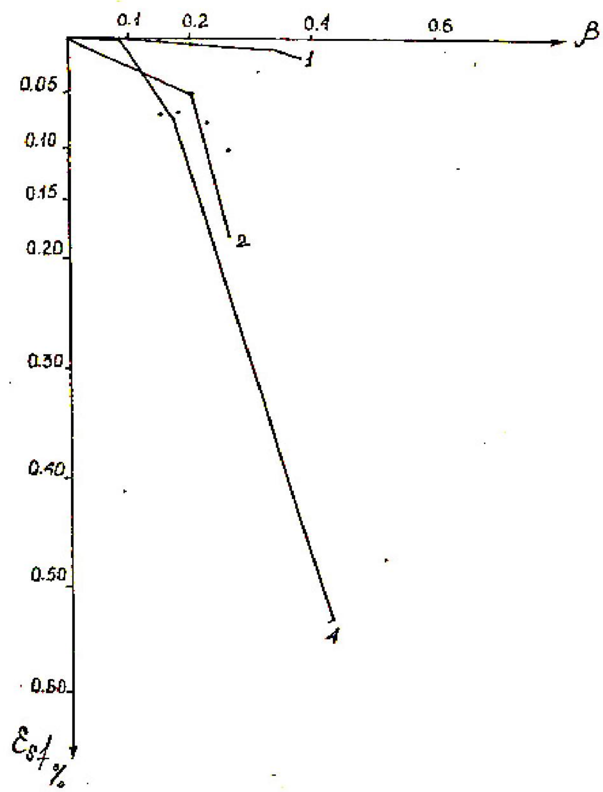

Fig. 10. Dependence of additional suffositional sedimentation ε_{sf} on degree of leaching β (well 7 Chapt. 4,65 - 4,95)

I-P=0,1 MPa,2-P=0,2 〖MP〗^a,4-P=0,4MPa

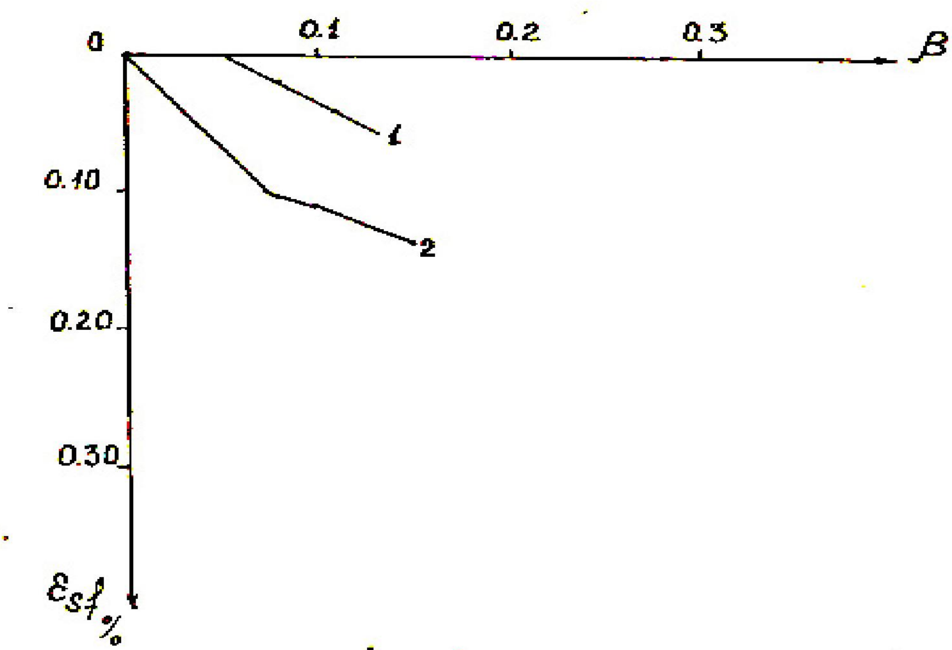

Fig. 11. Dependence of additional suffositional sediment ε_{sf} on the degree of ground leaching β (well 7 Chapt. 18,6 - 19,0)
I-P=0,1 MPa,2-P=0,2 MPa

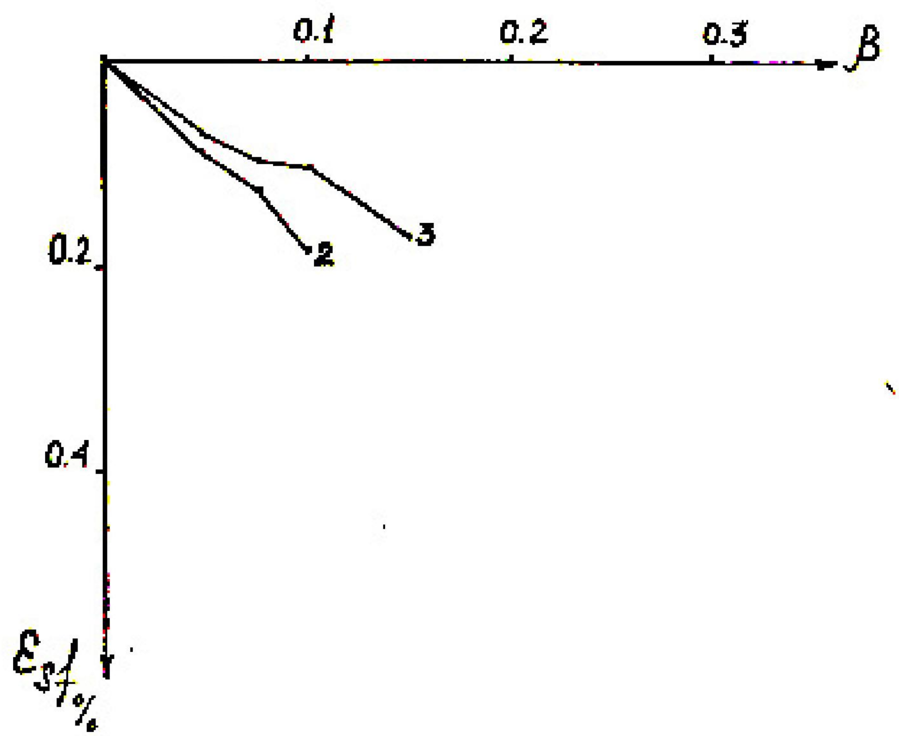

Fig. 12. Dependence of additional suffositional sediment ε_{sf} on the degree of ground leaching β (well 1 Ch. 9.95 - 10.25)
2-P=0,2 MPa,3-P=0,3 MPa

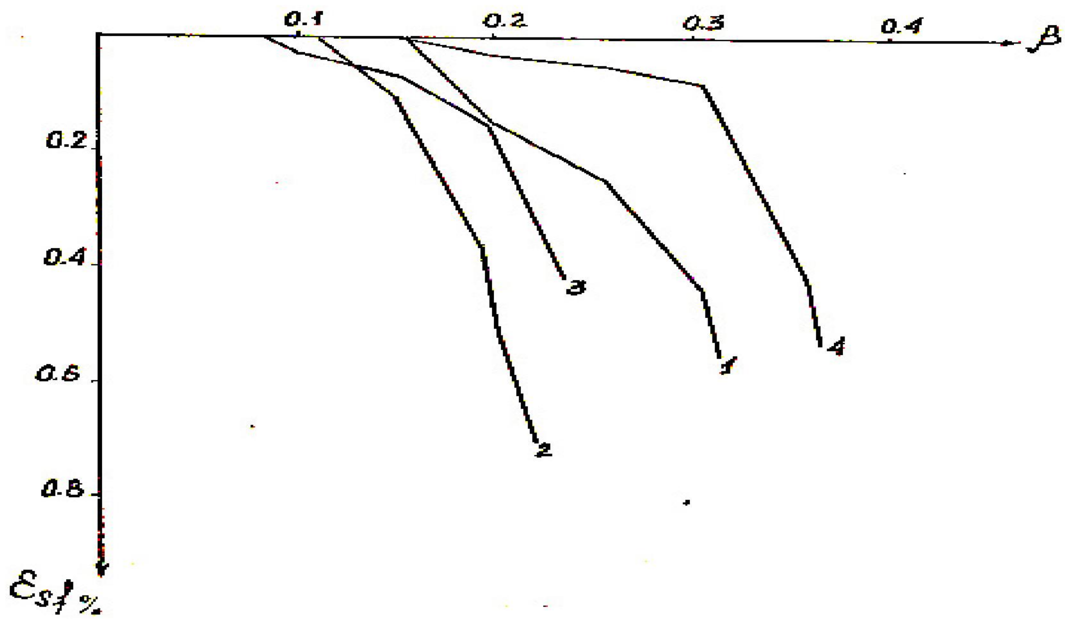

Fig. 13. Dependence of additional suffosional sedimentation ε_{sf} on the degree of ground leaching β (well 1 Ch. 9,3 - 9,6)
1-P=0,1 MPa; 2-P=0,2 MPa; 3-P=0,3 MPa
4-P=0,4 MPa

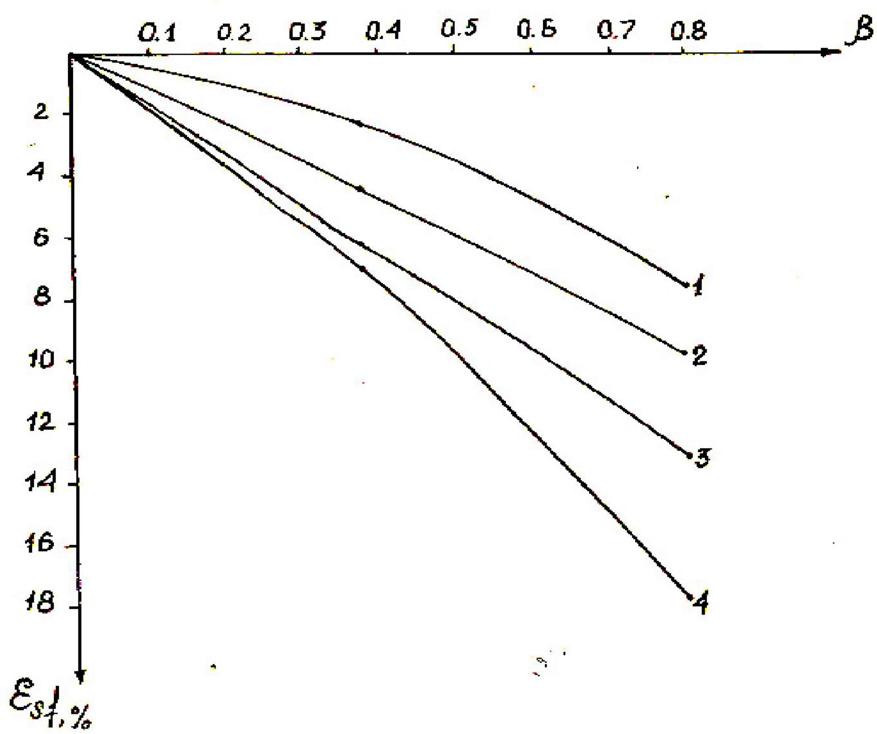

Fig. 14. Dependence of additional suffositional sedimentation of loam (well 7, Chapt. 13.9 - 14.2) on the degree of its leaching under loads
1-0,1 MPa; 2-0,2 MPa; 3-0,3 MPa; 4-0,4 Mpa

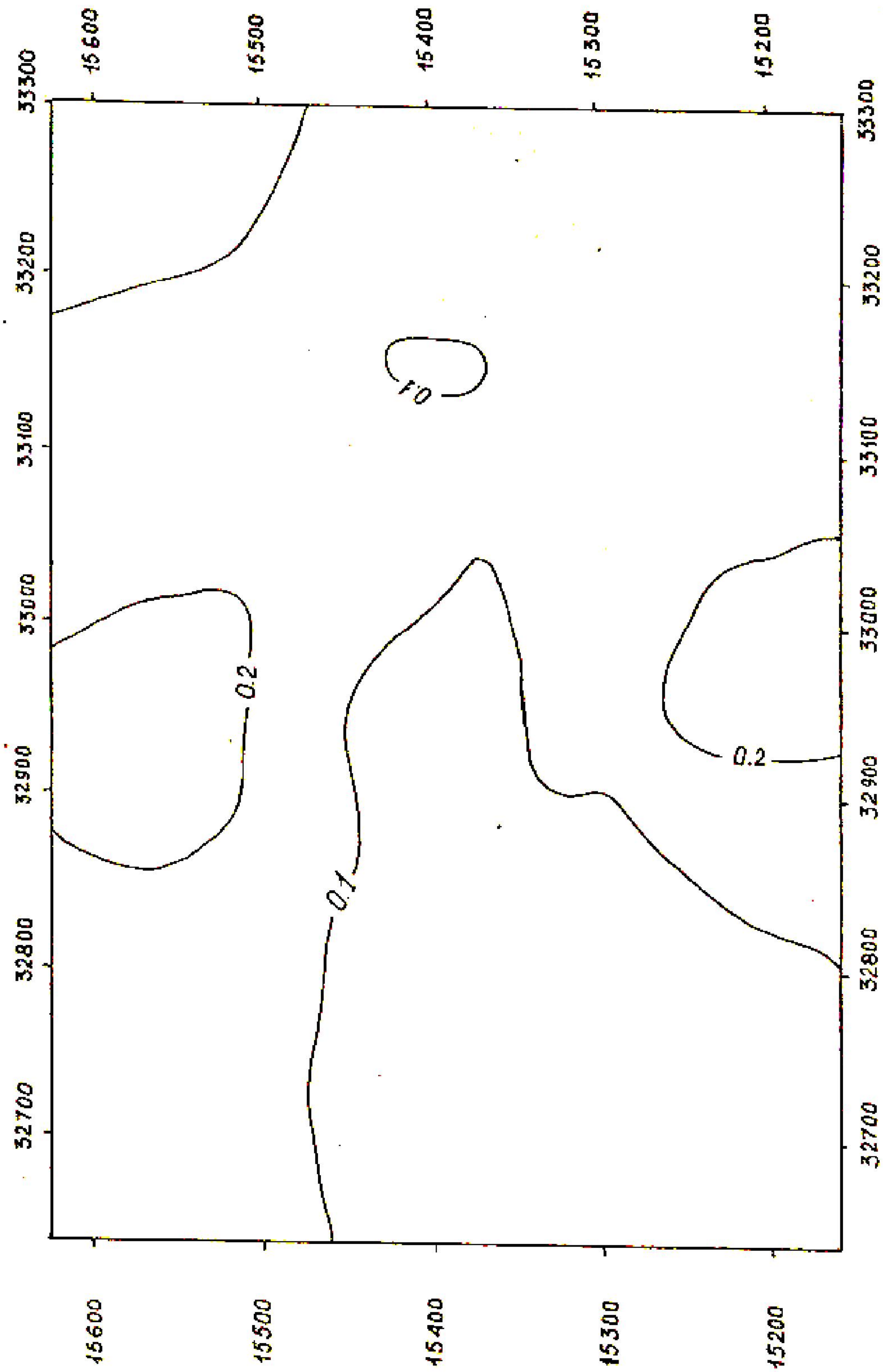

Fig. 15. Scheme of additional suffosion deposits in the KNPP site area at gypsum leaching (β=0,8) from grounds under external load P=0,1 MPa (4,0-8,0 m)

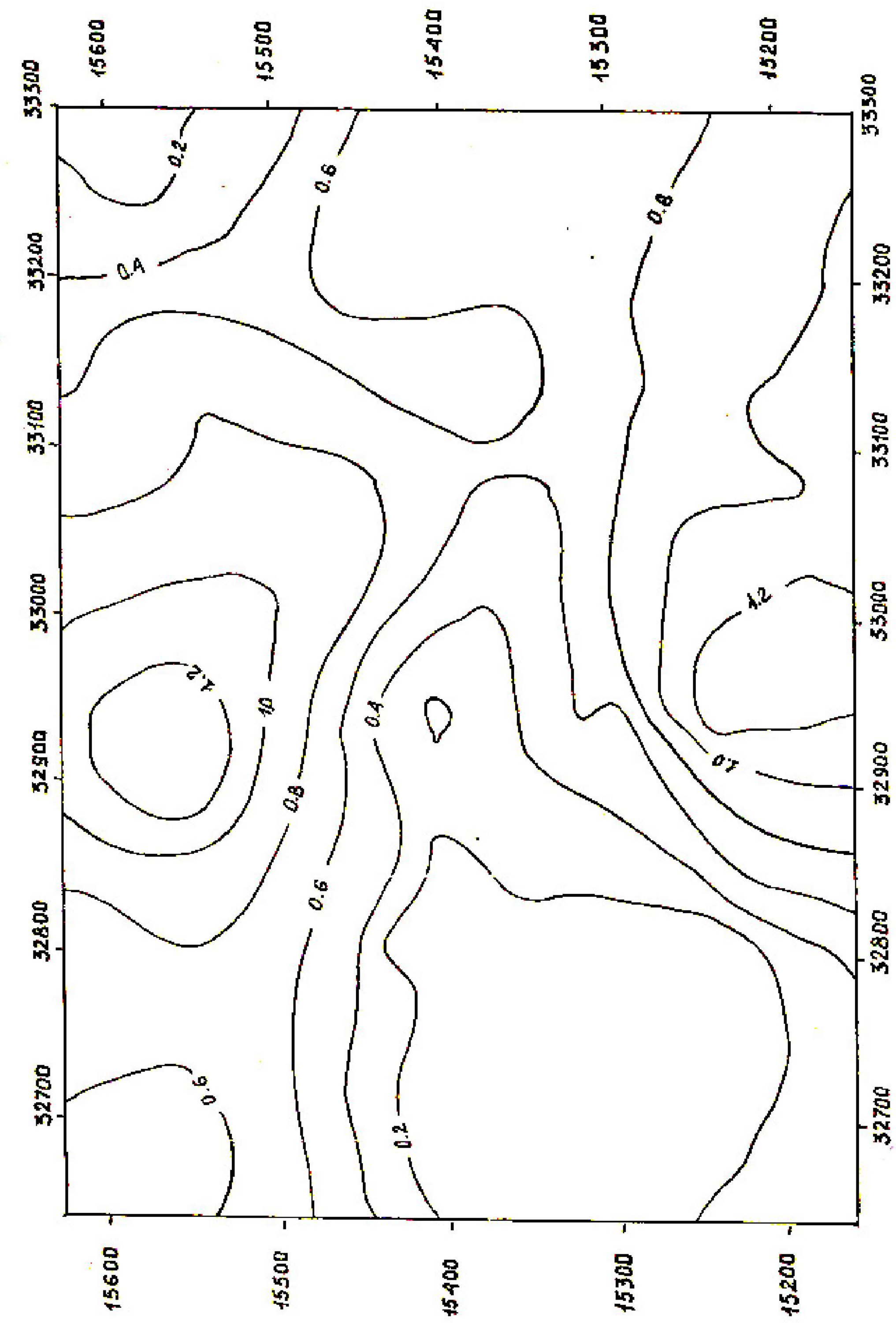

Fig. 16. Scheme of additional suffosion sediments in the area of KNPP site at gypsum leaching (β=0,8) from grounds under external load P=0,4 MPa (1,0-8,0 m)

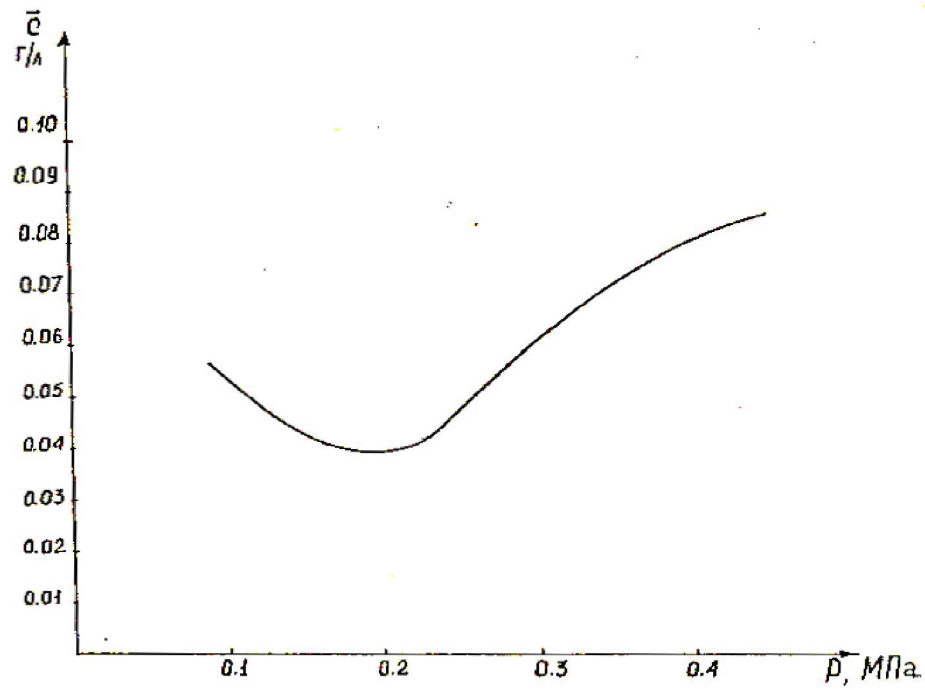

Fig. 17. Dependence of the diffusion leaching intensity on the external load on the sample

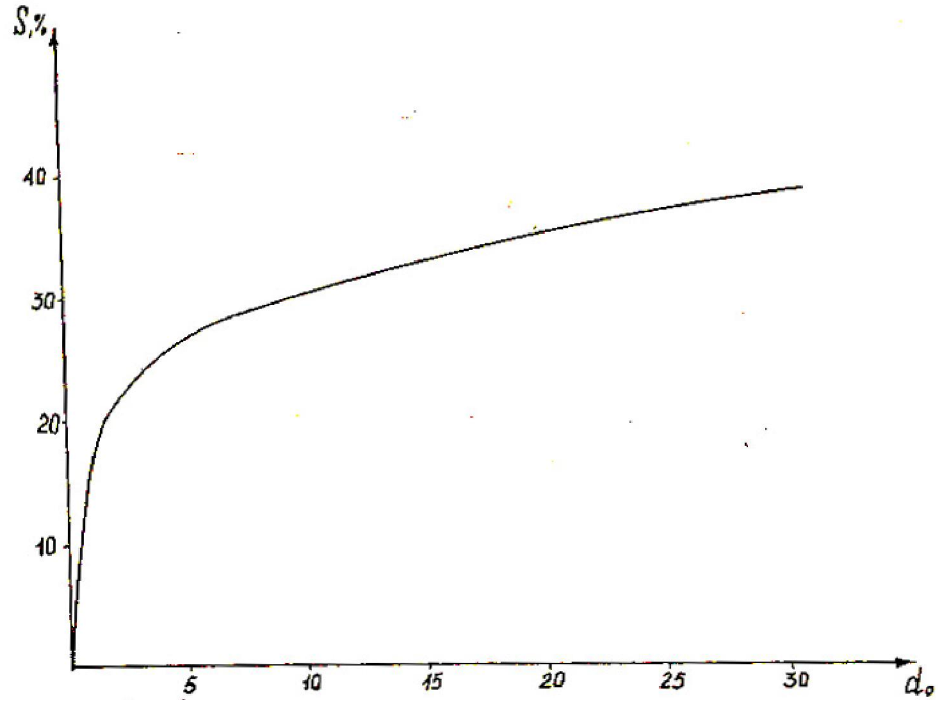

Fig. 18. The dependence of the proportion of the surface area of gypsum, involved in the dissolution during filtration leaching, on its specific content in the ground.

Table 1. Changes in physical and physical-mechanical properties of clay grounds as a result of leaching

Type of leaching	No. well. depth	State of the ground	Humidity, %	Plasticity limits			Density, g/cm^3		Porosity, P, %	Porosity coefficient, l	Modulus of deformation. E, MPa	Clutch MPa		Angle of internal friction		n
				W_L	W_p	I_p	P	ρ_d				$_{max}$	C_{min}	$_{max}$	$_{min}$	
Diffusion	7 – 4,95 =9,40	Natural. Water-saturated.$\beta = 0,40$ $\beta = 0,80$	23,2 24,1	32,9 51,8	22,3 28,3	10,6 23,5	2,05 2,11	1,67 1,70	39,5 38,4	0,65 0,62	20,0 15,1 17,7 17,6	0,028 0,027	0,015	24,5 18,5	21,5	11,2 3,9
	7 – 19,0	Natural. $\beta = 0,15$ $\beta = 0,80$	23,2 21,8	38,3	25,0	13,3	2,09 2,17	1,70 1,78	37,2 35,3	0,62 0,55	16,7 15,0 7,7	0,253 0,112	0,200	12 10,5	11	5,3 4,7
	1 – 9,6	Natural. Water-saturated $\beta = 0,26$ $\beta = 0,80$	20,4 23,5	35,145,2	26,1 27,2	9,0 18,0	2,01 2,12	1,67 1,72	38,1 36,3	0,62 0,57	28,0 22,2 21,4 14,2	0,035 0,025	0,033 0,025	25,5 18,5	20,5 4,5	9,1 8,0
	1 – 10,2	Natural. Water-saturated. $\beta = 0,11$ $\beta = 0,80$	23,4 24,5	44,7 43,8	25,4 27,7	19,3 16,1	2,01 2,07	1,63 1,66	39,4 34,9	0,65 0,54	15,4 13,7 13,3 9,5	0,050 0,035	0,018 0,015	29,5 20	25 12,5	10,4 5,4
	1 - 6,25	Natural. $\beta = 0,37$	19,6 23,1	34,1 37,0	24,8 24,9	9,3 12,1	2,09 1,94	1,67 1,58	38,2 41,5	0,62 0,71		0,01		28,5		10,7 2,6
Filtration	7 – 9,3	Natural. Water saturated and compactet at P=0,3 MПa $\beta = 0,27$	20,5 24,7 24,9	35,1	22,3	12,8	2,10 2,04 2,04	1,74 1,64 1,63	36,0 39,7 40,1	0,56 0,66 0,67	14,2	0,05 0,09 0,01	0,02 0,03 0,00	24 19,5 31	24 14,4 23,3	5,0 4,3
	7 – 10,6	Natural. $\beta = 0,10$ $\beta = 0,80$	22,4 24,6	42,1 45,1	25,9 26,8	16,2 18,3	2,12 2,00	1,72 1,61	37,0 40,8	0,59 0,69	10,3 8,0 6,8	0,025	0,009	24,5	23	6,4
	7 – 14,2	Natural. $\beta = 0,38$ $\beta = 0,80$	20,2 36,2	35,8 39,2	26,0 26,2	9,8 13,0	2,01 1,90	1,67 1,40	39,1 48,9	0,64 0,96	26,8 5,0 2,6	0,060 0,080	0,025 0,040	25 21	22 23	18,6 4,0

REFERENCES

[1]. Glazyev A.N., Morozova L.N. On the effect of salt leaching on deformability and strength of loess-like grounds of foundations of hydraulic structures. Gosstrojizdat, 1957. - p. 186-199.

[2]. Dorjiev A.G. Regularities of changing characteristics of mechanical properties of carbonate-bearing additive grounds during soaking and long filtration of water (by the example of the Caspian lowland). D. thesis of candidate of engineering sciences. M. 1980.

[3]. Regularities of filtration leaching of salts from grounds. - In V. of book: Problems of Building on loess grounds. - Voronezh, 1961. - P 27-31.

[4]. Zatenetskaya A.P., Safokhina I.N. Diffusion leaching of clays and its impact on engineering-geological properties of clay rocks. -M.: Science - P. 65-82.

[5]. Oknina N.A., Priklonsky V.A. Diffusion and diffusion leaching processes in clays and their impact on engineering and geological properties. - In kN: Research and Use of Clays. Lvov, 1958.

[6]. Oradovskaya A.E. Variation of filtration properties of saline rocks during prolonged filtration. - In: Dissolution and Leaching of Rocks. - Moscow State University of Civil Engineering, 1957 p. 175-183.

[7]. Recommendations on the method of predicting changes in the physical and mechanical properties of saline clay grounds during their leaching. Pniiis, 1983. - 125 P.

[8]. Ananyev V.P., Gilman Ya.D. et al. Exploitation and repair of buildings on loess subsidence grounds. - Moscow: Stroyizdat, 1977. – 102 p.

[9]. Biryukov N.S., Kazarnovsky V.D., Motilev Y.L. Methodical aid for the determination of physical and mechanical properties of grounds. - Moscow: Nedra, 1975. - 176 p.

[10]. Verigin N.N. On the salt dissolution kinetics during water filtration in grounds. - In: Dissolution and Leaching of Rocks. 1975.

[11]. Verigin N.N. et al. Methods of Forecasting the Salt Regime of Grounds and Ground Water. - M., 1979. - 280 p.

[12]. Problems of Ground Mechanics and Foundation Engineering,/ Scientific Notes,/ Edited by A.A.Mustafaeva

[13]. Hydrodynamic substantiation of prediction of underflooding of urban areas, - M.: Nauka. 1985,

[14]. Grote A.A., Shchulgina V.P. Construction properties of saline grounds. - In: Dissolution and Leaching of Rocks. - Moscow: Gosstroiizdat, 1975. - p. 133-160.

[15]. Denisov I.Ya. The Nature of Strength and Deformations of Grounds. - Selected. Works. - Moscow: Stroyizdat, 1972. - 279 pp.

[16]. Dzhumashev U.R. Features of Foundations of Industrial and Civil Structures on Saline Grounds. - Author's abstract. Dissertation of Candidate of Technical Sciences. - Moscow: 1982, - 20 pp.

[17]. Zatenetskaya N.P., Sofakhina I.N., Diffusion

clay leaching and its impact on engineering and geological properties of clay rocks - M,: Nauka, - P 65-82,

[18]. Zatenatskaya N.P., Ponkratova N.A., Basinskaya E.V., Deformation properties of saline clays, - Engineering Geology, 1983, - 5, P, 33-47,

[19]. Zelbrant V.A. About waterlogging of industrial areas, foundations, foundations and mechanics of grounds, -1987, -.

[20]. Changing of Ground Properties under the Influence of Natural and Anthropogenic Influences (Collection of Scientific Works). Ed. R.S. Ziangirov. -M.: Stroyizdat, 1981.

[21]. Il'ichev V.A., Grigoryan A.A. about settlement of Atommash Works as a Result of Long-Term Ground Soaking. - 1998. - № 4 . -C. 12-15.

[22]. Ismailov F.M. Prediction of chemical suffosion and settlement of foundations of structures using centrifugal modeling. Dissertation of Candidate of Sciences. - Baku, 1981,- 23 p.

[23]. Kapranov Y.I. About some exact solutions in problems of saline grounds. Izd. of AS USSR. - Ser . Fluid and Gas Mechanics. 1972. № 1 . P. 177-180.

[24]. Krichintsev A.N. et al. Solubility of inorganic substances in water (Reference Book). Chemistry Publisher, 1972. - C.420.

[25]. Kronik Y.A. Physical-mechanical and filtration properties of saline grounds. - In: Construction on Weak Grounds. - Riga, Stroyizdat, 1970.

[26]. Krutov V.I. Foundations and Foundations on Subsidence Grounds. - Kyiv, Budivelnik, 1982. - 224 pp.

[27]. Kurbanov A. Investigation of saline grounds for construction of earth dams. Ph.D. in Technical Sciences. - M.: 1980. - 21 pp.

[28]. Larionov A.K. Methods of Ground Structure Research. - Moscow: Nedra,1971.

6/22/2022