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SALINE LANDS OF DEALLUVIAL KIND OF THE PLAIN PART OF AZERBAIJAN

PREFACE

The soils got saline in considerable part of the plain lands of Azerbaijan. There are saline lands, having formed with the participation of subsoil waters among these soils as well. These soils mainly spread in all foothill zone of the republic.

There are sufficiently much materials about the origin of saline soils, having formed by alluvial-proalluvial way and their melioration in the literature at works of V.A.Kovda, 1946-1947; V.R.Volobuyev, 1948; L.P.Rozov, 1956 and others). However, it can be said that there are nearly no any materials about the origin and melioration of soils, having got saline by dealluvial way. V.A.Kovda (1937) and V.P.Volobuyev (1948) gave the first notion about such soils. The thoughts of V.A.Kovda and V.R.Volobuyev's thought about dealluvial saline lands was of general character, not basing on field experiments. No any idea was given about the melioration of such soils up to present day.

Nevertheless, the use of dealluvially saline lands in a definite degree was begun in our republic. However, because of these lands' being in bad water-physical and physical-chemical character mainly, procreates great difficulties. Nevertheless, it was important to learn the peculiarities of dealluvially saline lands and to prepare measures of their improving. This factor found its reflection in the special decision of the Azerbaijani Government as well.

We began this work since 1955, carried out by the leadership of Academician V.R.Volobuyev. Learning the peculiarities of dealluvially saline soils, we defined that it was not enough only to learn the existence of such soils in this or that field. It is urgent to learn the process of progress of those lands. That's why, building our investigation works namely in this aspect, we had to carry them mainly in three directions:

1) washing of soils, having formed in dealluvial way and learning of their generation conditions;
2) learning of water-salt dynamics of saline lands, having formed by dealluvial way;
3) learning of melioration of saline lands, having formed by dealluvial way.

CONDITIONS OF SOIL FORMATION

The studied soils cover the foothill zone of the republic, having spread in its plain part. The altitude of the territory above-sea level here is mainly 100-150 *m*, sometimes higher than this one.

Geological structure of the territory is densely connected with the geology of general plain. The Kur-Araz lowland was a big bay, lasting until the bottoms of the Great and Small Caucasus until the period of Baku. Ajinohur height, having risen after the Baku period, formed grey-gir plateau. Having formed because of the moving of the Caspian Sea backwards, the Kur lowland was filled by sediments, having brought by the Kur, Araz rivers and by their branches and changed into a plain in the Eastern Trans-Caucasus. According to V.R.Volobuyev (1953), surface structure of mountainous area, surrounding the Kur-Araz lowlands from the north and south consist of tectonic forms on which loam forms had been spread in a considerable area. At result of the activity of the ancient and present Caspian Sea, there a number of terraces of continent and sea origin were formed in the Kur-Araz lowlands, the height of which corresponds with the borders of stops of transgression and regression. V.R.Volobuyev mentions that continental traces mainly consist of two-origin reproduction. One of them is dealluvial-proalluvial fields and the other alluvial-proalluvial bringing cones of the rivers.

Alluvial-proalluvial cones of the foothills formed their train plain and foothill sloping plains together with dealluvial-proalluvial terraces.
Deposits of different mechanical composition of dealluvial rocks spread in these areas. These deposits gradually become heavier in the direction from high and very sloping dealluvial plates towards low train zone. Because of the very deep location of subsoil waters in dealluvial plates, they don't take part in soil forming process. Together with other factors, at the same time the climate condition of the territory also influenced the absence of subsoil waters here. The climate here is dry subtropical one. According to V.F.Figurovsky (1926), an average annual temperature in the territory was 25-27 degree, average annual precipitations 300 *mm*. Existing climate condition gives possibility of increase of half-desert plant kinds in the territory. The most spreading plants in the investigated territory are garaghan, alfalfa and ephemera.
The general characteristic feature of plant cover in dealluvial plates in the conditions of Azerbaijan is their adapting to dry climate and the salinity of soils. It is explained by their root system's spreading in deep layers of soils, having narrow leafs, mineralizing of high degree of leaf's seed-soak and secretion salts of some plant kinds through their leafs. Salts, having accumulated on leaf and trunks of garaghan settle to the soils, having washed by autumn rains. Salts, having washed off garaghan, are mainly sodium-chloride ones. From all of above-mentioned one can come to a result that the conditions of soil forming caused the complexity of soil cover. The first investigators of the soils of the Kur-Araz lowlands S.A.Zakharov (1927) and I.S.Tyuremnov 1927) indicated that grey soils here are of zonal type. The investigations of a number of other scientists (V.R.Volobuyev, H.A.Aliyev and others) proved that this thought was right. There are a number of soil types and kinds in this zone of our investigation territory. One can show brown, grey-brown, grey, salty, saline and other kinds. As the mentioned soil types and kinds had been explained in the works of the scientists (V.R.Volobuyev, H.A.Aliyev, B.M.Aghayev, M.E.Salayev, A.G.Zeynalov and others), we are satisfied by mentioning of the names of those soils, not characterizing them.

CHEMICAL-GEOGRAPHICAL CHARACTERISTICS OF SOILS

The factors of migration and origin of salts in salinity of soils

The history of formation of plain area in Azerbaijan creates possibility of explanation of accumulation of salts in the soils of the territory by this or other way. In the result of transgression and regression of the western bay of the Caspian Sea, existing before the fourth age, became the main influencing factor of salinity of the soils of the territory. The analysis of geological materials shows that salty deposits of the mountain systems, surrounding the plain territory of the republic, had weathered brought to slightly sloping areas of the territory is going on in the result of influence of external and inner factors by surface and subsoil flows. When saying *surface waters* we mainly consider of waters running through mountain plates. No doubt, that in this case, both the amount and chemical composition of the having brought salts depend on the salinity of having weathered rocks and their chemical composition, which in its turn is tightly connected with the geological history of the territory.

In order to explain the role of existing flows in the formation of having got saline in dealluvial form soils, let's pay attention to one of main areas of our investigations, i.e. at salinity process of soils of the Gurovdagh and Babazanan massifs. According to geological observations, the deposits of Gurovdagh-Absheron stage, in separate parts Baku and ancient Caspian stages are of complicated brakhian-tiklin deposits. There are boiling-with-oil in the forms of uvenil griffons and bitumen salzes, having mineralized, covered by a number of gas and oil drops in the plates and having weathered deep valleys. As it is seen from table 1, these waters got severely saline. The amount of salts in each liter of water is 21 *g*. NaCl salt prevails here.

Table 1

The results of analysis of griffon waters in the Gyurovdagh massif (by g/m/equiv. in 1 liter of water)

The surface of the mountain had complicated by a number of big and average largeness of mud volcanoes. The continuation of the Gurovdagh Mountain to the southeast is considered as asymmetric mixture of the Babazanan Mountain. The Babazanan borders by a jut, being the source of severely saline waters, having come from the depth. The having mentioned geological condition of the territory influenced very much to the formation of dealluvial current and their getting saline highly with different chemical compositions. Waters, having brought by dealluvial currents, move onto salty rocks, mixing together with griffon and mud volcanoes' eruption waters, making the deposits in the direction of their motion saline highly. That's why, when absorbing into soils in the direction of their motions, saline dealluvial currents cause gradual accumulation of mechanical fractions of salts in the soil. Due to the inclination, the speed motion is different in different parts of plates and they make precipitate salts in this or that part of soils in different amount. In the result of our investigations, having carried out in the Gurovdagh massif, we defined that the speed of dealluvial flows is big in big inclination part of the plates, and small – in less inclination part. That's why, the speed of current is wrong proportionate with the depth of passing waters into soils. In fact, dealluvial currents cover less depth in the areas with high speed and more depth – in small speed.

Picture 1.
Soil-hydrological zones of the Gurovdagh massif.
1 – the speed and direction of delluvial currents; 2 – falling current;
3 – rising current.

Thus, substances, having brought by dealluvial currents settle less in more inclination part and more in less inclination one. Because of it, dealluvial currents influence weakly to salinity of soils in upper part of plates and more in the lower train part of them. In fact, dealluvial currents pass little to the depth of soils in upper part of plates and having absorbed to the soil waters evaporate through the roots of plants. In addition, as dealluvial currents cover the beginning part of it in more inclination areas, the amount of salts become less in the composition of those streams and getting saline of soils goes on relatively weakly. In the described case, because of the area's being of more inclination, having passed to soils dealluvial currents can't remain there much, moving towards the lower areas through the interior of soils by remaining after the use of plants waters. That's why, having absorbed to soils dealluvial currents in more inclination plates not only can get saline of upper layers of soils, even carry them to lower parts of plates, gradually washing them.

The process of salinity of soils in less inclination areas goes on in contrary of having noticed case. In fact, when dealluvial currents having come to this part of plates move onto the surface of the territory, dissolve salts having met in their way and increase the density of solution. In other hand, the density of currents moving through the interior of soils also increases here. Dealluvial currents diminish their speed in both cases in less inclination part of the area, pass into the soil in that part. At last, solution, having absorbed into the soil, in the conditions of high temperature evaporate once again and cause the salinity of soils in different degrees.

At the same time, wild plants, existing in the territory also have big influence to the accumulation of salts in having got saline in dealluvial way.

As we have mentioned above, currant, alfalfa and ephemeral plants are the main ones, having spread in saline soils of dealluvial way. According to V.A.Kovda (1944), currant plants accumulate about 20-30% salts from the area of their roots' spreading into their trunks. V.A.Keller (1929) indicates that there are ash substances up to 10-15% in the composition of alfalfa plan. G.A.Govelson (1934) notes, that mainly chlorine prevail inside the ions, having accepted by alfalfa plant.

In the result of investigations, having carried out in the conditions of southeast Shirvan plain, Y.P.Logunova (1955) defined that there were about 47% of easily soluble salts in the root system of currant plant, among which prevail Na, K, Cl and SO_4 ions. There are only 10% of easily soluble salts in the composition of roots of ephemeral plants. Majority of salts here composes Na, K and Cl ions. Y.P.Logunova at the same time defined that the salts in the roots of currant plant, having spread in southeast Shirvan plain are very close to the chemical composition of salts in those soils. The only difference here is only in that that the comparison of ions of Cl/SO_4 is relatively less in currant plant. The author defined that annually 1,3 *ton/ha* mineral substances take part in biological circulation through the surface part of plants in the having described condition.

Thus, all these once again prove that the influence of plants in the accumulation of salts in getting saline by dealluvial way soils is very great.

The playing of prevailing role of above-mentioned plants in salinity of soils, firstly, is explained by their feeling well in saline atmosphere and by their being claimant to salts.

Plants, having spread in the described condition, have to extend their roots to deeper layers of soils in the struggle of drought in order to get enough humidity from there. Soil and clay here is more humid here in comparison with deep layers and at the same time being saline very highly. Because of it, plants, having fed by humidity here, at the same time have to accumulate salts of definite amount. In the result, those salts rise to the surface part of plants through their roots and after plants' spoiling or even in their live period pass into soils, having washed by rain waters. Thus, this causes the accumulation of definite degree of salts in the upper layer of soils.

In the result of our investigations we definitely defined that the process of diffusion also plays a great role in the accumulation of salts in saline lands of dealluvial way. It is right, that this process goes on very slowly naturally, but if taking into consideration of this process during the geological period, then no doubt that its influence can be felt considerably. Our investigations indicated that in saline soils of dealluvial ways, having used in irrigation conditions, the accumulation of salts mainly goes on in the result of the influence of diffusion process.

Detailed information will be given about it later.

General geographical characteristics of salinity of soils

Salinity degree of having investigated by us soils changes in big limits. This changing is about 0,1 up to 3% in one-meter upper layer of the soil.

The amount of salts in the soils of the most upper part of dealluvial plates is very little. Usually it does not go beyond 0,1%. The amount of salts gradually increases in lower, less inclination parts of the plates. Relatively high salinity of soils is observed only in very deep layers of them. The continuation of such saline lands towards the south composes weakly saline soils. Saline lands of weak degree cover larger area in the west and east parts of it than in south part of dealluvial plates. There spread saline soils of high degree in relatively low part of the territory. The amount of salts in two-meter layer of the soil here changes between 1-2%. Such kind of soils spread widely in dealluvial plates of the Mil, Garabagh and Shirvan plains. Saline lands don't compose an especial zone in the area of our investigations. They are met in the forms of big and small spots in saline lands of high degree. Saline lands have spread in the train zone of dealluvial plates. Although being not regulated case, saline and severely saline soils sometimes are observed in upper zones of dealluvial plates. Obviously, it is connected with its local character of that condition.

General geographical spreading regulations of salts

In the result of our investigations, we defined that the climate condition of the territory has great influence in the migration of salts. The climate becomes dry towards the southeast part from the northwest part of the territory. As the degree of evaporation increases in this direction, the salinity of soils and the amount of chlorine in them also increase very much. The increase of the atmospheric precipitation towards the north and northwest areas of the plain in its turn influenced the washing of chloride salts from the soils and the accumulation of alkalis there.

The geomorphologic condition of the territory also had great influence to the spreading of salts in difference amount and composition in the investigated area. In fact, the amount of salts in the upper and nicely natural drainage areas is small, but in lower areas – accumulated much. This regulation showed itself in chemical composition of salts as well. We defined the following main chemical composition of soils of dealluvial plates in the investigated plain: 1) hydro-carbonate salinity; 2) sulfate salinity; 3) chloride salinity. They have their half-kinds in their turns as well.

Soils, having got of h y d r o-c a r b o n a t e composition spread in the upper parts of dealluvial plates of the described territory. In all soils of the territory prevail bio-carbonates, sometimes – carbonates. Nevertheless, according to the amount of different ions and comparison of them to each other these soils are divided into two half-types: a) un-saline soils of hydro-carbonate-calcium composition. They spread in higher part of the territory; b) soils with hydro-carbonate-sulfate-calcium-sodium composition. Such soils spread in the low part of the zone.

Saline lands of s u l f a t e composition compose the middle part of plates in our republic. Together with it, depending on chemical composition of mountain rocks, having undergone of weathering, sulfate of soils is expressed in different degrees inside the zone. In fact, soils in the middle part of dealluvial plates in the Shirvan plain became severely degree of sulfate. At the same time, saline soils with sulfate composition here embraced relatively wide area. However, in the soils of the Mil and Garabagh plains, sulfate is expressed relatively weak. Nevertheless, the middle zone of dealluvial plates is of sulfate in all cases.

Being of sulfate composition in severe degree in the middle part of dealluvial plates of the Shirvan plain and embracing of larger areas of those soils is explained by gypsum composition of pl(e)iocene deposits of the mountains, surrounding the territory (M.R.Abduyev, 1958).

Spreading region of saline soils of c h l o r i d e composition is considered wide train zone of dealluvial plates in our investigated area. High degree chloride soils spread in not very large area in the characterized region. Such soils mainly cover the lowest part of the train zone of dealluvial plates. Saline soils of such composition embrace much more area especially in the east and southeast Shirvan plain.

Thus, according to the kind of salinity, soils in the described territory spread corresponding to the zonal law of salinity kind. No doubt, that it is explained by geological structure, climate condition of the territory, chemical composition of weathering mother rocks and dealluvial currents,

Types of salt profiles and defining them factors

The distribution of salts in soil profile gives chance of defining of the going of the direction of getting salinity in some degree. We composed the map of salty profiles of the soils of the investigated territory in this purpose. It must be mentioned that the map of salinity profiles of soils in Azerbaijan firstly was composed by A.S.Preobrazhensky. However, A.S.Preobrazhensky composed that map only due to dry remainder. Because of that, such map could not define the real condition of spreading of salts on profile of the soils of the Shirvan plain. That's why, that map was composed by M.R.Abduyev (1958) for the Shirvan plain later. When composing the map of salinity profile, together with spreading of salts in soils paid special attention to their chemical composition as well. We used the same way when composed the map of salinity profiles for the plain part of Azerbaijan. When composing the mentioned map, in order to form a right imagination about the plain area of the republic, we took into consideration the level of salinity profiles of the soils of all Kur-Araz lowlands (including Mughan and Salyan plains), Ganca-Gazakh massif, Jeyranchol plain. Composing the map of salinity profile of soils we used the existing analyses figures for above-mentioned areas (M.R.Abduyev, S.I.Dolgov, A.G.Zeynalov and M.E.Salayev, A.S.Preobrazhensky, Sh.G.Hassanov and others). We defined main six types of salt profiles for the mentioned regions:

1. Un-saline and equally distributed salinity profile with hydro-carbonate-calcium-sodium composition.
2. Getting saline from the depth salinity profile with hydro-carbonate-sulfate-sodium composition.
3. Settling in depth salinity profile with hydro-carbonate-chloride-sodium composition.

4. Getting saline, settling salinity profile with sulfate-chloride (chloride-sulfate)-sodium composition.

Picture 2.
The map of geographical distribution of salinity profiles.
1 – equally spreading salinity; 2 – getting saline from the depth salinity; 3 – settling in the depth salinity; 4 – getting saline settling salinity; 5 – getting saline upper horizon and saline salty profiles; 6 – Mingachevir water reservoir; 7 – swamps.

5. Getting saline, having washed of upper layer salinity profile with sulfate-chloride-sodium composition.

6. Got saline salinity salty profile with sulfate-chloride-sodium composition.

Un-saline and equally distributed salt profiles with hydro-carbonate-calcium-sodium composition embrace wide areas in the upper part of dealluvial plates. Soils, having got such type of salinity profile surround the characterized region as a border. As it is seen from the map (picture 2), such soils cover great area of the Alazan-Ayrichay valley and in the west part of the Mil and Garabagh plains. The soils of these areas got mainly saline. At the same time, salts in the soils have equally distributed.

However, in some cases, especially in the Mil and Garabagh plains, relatively big salinity is observed in the upper layer of the soils. Nevertheless, this does not indicate that such soils have got highly saline or salty. In fact, the amount of salts in those lands is not more than 0,1-0,2%.

Picture 3.
Un-saline and equally distributed salt profiles with hydro-carbonate-calcium-sodium composition.

The characterized soils are of hydro-carbonate-calcium-sodium composition in all cases (picture 3). Our investigations, carried out on the dynamics of salts indicated that in spite of changing of the amount of salts in the profiles of those soils in separate seasons of a year, in general, it does not cause the changing of configuration of salinity profiles.

Strongly saline salty profile of h y d r o-c a r b o n a t e-c a l c i u m-s o d i u m composition embraces the middle part of the upper zone of dealluvial plates of the investigated region. They distributed equally in every part of the territory. The spreading area with these salty profiles gets narrow from the east towards the west of the Mil, Garabagh and Shirvan plains. Relatively big area is observed in the Mil plain, very little one – in the Ganja-Gazakh massif. Relatively increasing of salts in these salty profiles shows itself in low layers of the soil. The amount of salts is very little in 1,5-2 *m* upper layer of the land. At the same time, they were divided equally in that layer. As it is seen from the graphics (picture 4), SO_4, Ca and Na ions prevail in such salty profiles.

Picture 4.
Un-saline salt profiles in the depth with hydro-carbonate-calcium-sodium composition.

The formation of the having described salty profiles is explained by the fallowing proofs. As there is not an influence of subsoil waters, salty solutions can't rise to the upper layers of the soil here and connected with it, there doesn't appear the accumulation of salts in that layer of the soil. From the other hand, in the stages of soil formation, having accumulated in that layer salts are washed away gradually under the influence of atmospheric precipitations towards the lower layers of the soil. In this case, re-rising of those salts to the upper layer of the soil is not rejected. However, the results of water-salt dynamics, having carried by us in the soils with such type of salty profile indicated that in all cases because of atmospheric precipitations the accumulated humidity becomes in limited amount. When precipitations are much in later years, they cause the washing away of more salts from the upper layers.

Thus, although of the seasonal migration of salts in the soils of the characterized areas, there appears possibility of gradual washing and diminishing of salt amount in the upper layers and increasing of un-saline layer of the soils.

Picture 5.
Settling in the depth salt profiles getting saline in hydro-carbonate-chloride-sodium composition.

Salt profiles with h y d r o-c a r b o n a t e-c h l o r i d e-s u l f a t e and s u l f a t e-c h l o r i d e-c a l c i u m-s o d i u m composition, having settled in the depth, had spread in the lower part of the upper zone of delluvial plates. Salinity profiles of such soils embrace comparatively wide areas in the eastern and southeastern Shirvan and Jeyranchol massif. Gradual increasing of salts from 80-*cm* depth and sharp increasing – from 120-*cm* depth is typical for these soils. Although, the accumulation of little amount of salts in upper layers of the having described depth, their spreading here carries out a stepped character.

As it is seen from the presented graphics (picture 5), the composition of salts is very different in these soils. Although some salinity profiles have of hydro-carbonate-sulfate-calcium-sodium composition, others are of hydro-carbonate-chloride-sodium. Nevertheless, the configuration of salinity has the same form in both cases.

Getting saline, having settled salinity profiles of sulfate-chloride and chloride-calcium composition form great area in the described territory. Such kinds of salinity profiles are typical for the middle zone of dealluvial plates. The thickness of relatively un-saline upper layer of these soils diminishes very much (picture 6), composing averagely 35-50 *cm*. Nevertheless, the amount of salts in the described upper layer is very much in comparison with the upper layers of the above-mentioned lands (0,5-0,8%). The amount of salts in the got saline low layers of the soil is much more – Na, SO_4 and Cl ions are in big amount.

Picture 6.
Getting saline salt profiles with having washed upper layer in sulfate-chloride-sodium composition.

The formation of salinity profiles in the described areas is explained with that that the surface waters, becoming saturated by salts and waters of upper layer, having formed in the upper zone of dealluvial plates, flowing in the direction of inclination, absorb into the soil in this part. However, as precipitations are less here (200-300 *mm*), dealluvial currents appear not much. In fact, having formed dealluvial currents can only absorb up to the layer of spreading of main parts of plant roots. Plants assimilate the having absorbed humidity and accumulate salts in that layer, evaporating it by the way of transpiration. As a result, it causes the formation of salinity profiles in the having characterized form.

Salinity profile of saline lands with having washed of the upper layer, getting saline in c h l o r i d e-s o d i u m composition, had spread in the train zone of dealluvial plates. According to the composition, amount and spreading on the profile, salts sharply differ from all above-mentioned salinity profiles. Firstly, the thickness of having washed upper layer of soils here is very little (5-10 *cm*), from the other point, according to the composition of salts, soils got saline only by chloride salts (picture 7).

Picture 7.
Getting saline, having settled salt profiles with sulfate-chloride (chloride-sulfate)-sodium composition.

Having got saline salty soils with s u l f a t e-c h l o r i d e-m a g n e z i u m-c a l c i u m-s o d i u m composition is not so typical for the having mentioned dealluvial plates. However, when composing the map of salinity profile of soils, we met salty soils, having got saline because the influence of subsoil waters. That’s why, we consider expedient to give a brief characteristics of those soils.

Picture 8.
Saline salt profile with sulfate-chloride-sodium composition.

These soils are divided into two types as well. However, as the problem of their characteristics and geographical spreading doesn’t concern to our subject, we joined the types of salinity profiles of those soils in one group. As it is seen from the graphics (picture 8), the amount of salts is very high in all profiles of these soils. It can be said that they had spread equally in the profile, except the upper layer of the soil. Cl and Na ions mainly prevail there.
Thus, it must be mentioned that the spreading of salinity profiles obeys definite zonal regulations in the having characterized region. This regulation shows itself in the gradual changing in the direction from the upper strip towards the train strip depending on the amount and composition of salts.

WATER-SALT DYNAMICS OF SOILS

We carried out the investigations on water-salt dynamics of soils in dealluvial plates of Harami, Girovdagh and Babazan massifs. Let’s characterize the natural soil condition in general form of having investigated massifs before the describing of water-salt dynamics of soils.

Natural soil condition of the object

Locating in southeast of the Shirvan plain, Harami, Girovdagh and Babazan massifs have dry, hot subtropical climate condition. Average annual temperature here is + 15 degree and the amount of average annual precipitation 250 *mm*. maximum evaporation is observed in summer, in the period of minimum of precipitations. At the same time, there blows strong northwest winds in this period. The existing climate condition caused the development of xenon plants and very early mineralization of organic substances. As it is seen in the scheme, having composed for the Gurovdagh massif (picture 9), mechanical composition of soils becomes coarse towards the heights of the plates. Soils in upper zone are light and mid-clayey. The amount of physical clay in one-meter layer averagely composes 40-45%. As the

mechanical composition of soils in the middle zone becomes heavy, the amount of physical clay here reaches 50-70% and soils become heavy clayey and light clay. Soils in the train zone of the territory are mainly of heavy clay. The amount of physical clay in different layers of soils is beyond 80% in all profile in general.
The hydro-geological structure of the territory is characterized by locating of subsoil waters' level very deep. Sometimes subsoil waters are not observed here even in some ten meters depth. That's why, the influence of subsoil waters in the process of soil forming is mainly absent here.

Picture 9.
Mechanical composition scheme of the soils in the Gurovdagh massif.
1 – light clayey; 2 – average clayey; 3 – heavy clayey; 4 – light clay;
5 – average clay; 6 – heavy clay.

Having mentioned natural condition of the territory caused the formation of grey-brown saline soils here. Sometimes malting process also developed in those soils as well (Babazanan). There is section-like A layer, prism-like grey B and consisting of illuvial clay with carbonate C layer, expressed openly in the profile of these soils. All these and much amount of absorbed Na complex indicate the salinity of these soils. As it is seen from table 2, the amount of absorbed sodium is 10-26% of the absorbed substances of the middle zones of dealluvial plates (cuts 231 and 237). If the amount of HCO_3 ion is 0,08-0,1% in plough and under-plough layers of the soils according to the results of the analysis of water extract, then, it falls to 0,0200,03% in low layers.
Big amount of sodium in the soils of the territory is explained by the following reasons.
The results of analyses of the samples of rock and griffin waters, having taken from the mountainous area, surrounding the territory indicate that Na ion prevails in the composition of them. Its amount in griffon waters is 1/3 of the sum total of salts (see table 1) and in the composition of rocks – 0,5-1,0 (see table 3).
Thus, main reason of the accumulation of absorbed sodium in the soils of the territory is considered the influence of dealluvial currents.

Table 2

The amount of absorbed substances in spreading soils in dealluvial plates of the Gurovdagh and Babazanan massifs

Table 3

Chemical composition of weathering rocks in the Harami massif

We think that the accumulation of sodium in soils at the same time goes on by biological way. Organic joining of sodium in alfalfa and currant plants, having spread in the territory, is the biological source of sodium, having formed here. In ashy substances of such plants, the amount of sodium is considerable. When rotting away of the remainders of these plants there is formed sodium-bio-carbonate ($NaHCO_3$) and sodium-carbonate (Na_2CO_3). In this case, sodium of those joints is absorbed into the soil and calcium-cation is taken away from its absorbing complex, forming calcium-carbonate, hardly soluble in soil solution according to the following reaction:

$S.Ca + Na_2CO_3$ $S. 2Na + CaCO_3$ (S here is – soil)

Alfalfa and currant plants, at the same time salts migrate from the low layers of the soils to the upper layers. Later on, these salts are washed again to the lower layers of the soils by rainwater. Thus, the amount of absorbed sodium gradually increases in the washed layer of the soil.
The soils of having characterized massifs got highly saline, about which we have informed above. That's why, we'll satisfy by noting of some characteristic results of salinity here.

Picture 10.
The scheme of salinity of the soils of the Gurodagh massif

High degree of salinity begins from different depth of soils in separate parts of the territory. In fact, although 60-80 *cm* upper layer of the upper zone of dealluvial plates didn't get saline, nevertheless, there is observed plenty number of amount of salts in lower than it layers. Although the thickness of un-saline upper layer in the middle zone of the territory diminishes, the amount of salts is much more than in the upper zone. Below the relatively less saline layer, the amount of salts is much as in saline soils.
Un-saline layer in the upper part of soils, spreading in the train zone of the territory is mainly absent. Nevertheless, the upper layer of the soils got saline very little in comparison with the lower layers. All these are openly seen in the scheme of picture 10.
One fact must be mentioned that in the soils of the train zone the maximum amount of salts is accumulated in the middle layer of it.
According to hydro-geological information, subsoil waters locate approximately in 6 *m* below in this part of the territory. That's why, the rising of subsoil waters by capillary pipes reaches approximately 110-120 *cm* of depth from the surface and subject to evaporation from that depth. As it is seen from the scheme of picture 11, dealluvial currents can only pass up to 70-*mm* of depth and wash salts in the soil up to that depth. Namely because of this, the maximum accumulation of salts shows itself in the depth of joining of these two influences.
Due to morphological structure, saline soils, having formed in this zone look like takir.
According to chemical composition, the soils of the characterized territory got mainly saline by sodium-chloride and sodium-sulfate salts.
T h e m e t h o d o f i n v e s t i g a t i o n s. Observations were periodically repeated once in two months. Soil samples, each being three repetitions from the genetic layers of soil cuts, were taken from land cuts. In later observations, the samples were taken in two repetitions each. The humidity of soil samples was defined by the way of drying.

The dynamics of humidity of soils

The problem of dynamics has been learned and carried out necessary generalizations by a number of investigators (A.A.Izmailsky, 1984; G.N.Visotsky, 1934; V.A.Kovda, 1946; V.R.Volobuyev, 1951; A.A.Rode, 1956 and others).
As the result of our investigations, having carried out in the above-mentioned massifs, we defined that humidity changes in big amount in the soils of the territory.
Although the humidity of soils in some squares subjected dryness for a long period, nevertheless, there is high amount of humidity in definite depth of the soils of other squares. The thickness of layer with dynamic humidity in this or that soil is different. In fact, although the amount of humidity is weakly changeable and embraces little depth, then in other soils this is more changeable and embraces big depth.
At the same time, there is observed of some peculiarities of the having characterized soils being common. All these indicate the usefulness of separately characterizing of the results for

each soil type of our investigations, carried out in different stationer squares. There are located 11 stationer squares on 4 profiles in the objects of our investigations (picture 11).

Picture 11.
Locating scheme of stationer squares in dealluvial plates of southeast Shirvan.

Profile 1

S q u a r e 2 3 0. This square is located in the inclination part of spreading currant and ephemeral plants in the upper zone of dealluvial plates in the Gurovdagh massif. The soil of it is clayey. Majority of salts accumulated below the depth of 30-40 *cm*.

Humidity is more dynamic in 50-60 *cm* upper layer of the soil. Beginning since the end of spring up to autumn, the amount of humidity in this layer of the soil diminishing, reaches 3-9%[1]. In autumn with much precipitations, its amount rises, reaching 17-18%. As it is seen from picture 12, the maximum amount of humidity in that thickness of the soil is 20-27%, which is observed in winter months.

Below this layer, having got very dynamic humidity up to 50-60 *cm*, the amount of humidity is mainly stable. The amount of humidity changes very little from here up to two-meter depth (between 10-12%). Very rarely, especially in the depth of 170-200 *cm*, the amount of humidity diminishes relatively, reaching 13-14%.

S q u a r e 231 is located in slowly inclination even plain area, covered with alfalfa plants in the middle zone of dealluvial plates[2]. The mechanical composition of the soil in 60-70 *cm* upper layer is clay and below it – clayey. The amount of salts in 20-30 *cm* upper layer is less (0,3-0,5%), in the lower layers – more (1,2-1,5%).

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[1] *Humidity is given by percent on absolute dry soil.*

[2] *Thesquares on the 1st and 2nd profiles are located in delluvial plates of Gurovdagh.*

Picture 12.
Chrono-isoplets, indicating the dynamics of humidity in square 230.

The dynamics of humidity looks like of square 230. The only distinguishing peculiarity of them is relatively thickness of upper layer with humidity dynamics here. Minimum humidity in 10-*cm* upper layer is observed in June-October. Increasing in autumn, the amount of humidity reaches 20-23% in winter months, against 12-16% in autumn in one-meter layer of the soil. As in square 230, the changing of humidity in soil layer, located lower than the dynamic one is very stable. Although the amount of humidity is relatively high here, it changes in very narrow scale (15-19%, picture 13).

Thus, in spite of corresponding of the dynamics of humidity and the regime in both squares, nevertheless, there is a great difference in amount of humidity. Having relatively more humidity in square 231 is explained by less inclination and absorbing much of dealluvial currents to the ground.

S q u a r e 232 is located in spreading area of saline plants of **statice-sricta** kind in the train zone of dealluvial plates. Its soil is clay, having saline-like salt profile. According to the regime of humidity, this square sharply differ the above-mentioned ones.

Maximum humidity (more than 20%) appears in one-meter layer of this soil in winter and early spring months. Minimum humidity is observed since June up to October. The amount of humidity in 20-*cm* upper layer diminishes to 3-7%, waving between 10-14% in 20-50-*cm* layer.

Picture 13.
Chrono-isoplets, showing the dynamics of humidity in square 231.

As it is seen from the graphics (picture 14), the middle layer of the soil is characterized by stable and mild humidity. Humidity in this layer can considerably change only in years with much rain. Changing limit of humidity in other years is very little (15-20%).
The characteristic feature of this square is its having maximum humidity in low layers of the soil.
Thus, according to the regime of humidity, the soil here is divided into three main layers: 1) the upper layer of the soil, having relatively little humidity and high dynamics; 2) the middle layer of the soil with mild humidity and stable dampness; 3) the low layer of the soil, having high degree of humidity and relatively dynamic damping.

Picture 14.
Chrono-isoplets, indicating the dynamics of humidity in square 232.

S q u a r e 233 is located in the even plain area with currant and ephemeral plants of the train zone of dealluvial plates. Its soil is mechanical composition with clay. Highly degree salinity begins from the depth of 30-*cm*.
Gradual increase of humidity towards the lower layers of the soil is its characteristic feature. According to changing of humidity, the soil is dynamic on all profile.
40-60 *cm* of upper layer of the soil is characterized by minimum humidity in summer months (5-8%), mild – in autumn and spring months (10-12%) and maximum (more than 20%) in winter months (picture 15).

Picture15.
Chrono-isoplets, indicating the dynamics of humidity in square 233.

It can be said that, the upper layer of the soil gets humid of high degree all year long. During the years of observations, the amount of humidity here hesitated between 15-19%.
Maximum damping (in amount of 20-25%) is observed in low layer of the soil. it gradually changes in different times of a year.

Profile 2

Stationer squares, having put here are located parallel to the stationer squares of profile 1. Profile 2 is located in dealluvial plates of Gurovdagh, in northwest, approximately 3 *km* aloof of profile 1.
Although s q u a r e 236 was located in the same natural condition with square 230, nevertheless, the presence of openly expressed, illuvial with high density layer caused sharply differing of humidity regime of square 230. Together with relatively dynamic of humidity in all profile of the soil, this or that layer has definite changing regulation. As it is seen from picture 16, there is little amount of humidity (5-10%) in low layers of the soil. relatively big humidity (11-14%) is observed in the middle layer. High degree of humidity (approximately 23%) is noticed during short period. It is especially met in winter (January-March) in 10-20 *cm* upper layer of the soil. Minimum humidity of 2-5% is observed since the end of spring, in

summer months. It must be mentioned that the process of drying of humidity in general covers 80 *cm* of depth.

Picture 16.
Chrono-isoplets, indicating the dynamics of humidity in square 236.

An average amount of humidity in the upper layer of the soil is noticed in spring and autumn months.
Thus, the described square is characterized by the presence of dry layer with very little humidity in the middle layer of the soil. The existence of this layer is explained by much inclination of the territory, causing less absorbing of precipitations and dealluvial currents to the ground from one hand, and secondly, the presence of illuvial layer, having firm denseness, in the soil.
S q u a r e 234 is located approximately in the same parallel with square 231 in the middle zone of dealluvial plates. The areas are mainly covered by currant plants. It has clay ground. The amount of salts in 20-30 *cm* layer is relatively little (0,5%) and in low layers – about 3%.
Humidity, being very high in deep layers of the soil during whole year and its dynamism on all profile is typical feature for this square.
High degree of evaporation, existing in the upper layer of the soil in summer months causes the diminishing of humidity up to 9-10%. Humidity begins to rise in the upper layer towards autumn. The amount of humidity in that layer reaches 15-18% then, reaching the maximum in winter months (20-22%). Changing of humidity in spring goes on approximately as in autumn (picture 17).

Picture 17.
Chrono-isoplets, indicating the dynamics of humidity in square 234.

Humidity is mainly stable in 50-150 *cm* middle layer of the soil. During all observation period, the amount of humidity here changes between 15-18%.
Humidity's being much more dynamic is observed in low layer of the soil. High degree damped counter here, at times disappear, or again shows itself due the seasons of year.
S q u a r e 235 is located in the even, plain area without any plant cover in the train zone of dealluvial plates. The soil is clay and mainly saline. 10-15 *cm* upper layer is relatively saline.
The presence of high humidity covering big depth (up to 150 *cm*) is typical for the upper layer of the soil in winter months. Humidity composes 20-25% in that layer during this period. Drying of humidity, covering relatively small depth (20-30 *cm*), is observed in summer months. Diminishing, the amount of humidity falls to 7% during this period.

Picture 18.
Chrono-isoplets, indicating the dynamics of humidity in square 235.

The amount of humidity changes between 12-17% in the upper layer of the soil, having named dynamic, in spring and autumn months.
The low layer of the soil is characterized by high and stable humidity during the whole of year (picture 18).
The presence of maximum humidity during all observations in the middle layer is typical in the soils of this place.

Profile 3

This profile of stationer squares is located in dealluvial plate of the Babazanan massif.

S q u a r e 238 s located in the clay-clayey soil area with increased alfalfa plant, having very little inclination than squares 230 and 236 in the upper zone of delluvial plate. There is very dense illuvial layer in the soil. High degree salinity mainly begins from 30-40 *cm* depth of the soil.

According to the regime, during all years of observations, 50-60 *cm* upper layer is characterized by being dynamic. Sometimes in August-October, its amount up to 70 *cm*, increasing gradually reaches 15-18%. Maximum humidity (up to 25%, sometimes even more) is observed in winter. The amount of humidity gradually diminishes in the characterized layer in spring months, reaching the minimum in summer.

Picture 19.
Chrono-isoplets, indicating the dynamics of humidity in square 238.

As it is seen from picture 19, the middle layer of the soil is characterized by the presence of stable humidity in all observation years. Having very little amount, humidity changes here in very small limits. It is explained by the influence of transpiration of alfalfa plants growing here.

Humidity, below the depth of 120 *cm*, has stable character. However, the amount of humidity is relatively much here.

S q u a r e 237 is located in even plain area of spreading of current plants in the train zone of dealluvial plate. Its soil is clay and saline-like.

The regime of humidity mainly corresponds with square 238. The only difference is in that that the upper layer, having got dynamic humidity, is thicker than this one (picture 20).

Picture 20.
Chrono-isoplets, indicating the dynamics of humidity in square 237.

Profile 4

This profile of stationer squares is located in dealluvial plate of the Harami Mountain. The inclination of the territory gradually diminishes from north towards south. Two stationer squares were placed here.

S q u a r e 239 is located in very inclined upper zone of dealluvial plate. Plant cover consists of currant and ephemeral plants. The territory had become complicated in a number of nameless ravines, having formed as the result of influence of dealluvial currents. 50-70 *cm* upper layer of the soil is clayey and low layers – sandy. However, it must be mentioned that the soil became so harder in the result of salinity process that it is even difficult to dig it by bore with sharp top. All of these caused to form defining humidity regime in the soils of this area. As it is seen from picture 21, the soils of the territory are characterized by their being dry of maximum degree during all year long. Due to the seasons of a year, dry soil layer here embraces different depth. It can be said that all profile of the soil becomes dry majority of time of a year. During very short period, there is observed only relatively more humidity in 40-50 *cm* upper layer of the soil. In this case, high degree humidity is observed in autumn-winter months, as in previous squares.

Picture 21.
Chrono-isoplets, indicating the dynamics of humidity in square 239.

Although being dry of the soil profile all year long, nevertheless, here is also noticed very dynamic character of humidity as well. If humidity dynamics in the upper layer of the soil is connected with the climate, obviously, in low layers, it is explained by the evaporation of humidity of different amount by the way of transpiration in the periods of vegetation of plants. In general, the dryness of the soil is explained by inclination of the territory very much and firm denseness of it.

S q u a r e 240 is located in even plain of saline area of the train zone of dealluvial plates. The last part of nameless ravines, which we have mentioned above, ends here. The mechanical composition of the soil is clay.

According to the regime of humidity, it sharply differs from square 239. Getting humid from the depth is typical for these soils. The amount of humidity changes between 15-20% in majority times of a year in the second-meter layer of the soil. Getting humid of one-meter upper layer of the soil is very dynamic. The amount of humidity here in autumn months is 10-12%, in winter – up to 25% here. Beginning since March, the amount of humidity gradually diminishes and since May up to September, diminishing sharply falls to minimum amount (to 3-8%). Getting dry of the soil in September (1956) covers 1,5 *m* of depth. The amount of humidity in that layer falls to 10-12% and in 30-*cm* layer – to 8% (picture 22).

Thus, we can make the following results, due the having said about the water dynamics.

The results of our three-year observations indicated that the water dynamics of the soils is tightly connected with the climate condition, the surface structure of the territory, the amount of dealluvial currents and interior peculiarities of the soils, having characterized by us.

Picture 22.
Chrono-isoplets, indicating the dynamics of humidity in square 240.

Annual changing of humidity in soils indicates that the dynamics of humidity carries a general character in different squares.

Connected with the influence of the climate and dealluvial currents, 40-60-*cm*, sometimes 70-80-*cm* upper layer of the soil is more dynamic in changing of humidity.

Humidity regime of soils in the upper zone of dealluvial plates carries changeable character, connected with water evaporation ability of currant plants with long roots.

In the soils of the middle zone of dealluvial plates, especially in the train zone, typically humidity is much in deep layers of soils, being very dynamic in the upper layer.

Thus, due to the dynamics of humidity, having characterized soils are divided into three main layers:

1. The upper layer of the soil in 50-80 *cm* of thickness with very dynamic humidity.
2. The middle part of the soil with stable humidity and very dry.
3. The low layer of the soil of 50-70 *cm* of thickness with high degree of humidity.

No doubt that in their turn, these features of the dynamics of humidity influenced the dynamics of salts as well.

The dynamics of salts in soils

We are going to explain the dynamics of salts due to above-mentioned succession.

Profile 1

In the soils of s q u a r e 230, the dynamics of salts is expressed relatively weak. Some relative dynamism is only observed in 60-*cm* upper layer of the soil.

During the years of observations in these soils, we noticed that the gradual increase of salts towards the low layers of the soil is typical. During the majority of observation period, the amount of salts in 40 *cm* upper layer was very little (0,1-0,2%). Some regulation is observed in dynamics of salts in the upper layer of the soil. In fact, not depending on the seasons of a year, the amount of salts at times rises, or diminishes (picture 23). Such regulation indicates itself in changing of the thickness of un-saline upper layer of the soils during the observation period.

Picture 23.
The dynamics of salts in square 230.

The changing of salts was expressed very sharply below the depth of 60 *cm*. If the contours, indicating salinity gradation at the beginning of the observation period, changed on straight line, then, in later periods, some of those contours disappeared for some definite time and showed themselves again. All of these indicate the difference of meteorological factors and dealluvial currents of the dynamics of salts in the soils in different tiles of a year.
S q u a r e 231. The dynamics of salts in this square resemble of square 230. Nevertheless, due to the regime of salts, they differ from each other very much.

Picture 24.
The dynamics of salts in square 231.

The dynamics of salts in 60-*cm* upper layer of these soils is expressed very weakly. It shows itself more openly in the contours, indicating gradations of 0,2-0,5 and 0,5-1,0%. These contours mainly changed on straight line (picture 24) during all observation periods.
The typical feature of the dynamics of salts in the square is because of salinity's being in the middle layer of the soil. There is felt the salts' being very dynamic of upper and somehow low and diminishing of their amount in considerable degree. Maximum salinity, existing in the middle layer of the soil, disappears during this period and the amount of salts increases towards the low layers gradually.
All of these indicate the special connection between water and salt dynamics in the soil.
S q u a r e 232. The direction of salinity gradations, existing in the middle layer of the soil in this square during long period is towards upwards. They get forms of cones like in low layers of the soil. Being dynamic of salts in the upper layers of the soil is typical. Here, in different observation periods, salts gradually, sometimes sharply diminish (picture 25). There is observed gradual diminishing of salts in the low layer of the soil as well.

Picture 25.
The dynamics of salts in square 232.

Such case caused the direction downwards in later stages of observation periods of contours, indicating different salt gradations in the soil.
Thus, the explanation of salts' dynamics indicates that although gradual diminishing of salts towards low layers of the soil here, the soil profile subjected of washing process.
S q u a r e 233. The dynamics of salts in the soils of this area carries out stable character and this stability is observed in all of the profile of these soils. First of all this regulation shows itself openly in the increase of the amount of salts from the upper layers of the soil towards the lower ones during all observation period (picture 26).

Picture 26.
The dynamics of salts in square 233.

The rise of salts in the soil is observed in summer months, diminishing – in winter ones.

Profile 2

S q u a r e 236. Salts' being dynamic in the soils of this area towards lower layers is typical here. The dynamics of salts in un-saline upper layer of the soil mainly changes on straight line.

Picture 27.
The dynamics of salts in square 236.

Salts compose the maximum amount (more than 2%) during long period in the middle layer of the soil.

As it is seen from picture 27, although the gradual diminishing of salts in the second half of the observation period, nevertheless, in this state, their maximum amount is observed in the middle layer of the soil during short period.

S q u a r e 235. The soils of this area differ from the above-mentioned ones by salts' being very dynamic on all profile. The dynamism of salts here is especially openly observed below of 70-*cm* depth of the soil in this case.

The dynamism of salts in the upper layer of the soil goes on very gradually. Being very little in this layer of the soil, the amount of salts changes in very little limits.

The typical feature of this area is the presence of maximum amount of salts in the middle layer of the soil during the observation period. The amount of salts is relatively little below this layer (picture 28).

Picture 28
The dynamics of salts in square 235.

Subjected to great changes of contours, indicating of 0,2-0,5% and 0,5-1,0% salinity in the soil during different periods and disappearing one of them sometimes show their having subjected to washing process of these soils during much precipitations.

S q u a r e 234. Apart of not very thick middle layer of the soils of this area, the dynamism of salts is typical in all profiles during all of a year.

Although having accumulated relatively more of salts in 30-*cm* upper layer of the soil in September (1955) and February (1956), then, their amount gradually and during winter-spring months of 1956, sharply diminishing reached the minimum.

Salts are present in maximum amount in the upper layer of the soil. Their dynamism is very stable.

One more feature of the soils of this area is relatively little presence of salts in its 80-150-*cm* layer during the observation period. The amount of salts, locating in the layers below and above of this depth, is very much (picture 29). It is explained by the lightness of mechanical composition of the soil in that layer from one hand, and from the other, by the diffusion process, existing here.

Picture 29.
The dynamics of salts in square 234.

It can be said that the deep layers of the soil is characterized by the presence of maximum amount of salts during all observation years.

Being dynamic of salts below of 1,5 *m* of depth is other characteristic feature of the soils of this area. The curve, indicating the changing of salts here, is very changeable, embraces the soil layer of different thickness, due to the seasons of a year.

Profile 3

S q u a r e 237. Characteristic feature of the dynamics of salts here is u-salinity of the upper layer of the soil and hesitation of salts between 0,1-0,2% during the period of observation. Washing of salts in this case is observed in winter months and their relatively rise in summer months (picture 30).

The amount of salts in lower layers gradually increases. In this case, the dynamism of salts in the middle layer of the soil is very little, in deep layers – relatively more. Maximum amount of salts, hesitating between 2,5-3,0%, sometimes even more than 3%, is noticed in deep layers of the soil. Although the amount of salts is comparatively stable here, nevertheless, the contour, indicating that amount, at times rises in the profile or falls due to the seasons of year.

S q u a r e 238. In general, the dynamics of salts here looks like of square 237. However, the soils of this area have their own peculiarity. This is indicated in less thickness of un-saline upper layer of the soil and their much dynamism in this layer.

Picture 30.
The dynamics of salts in square 237.

During the autumn, winter and spring months of 1956-57, together with some diminishing of the amount of salts, there increased the thickness of that un-saline layer. The increase of salts was observed in the having characterized layer during the autumn-winter months of the following year. The contour, indicating 0,1-0,2% in the upper layer of the soil disappeared this time and it was replaced by the contour, indicating of 0,2-0,5%.

Picture 31.
The dynamics of salts in square 238.

Although reappearing of the contour, indicating of 0,1-0,2% of salinity in summer months, the thickness of the layer, having embraced by that contour, diminished very much.

The dynamics of salts below the upper layer of the having characterized soil mainly changed as in squares 237.

Profile 4

Although the presence of some dynamism in changing of salts during different periods of a year in the soils of square 239, the amount of salts in separate layers carries a stable character. As it is seen from picture 32, the amount of salts towards the low layers of the soil gradually rises during the years of observation.

Picture 32.
The dynamics of salts in square 239.

The upper layer of the soil didn't get saline and the amount of salts here during the period of observation was less than 0,2%. Although the dynamism was not noticed very much in changing of amount of salts, nevertheless, it was openly indicated in changing of the thickness of the un-saline upper layer of the soil during different periods of a year.

The dynamics of salts in the low layer of the soil is mainly as of its upper one.

S q u a r e 240. It differs from square 239 by less thickness of un-saline upper layer of the soil and having the amount of salts here approximately two times more. From the other point, much salinity of the soils of this area is typical. Although the gradual rise of salts towards the low layers of the soil, it is typical of their maximum accumulation in the middle layer of the soil during separate periods. The amount of salts in the above and below of this is very little (picture 33).

Thus, it must be noted that all upper layers of the having described soils are characterized by very little salinity.

Picture 33.
The dynamics of salts in square 240.

The soils of some squares are distinguished by the accumulation of maximum amount of salts in the middle layer of the soil.
In general, the increase of salts towards the lower layers of all soils is typical.

Common results of water-salt dynamics of the soils

Looking through water-salt dynamics of the having characterized soils together, there can be mentioned the following:
Water-salts dynamics of the soils of having described region changes due to sloping of the territory.
According to water-soil dynamics, the soils of having investigated squares are divided into three main groups:
The soils of the squares (236, 239) located in the upper zone of dealluvial plates are included to the first group. The humidity of the soils of this area has un-washable character. In fact, as the result of the influence of atmospheric precipitations and dealluvial currents, although the presence of relatively more of the amount of humidity in the upper layer, nevertheless, the amount of humidity in low layers of it is very little.
It must be noted that there is contrary dependence between the dynamics of humidity and the dynamics of salts. In fact, although the amount of salts reduced to zero (less than 0,2%) in the upper layer of getting much humid soil, then, in the low layer of the soil with extremely less humidity the amount of salts composes majority (1-2).
Soils, spreading in the middle zone of dealluvial plates and partly in the train zone include to the second group (squares 230, 231 and 237). These soils are characterized by much dynamism of humidity and salts in the upper layer. The thickness of dynamic upper layer of the soil here is approximately two times more than in upper zones of dealluvial plates. Although comparatively less dynamism of humidity and salts in low layers of the soil, their amount is very much.
Soils, spreading in the train zone of dealluvial plates (squares 232, 234, 235, 238 and 240) are included to the third group. According to the regime of both humidity and salts, the soils of this area are distinguished by their dynamism on all of the profile. Both amounts of humidity and salts here is more in comparison with previous zone. Although of the gradual increase of salts towards the lower layers of the soil, their maximum amount is in the middle layer of the soil during all observation years.

THE MELIORATION OF SOILS, HAVING GOT SALINE IN DELLUVIAL FORM

About the washing practice of saline soils

The washing process of saline lands in Azerbaijan began almost since 1930. This work was carried out in three areas in Mughan experimental station (Jafarkhan), in Garachala state farm and in the Southern Mughan. At present, considerable practical materials were collected in the field of washing of saline soils and important results were got of them. These results, having got from Azerbaijan and as well as from other regions of the USSR, were properly lightened (V.A.Kovda, V.R.Volobuyev and others). The work "Washing of Saline Soil" (V.R.Volobuyev, 1948) is especially important. Generalizing of all materials, having dedicated to the washing of soils, V.R.Volobuyev indicated active and passive forms of motions of salts. When saying an active form of salts' motion, the author takes into consideration of their displacement in the soil by the way of diffusion. Washing of salts by the influence of waters is the passive motion of salts.

Making better of saline lands in melioration is mainly carried out by passive motion of salts. It can be said that this work is mainly done by washing of salts in the conditions of simply plough-making (turning over of plough layer). No doubt, that this method gives positive result in the melioration of soils having got saline by dealluvial-alluvial way. We also carried out our experiments by this way in the melioration of soils having got saline by dealluvial form firstly. The way, results of which we will explain later, doesn't give positive result in the melioration of soils having got saline by dealluvial form. That's why, we had to carry out our later experiments by other way.

We carried out our experimental works referring of the washing of soils in Siyazan-Sumgayit, Gurovdagh massifs and in dealluvial plates of Bozdagh (Subsidiary worker equipment state farm in the Mingachevir region). In order to make the results of our experiments more reliable, these works were carried out in two typical soils fields of each object. Although the experiments were carried out in soil areas with salinity of dealluvial form, nevertheless, the difference of natural soil condition caused the diversity of the results. That's why, we will explain experimental results of each object separately.

The way of experiments

As simple plough (turning over of plough layer) didn't give good results in washing of soils having got saline by dealluvial form, we approached the washing of these soils by other way.

As saline lands of dealluvial form usually have bad physical-chemical peculiarity, we firstly considered expedient to make deep (40 *cm*) plough in their washing. Majority of salts usually accumulate below plough layer. That's why, we couldn't carry out simple deep plough in washing process. In fact, in this case, salts in big amount in the low layer of the soil could be turned to the upper layer of the soil. Thus, washing of plough layer, which was not saline before and got artificially saline layer by us, will be irrational labor and expenses. That's why, when washing o soils having got saline by dealluvial form, we considered important to carry out plough works without turning over of the upper layer of soils.

Experiments were carried out according to the following variants:

1. Washing of soils without drainage;
2. Washing of soils in drainage background;
3. Washing of soils in monoliths;
4. Washing of soils by carrying of tier plough;
5. Washing of soils after giving of 5 tons of gypsum to each *ha* of soils;
6. Washing of soils after giving of 15 tons of gypsum to each *ha* of soils;
7. Washing of soils after giving of 10 tons of gypsum and 40 tons of manure to each *ha* of soils.

There was not carried out the 4th and 5th variants of experiments in Gurovdagh massif and in dealluvial plates of Bozdagh and the 7th variant – in Siyazan-Sumgayit massif.

Pictue 34.
The scheme of location of experiments.
1 – drainage; 2 – washing of soils in drainage background; 3 – washing of soils without drainage; 4 – washing of soils in the field after giving of 15 tons of gypsum to each *ha*; 5 – washing of soils in the field after giving of 10 tons of gypsum and 40 tons of manure to each *ha*; 6 – the place from where the soil samples were taken; a – after the first irrigation; b – after the second irrigation; c – after the third irrigation.

The bigness of each experiment bed was 10-15 m^2. There were accepted three irrigation norms for each variant of the experiment (There was carried out only one irrigation norm in the variants of Siyazan-Sumgayit massif with gypsum giving).

1. The first irrigation norm of giving of 4000 m^3 to each *ha*.
2. The second irrigation norm of giving of 8000 (4000 + 4000) m^3 to each *ha*.
3. The third irrigation norm of giving of 12000 (4000 + 4000 + 4000) m^3 to each *ha*[1].

As the experiments were carried out during summer period in Siyazan-Sumgayit massif, woods were put on the beds and they were covered by thick grass after the use of each irrigation norm.

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[1] *When saying the first, the second and the third irrigation in the explanation of the experiments, it is considered irrigation norms having given by 4000, 4000 + 4000, 4000 + 4000 + 4000 m^3 to each ha.*

WASHING OF SOILS HAVING GOT SALINE IN DELLUVIAL FORM

Experiments, carried out in the Siyazan-Sumgayit massif

The experiments in the Siyazan-Sumgayit massif were carried out in the territories of the collective farms named after N.Narimanov and Kalinin. The work in this massif was carried out together with A.Sh.Bibarsova, candidate of agricultural sciences. Junior scientific worker Sh.H.Tahirov and chief laboratory assistant I.Sh.Iskandarov also took part in carrying of the experiment. Sh.H.Tahirov was busy with washing of soils in the monoliths having taken by us. I.Sh.Iskandarov took part in the works of field experiments only for 10 days.

The results of experiments, carried out in the collective farm named after N.Narimanov in Siyazan region

a) Natural soil condition of an experimental field. Experiments are located in the even plain area of old plough place having covered by currant plants in the train zone of dealluvial plates. The surface of experimental field having got grey-like brown soils was complicated with a number of wide clefts. Morphological peculiarities of the soil are distinguished by the following:

A 0-11 *cm* – grey-like brown, heavy clayey, prism-like, hard, passage open;

B_1 1-28 *cm* – clear grey-like brown, heavy clayey, very hard, pillar-like, small roots of plants, dry, gradual passage;

B_2 43-61 *cm* – grey, heavy clayey, pillar-like, very hard, weak humidity, clear passage;

C_1 61-92 *cm* – brown-like, clayey, small veinlets of gypsum in the form of very hard druz, less humidity, gradual passage;

C_2 92-107 *cm* – grey-like brown, light clayey, soft-like, a number of gypsum crystals, humid, gradual passage;

C_3 107-125 *cm* – looks like the previous layer, with some light color and less amount of gypsum, clear passage;

D 125-150 *cm* – blue-like grey, clayey, soft-like, rare gypsum veinlets, less humidity.

As it is seen, their passage in separate layers of the soil is clear and sometimes sharp. There exist wide clefts in 62-*cm* upper layer. The volume weight of the soil is relatively less in the upper layer (1,14), increasing sharply towards the lower layers (table 4).

Table 4

Volume weight and mechanical composition of the soils of the collective farm named after N.Narimanov in Siyazan region

As it is seen from the table, according to mechanical composition, the middle layer (43-92 *cm*) especially differs. The amount of physical clay here is more than 80% here. This indicates that that soil is saline of some degree. Having a big amount of Na kation in its absorber complex especially proves the salinity of the soil. The amount of having absorbed Na in the soil composes 26% of the absorbed essences.

Although that the amount of salts in 43-*cm* upper layer is about 0,2%, reaching 0,52-0,85% it sharply rises in lower layers. As it is seen from table 5, the maximum amount of salts in the soil (1,344%) is observed in its 92-107-*cm* of depth.

HCO_3 prevails in the upper half-meter layer of the soil and in low layers – SO_4, Na and Cl ions. Thus, the soil got saline in hydro-carbonate-chloride-sulfate-sodium composition.

Table 5

The results of analysis of water extract in the soil before washing of the collective farm named after N.Narimanov in Siyazan region

b) Washing of soils without drainage and in the background of drainage. The results having got from these variants of experiments mainly were analogous. That's why, we give their explanation together.

Before speaking about washing of salts in these variants, let's deal on absorbing of irrigation waters into the soil and dynamics of humidity.

Water could penetrate to 75-*cm* of depth of the soil after the first irrigation. Leaking of water to the sides of experimental beds embraces 28-*cm* of distance. Water approximately could penetrate to 120-*cm* of depth of the soil after the second irrigation. At the same time, leaking of water to the sides of the beds embraced rather big distance (123 *cm* in 10-*cm* depth, 80 *cm* in 40-*cm* depth). Absorbing of water in the third irrigation penetrated to the depth of 170 *cm*, but leaking to the sides of beds mainly didn't change.

Samples of soil were taken from one-meter of depth after the first and second irrigations and after the third one – from a meter and a half of depth. As it is seen from table 6, there were great changes in amount of humidity during the washing of soils. This change was mainly observed in the depth of absorbing of water to the soil. It must be mentioned that the increase of humidity in the soil was especially openly noticed in half-meter upper layer after the first and second irrigations. The noticeable rise of humidity of the soil after the third irrigation occurred in deeper layers of the soil as well.

Table 6

The dynamics of humidity in washing of the soil of the collective farm named after N.Narimanov in the Siyazan region*

Although of leaking of water from the beds in experimental fields, but it didn't pass to drainage. It is obviously explained by salinity of the soil in high degree.

**Here and in later explanations of experiments, amount of humidity is given with % in absolutely dry soil.*

Table 7

The dynamics of humidity in washing of the soils of the collective farm named after N.Narimanov in the Siyazan region*

**In the tables, where CO_3 ion is not indicated, we defined their absence in the result of analysis.*

Speaking about washing of salts, we must mention that there is observed very little diminishing of them up to one-meter of depth of the soil after the first irrigation. Although of washing of dry remainder in very little amount in this case, nevertheless, the amount of chloride composed very big amount (more than two times). One-thirds of dry remainder in half-meter upper layer of the soil after the second irrigation mainly was washed away. There was not considerable change in amount of chloride (table 7). Amount of salts increased very much in the second half-meter layer of the soil. The third irrigation didn't give the expected result. So, in spite of washing of salts in the soil profile, there was observed their restoring in the upper half-meter layer. There occurred some changes in amount of HCO_3 ion in the soil during the process of washing. Although this change wasn't noticed in experimental beds in the background of drainage, then, it appeared considerably much in the beds without drainage.

c) Washing of soils by carrying out of plough with stage in them. Carrying out experiments in this variant, the upper ten *cm* layer was taken and put away part by part as carefully as possible, then 30-*cm* low layer softened and taken aside and then the previous 10-*cm* layer was put in its place and the soil was given one water norm (by 400 m^3 to each *ha*). The results having taken from this version of the experiment are given in table 8.

Table 8

Washing of the soils with carrying of staged plough in the collective farm named after N.Narimanov of the Siyazan region (by %)

As it is seen from the table, waters having given to the soil caused washing of salts in definite degree. However, in this case chloride was washed more in comparison with dry remainder. In fact, if chloride was washed more than three times in half-meter layer of the soil, then, there was very little change in amount of dry remainder. Such kind of comparison in comparatively less amount is noticed in 50-80-*cm* depth of the soil as well. It must be mentioned that the having spoken versions could not influence the dynamics of humidity of washing of soils. In fact, as it is seen from table 9, high humidity was only observed in 50-*cm* upper layer of the soil.

Table 9

The dynamics of humidity in washing of soils with carrying out of staged plough in the collective farm named after N.Narimanov of the Siyazan region

d) Washing of soil in monoliths. Washing of soil in monoliths gave more qualitative result. It is seen from the figures of table 10 that the washing of salts went up to the depth of one meter.

Table 10

Washing of the soil in monoliths (by %)

Washing of salts was especially much more in the second half-meter layer of the soil. Chloride was washed very much in comparison with dry remainder. In fact, washing of dry remainder in one-meter layer was twice and chloride – about 5 times.

d) Washing of soils with giving of gypsum in the account of 5 and 15 tons to each *ha*. The results of these versions of experiments are explained together. As it is seen from table 11, giving of one water norm in the account of 4000 m^3 to each *ha*, not only influenced the washing of salts away from the soil, even increasing of the amount of salts in the upper layer of the soil. This increase was even more observed in the field, where was given 15 tons of gypsum to each *ha*. This state is explained by the rise of the amount of salts because of solution part of the gypsum having given to the territory.

Table 11

Washing of the soil in the field with gypsum of the collective farm named after N.Narimanov in the Siyazan region (by %)

Table 12

The dynamics of humidity in washing of fields with gypsum of the collective farm named after N.Narimanov in the Siyazan region

As only one water norm was used in the field with gypsum, we could not correctly define the dynamics of salts in the soils in comparison with the previous versions.

It must be mentioned that the giving of gypsum caused the increase of water permeability ability and humidity of the soil. This gave more positive result than of the soil with giving of 15 tons to each *ha* area (picture 35 and table 12).

Picture 35.
The influence of the soil with gypsum to water permeability in the collective farm named after N.Narimanov of the Siyazan region
1 – control; 2 – field, with 5 tons of gypsum to each ha; 3 – field, with 15 tons of gypsum to each ha.

Experiments, carried out in the collective farm named after Kalinin of the Sumgayit region

a) *Natural soil condition of the experimental field.* The soils of the experiment field having located in the area of sloped plain region are grey-brown lands, having formed on dealluvial drifts, covered with alluvial deposits. Very low harvest is taken from grain-crops having cultivated in the field. Morphological description of the soil is given below:

A 0-33 *cm* – grey, clayey, prism-like, soft (plough layer), prism-like forms are noticed in separate big clods, dry, sharp passage;

B 33-54 *cm* – clear chestnut, heavy clayey, big pillar-like, hard, humid, clear passage;

C_1 54-78 *cm* – chestnut, clayey, soft-like, with gypsum, humid, gradual passage;

C_2 78-109 *cm* – clear-chestnut, clayey, separate point formed, hard, gypsum clods, weak humidity, gradual passage;

C_3 109-130 *cm* – alike previous layer, somehow clear color, with light mechanical composition and much amount of gypsum;

D 130-160 *cm* – alike previous one, without gypsum, with somehow clear color.

Increasing towards low layers of the soil, the maximum amount of salts (1,07%) is accumulated in the depth of 109-130 *cm*. Cl and Na ions prevail here. As it is seen from table 13, chemical composition of the soil is of hydro-carbonate-sulfate-chloride-sodium.

Table 13

The results of analysis of water extract before the washing in the collective farm named after Kalinin of the Sumgayit region

Table 14

Mechanical composition of the soil before the washing in the collective farm named after Kalinin of the Sumgayit region

Mechanical composition of the soil in one-meter upper layer is heavy clayey and clayey – in low layers (table 14).

b) *Washing of soils without drainage.* As it is seen from table 15, dry remainder and chlorine in the soil were subjected to washing after the first irrigation. In this case, amount of chlorine in one-meter upper layer diminished more than four times. There was relatively less change in the amount of dry remainder. Amounts of dry remainder and chlorine in half-meter upper layer increased some more after the second irrigation.

Although of relatively rising of chlorine in the second half-meter layer, the amount of dry remainder diminished. In comparison with the first irrigation, the amount of chlorine increased for three times in one-meter layer.

In spite of somehow washing of salts in half-meter upper layer of the soil after the third irrigation, there was noticed the rise of salts in the second half-meter layer. Amount of chlorine changed towards rising in one-meter layer.

c) *Washing of soils in the background of drainage.* It must be mentioned that there was got the results alike the sums of the previous experiment version (see table 16). It must be indicated that the dry remainder in half-meter upper layer of the soil here was washed somehow more and in the second half-meter layer – less in comparison with experimental version without drainage. However, the diminishing of salts in one-meter layer was averagely the same with the previous experimental field. The second irrigation norm gave an unexpected result. In fact, salts not only weren't washed in this case, in the contrary, increasing their amount became even more in the soil than before the second irrigation. Although of somehow washing of salts during the third irrigation in comparison with the second one, nevertheless, it was more than the previous amount. It must be mentioned that in both versions of experiments, the regulation of salt changing is similar in definite degree to the dynamics of humidity in the washing process. As it is seen from table 16, the considerable increase of humidity after each irrigation occurred in 50-75-*cm* upper layer of the soil. Their amount didn't change as far in the low layer. That's why, this state caused rising of salts to the upper layer of the soil by the way of diffusion.

Table 15

Washing of soils without drainage and in the background of drainage in the collective farm named after Kalinin of the Sumgayit region (by %)

Washing of soils without drainage

Washing of soils in the background of drainage

c) *Washing of soils in the fields with giving of 15 tones of gypsum to each ha.* As it is seen from the graphics (picture 35), the washing process in the field with giving of 15 tons of gypsum sharply increased water permeability of the soil in 33-*cm* upper layer of the soil.

Table 16

The dynamics of humidity in having washed soils of the collective farm named after Kalinin of the Sumgayit region

Water permeability of the soil in that layer with 5 tons of gypsum to each *ha* increased very little. The similar result was taken in the 33-50-*cm* of layer of the soil. In fact, water permeability of the soil with 15 tons of gypsum to each *ha* in the mentioned layer increased much in comparison with 5 tons of gypsum – less. All of these were clearly reflected in the presented curves.

Picture 36.

Influence of gypsum to water permeability of the soil in the collective farm named after Kalinin of the Sumgayit region.

Table 17

Changing of humidity in having washed soils of the collective farm named after Kalinin of the Sumgayit region

The increase of water permeability of the soil at the same time influenced the dynamics of humidity. It is seen from the figures of table 17 that, amount of humidity in 60-*cm* upper layer with giving of 15 tons of gypsum to each *ha* increased much more in comparison with control than in the field with 5 tons of gypsum – relatively less.

Experiments, carried out in the Girovdagh massif

a) Natural soil condition of the experimental field. Experiments were located in grey-like brown, saline soil field having formed under wormwood plants of slightly sloped plain in the middle zone of dealluvial plates. Morphological features of the soil consists of the following:

A 0-14 *cm* – grey, clayey, prism-like, hard, roots and rootlets of plants, dry, clear passage;

B_1 131 *cm* – brown-like grey, clayey, hard, big, pillar-like, rare plant roots, dry, gradual passage;

B_2 31-56 *cm* – dark brown, clayey, small, pillar-like, hard, humid, sharp passage;

C_1 56-80 *cm* – dark brown, clayey, without structure, hard, a lot of gypsum concentration, humid, gradual passage;

C_3 109-143 *cm* – brown-like, clayey, soft, humid, rare spots of gypsum, clear passage;

D 143-200 *cm* – clear brown, clayey, soft, humid.

In order to make easy the results of experiments in comparison with the initial condition of the soil, the samples were taken not from genetic layers, but from definite depths.

There is definite discrepancy between the names having given due to mechanical composition and results of the analysis in morphological description of the soil.

It can be seen from the above given morphological description and from table 18. According to the figures of the table, the soil is clayey and heavy clayey on all of the profile. The heaviest layer due to the mechanical composition is the fifth layer of the soil. The amount of physical clay here is more than 80%, which, obviously, is explained by salinity of the soil.

Table 18

Mechanical composition of the experimental field soil in the Girovdagh massif

Table 19

Amount of having absorbed substances in the experimental field soil of the Girovdagh massif

It becomes clear from the figures of table 19 that the amount of absorbed Na in the upper layer of the soil composes about 5% of all absorbed substances and in lower layers – 10-24%.

Although of prevailing of the absorbed Ca in the soil, composing of Na a big amount indicates being saline of high degree of that land. In its turn, this is proved due to the results of morphological description and micro-aggregate analysis of the soil. As we know, micro-aggregate composition of soil is the main factor of defining of its structural degree. It is seen from table 20 that the dispersion degree in half-meter upper layer of the soil of having described lands is very high. The dispersion degree of the soil here is more than 60-70%. Its amount is very little in low layers. It indicates of not having high water solidity of aggregates in those lands.

Table 20

Micro-aggregate composition and dispersion degree of the experimental field soil in Girovdagh massif

The soil got high degree of saline. Salts sharply increase towards the low layers of the soil. In fact, having got of 0,36% of amount in the 10-*cm* upper layer, the amount of salts reaches 0,96, 3,16% in lower of it layers. As it is seen from table 21, Cl and SO_4 anions and Na ions prevail there. S_1 ion prevails in one-meter depth, below of that depth – SO_4 ions. HCO_3 is much (0,052-0,122%) in the upper layer of the soil and less – below. The amount of Ca sharply increases towards low layers of the soil. Corresponding to it change was defined in amount of Mg. Thus, the soil got saline in the composition of sulfate-chloride-sodium.

b) Washing of soils without drainage and in the background of drainage. It was defined from the results that the results of these two versions of experiments were very similar to each other. That's why, here will be given only the explanation of the middle figure of them here.

Table 21

The results of water extract of the soil before washing in Girovdagh massif

It is seen from the figures of table 22 that there are specific results of washing of soils in this version of experiments. In fact, the amount of salts in half-meter upper layer of the soil was washed for more than a half. The washing of chlorine gave even more good result. Its amount diminished for about ten times in the mentioned layer. In the contrary, the amount of HCO_3 ion considerably diminished in one-meter layer.

The second irrigation norm couldn't influence positively to washing of salts in the soil. In this case, the amount of salts in half-meter upper layer very increased in comparison with the first irrigation. This growth was more than three times in chlorine. It must be mentioned that the amount of chlorine considerably diminished in the second half-meter layer of the soil. However, the amount of dry remainder increased in that layer, but diminished in the third half-meter layer.

Table 22

Wshing of soils without drainage and in the background of drainage in Girovdagh massif [middle figure of two versions (by %/m/equiv.)]

The results of the third irrigation norm indicate that during this period the growth of dry remainder in the soil went on. The growth was approximately two times in the first half-meter layer.

In spite of the growth of dry remainder during of the third irrigation, the amount of chlorine continued diminishing. However, the amount of HCO_3 ion considerably increased and in addition, CO_3 ion was formed there. Although existing after the second irrigation as well, its amount increased much more after the third irrigation (table 22). As it is seen from the table, the amount of the dry remainder diminished very much after the second and third irrigations. We think that it is explained by the accumulation of salts in the upper layer of the soils, having come from the low layers of the ground and by going on of diffusion process. Subjecting to the process of diffusion of salts can be explained by the following.

We have above mentioned that there is high salinity in these soils. That's why, waters of the first irrigation norm could penetrate to the low layers of the soil through wide clefts. Because of that, the first irrigation norm caused considerable washing of salts from the soil. Waters of the second and third irrigation norms absorbed into the soil very slowly (the second irrigation during 14, the third one – during 17 days). In its turn, it caused the swelling of mechanical fractions in saline soils and remaining of water in it. Waters having accumulated in big amount in lower layers of the soil created possibility of gradual dissolving of salts and their rising to the upper layer through capillary pipes. Climate of air, having high temperature here (the experiment began since the second half of March and finished at the end of April), also influenced the rise of salty solution from the lower layers of the soil to the upper one. All of these caused the going of diffusion process in the soil and re-salinity of the soil during the irrigation.

c) Washing of soil with giving of 15 tons of gypsum to each *ha*. Washing of soils in this version gave better result in comparison with the previous experimental field. It is seen from the figures of table 23 that the first irrigation norm influenced the washing of salts in 125-*cm* layer of the soil. Considerable amount of washing of dry remainder occurred in half-meter upper layer of the soil. It can be said that, washing composed half of salts in this layer. However, it must be mentioned that, although of washing of salts in half-meter upper layer, nevertheless, the amount of salts in 10-*cm* upper layer increased more than two times because of having given gypsum. Washing of salts of great amount was observed in the second half-meter layer of the soil as well.

Table 23

Washing of soils in the field with giving of 15 tons of gypsum to each *ha* in Girovdagh massif (by %/ m/equiv.)

Washing of chlorine gave better result. In fact, it diminished for 30 times in half-meter upper layer, more than three times in 50-75 *cm* layer. At the same time, there were definite changes in amount of HCO_3 ion. In comparison with the first irrigation, the second irrigation caused the washing of dry remainder up to half in 122 *cm* layer of the soil. Half-meter upper layer mainly became fit for plants. Having washed, chlorine went down to 0,01% in 75-*cm* soil layer. Diminishing of chlorine occurred in lower layers as well. There was observed the growth of salts below of 125-*cm* layer. HCO_3 ion diminished both after the first and second irrigations. Washing of dry remainder in the third irrigation was observed in all depths of the having investigated soils. 75-*cm* upper layer of the soil became fit for plants. Diminishing, the amount of chlorine fell down to 0,007-0,018% in one-meter layer of the soil. The change in washing of HCO_3 ion during the third irrigation was more interesting. So, HCO_3 not only washed away, in the contrary, its amount sharply increased. It is simply enough to indicate that the amount of HCO_3 composed 0,107% in 25-50-*cm* upper layer of the soil after the third irrigation, i.e. it grew for 5 times in comparison with the first irrigation and for 2,5 times – with the second irrigation. At the same time, the third irrigation norm caused of formation of CO_3 ion from all of the having investigated depth of the soil. Before explaining of changing of alkalis in this direction during the norm of the third irrigation, let's speak a little about the results of the analysis of water extract. In this case, it is more interesting the direction of the change of NaCl and Na_2SO_4 salts in the process of washing. As it is seen from table 24, there was a great change in chemical composition of the soil after the third irrigation. In this case, NaCl was completely washed in one-meter layer of the soil. Although of definite washing of Na_2SO_4 salt, nevertheless, it prevailed in the soil. $CaSO_4$ salt prevails in 0-10 *cm* layer. No doubt, that prevailing of $CaSO_4$ and Na_2SO_4 salts in the soil profile after washing is explained by artificial giving of gypsum to the soil.

Table 24

The results of analysis of water extracts of the soil after washing of the soils with giving of 15 tons of gypsum to each *ha* in Girovdagh massif

Thus, diminishing of HCO_3 ion in this version of the experiment during of the first and second irrigations occurred because of the having given gypsum.
In fact, entering the reaction with Na in the absorbed complex in the process of washing, the having given to the soil gypsum caused taking it away from the absorbed complex and diminishing of HCO_3 ion according to the following formula:

$$\mathbf{2NaHCO_3 + CaSO_4\ (oxlar)\ Ca(HCO_3)_2 + Na_2SO_4}$$

The growth of NCO_3 ion and re-forming of CO_3 ion after the third irrigation norm is explained by washing away and finishing of gypsum having given to the soil after the second irrigation norm and by formation of normal soda in the soil according to Gilgard's reaction during of washing process.

$$\mathbf{Na_2SO_4 + CaCO_3\ (oxlar)\ Na_2CO_3 + CaSO_4}$$

In this case, as A.P.Rozov indicated (1956), the re-formed soda is not dangerous so much. As easily dissolved in water other salts, it can easily be washed away from soils during following irrigation. However, it seems to us that in order to prevent the formation of soda in the soil after the third irrigation, it would be expedient of giving small doze of gypsum after the second irrigation.

d) Washing of soils in the fields of giving of 10 tons of gypsum and 40 tons of manure to each *ha*. In spite of alikeness of the results of this version with the results having got from the field with gypsum, some differentiating features also are noticed here. Washing away of salts in definite degree in the first irrigation norm was observed up to 125 *cm* of depth. However, washing of considerable degree occurred in 75-*cm* upper layer of the soil. The amount of dry remainder in this layer approximately diminished for three times. Diminishing up to nil degree practically, the amount of chlorine fell down from 0,410% to 0,027%. The amount of HCO_3 ion diminished up to half (table 25).
The second irrigation norm influenced the washing of salts more positively. Dry remainder in 1,5 *m* layer diminished more than two times and a half in comparison with the initial amount and for two times in comparison after the first irrigation. The amount of chlorine diminished for three and a half times in the mentioned layer. It must be noted that the 75-*cm* upper layer became fit for plants because of the amount of chlorine. A considerable diminishing in amount of HCO_3 ion was observed.
It is seen from the figures of table 25 that the third irrigation norm caused of becoming fit of one-meter upper layer of the soil for plants. The amount of chlorine in that layer grew a little. However, as this growth if very little, it doesn't procreate danger for development of plants.
The third irrigation norm presented undesirable result in changing of alkalis. In fact, their amount sharply increased in 1,5 *m* of depth of the soil. This growth was especially bigger in saline layer (in 25-75 *cm* layer) of the soil.
The results of analysis of water extract having given in able 26 indicate that there was observed the diminishing of ions in great amount in the process of washing. In spite of the growth of amount of SO_4 ion in this case, it again prevailed in the soil profile. Amount of Na ion sharply diminished. S_1 ion considerably diminished in 75-*cm* upper layer of the soil.

Table 25

Washing of soils in the field with giving of 10 tons off gypsum and 40 tons of manure to each *ha* in Girovdagh massif

Thus, after having washed the soil had the composition of hydro-carbonate-sulfate-sodium in this version of the experiment.

Table 26

The analysis of water extract after washing of soils in the field with giving of 10 tons of gypsum and 40 tons of manure to each *ha*

Diminishing of HCO_3 sharply after the first and second irrigations is explained by giving of gypsum to the soil. However, considerable growth of HCO_3 and reforming of CO_3 again after the third irrigation is explained by finishing of gypsum having given to the soil and rotting in definite degree of manure, which joins with Na_2SO_4 and $CaCO_3 + CO_2$ through its CO_2 excrete and forming of $NaHCO_3$ and Na_2CO_4 in the result of their reaction. That's why, in order to bar the growth of HCO_3 and the formation of CO_3 after the third irrigation in the soil, there must be given additional 3-5 tons of gypsum to each *ha* after the second irrigation or to carry the having defined gypsum norm to the calculation of 15 tons. It can be mentioned here that in this version of the experiment, the process of washing can be finished after the second irrigation. As 75-*cm* upper layer of the soil is practically free of salts in this case. For normal development of plants, usually there is demanded 0,3-0,6% of dry remainder and less than 0,04-0,06% of chlorine in 70-*cm* layer of the soil.

From his experiments, V.R.Volobuyev (1947) came to the conclusion that when the amount of chlorine was 0,04% in 75-*cm* layer of the soil in the conditions of the Salyan plain and about 0,05% in Northern Mughan, it doesn't influence negatively to high harvest of cotton. The author notes that having got of salinity up to 0,25% doesn't procreate danger for normal growth of cotton. All of these once again prove that in this version of the experiment, the works of washing of soils can be considered finished after giving of the second irrigation norm. In fact, in this state, the amount of chlorine diminishes to 0,02% and dry remainder is not more than 0,35% in 75-*cm* upper layer of the soil. These indicators show much thickness of having washed soil layer and considerably less of amount of salts than V.R.Volobuyev's suggestion.

The having presented suggestion about this version of experiments can be said about the experiment version with giving of 15 tons of gypsum to each *ha* as well. In fact, the amount of salts sufficiently diminishes after the second irrigation here too (see table 23).

Experiments, carried out in dealluvial plates of Bozdagh

Experiments in this object were carried out in two typical fields of the territory of Mingachevir Worker Supply State Farm (at present – an experimental field of the Azerbaijan Agricultural Institute). One of experimental fields was in the soils for the use of fruit trees, the other – in the soils, not used under plants. These fields will be named as the first (used) and the second (not used) in the text.

Experiments, carried out in the first field

a) *Natural soil condition of the experimental field.* Experiments were located in grey-like brown soil field of a fruit garden. Morphological features of the soil are the following.

A_1 0-10 *cm* – brown, clayey, prism-like, slightly soft, roots and rootlets of plants, dry, gradual passage;

A_2 10-27 *cm* – brown-like grey, clayey, hard, heap-like, hard, rare plant rootlets, clear passage;

B_1 27-48 *cm* – grey-like straw, clayey, hard, rare plant rootlets, weak humidity, gradual passage;

B_2 48-69 *cm* – with straw, slightly clayey, weakly expressed structure, hard, humid, gradual passage;

C_1 69-88 *cm* – brown, sandy, without structure, humid, gradual passage;

C_2 88-127 *cm* – grey-like brown, slightly clayey, rare gypsum vein lets, weak humidity, clear passage;

D_1 127-156 *cm* – looks like the previous one, but there is not gypsum here;

D_2 156-200 *cm* – grey-like straw, heavy clayey, humid.

Salinity degree of the soil increases towards lower layers. As it is seen from table 27, maximum amount of salts are accumulated in the middle layer of the soil. From the ions, Cl and SO_4 of anions and Na cations prevail there. The soil got saline in chloride-sulfate-sodium composition.

Table 27

The analysis of water extract before washing of the soil in the first experimental field

b) *Washing of soils in the background of drainage.* The result of the experiment indicated that the changing of salts during the washing of soils in the background of drainage is as in the experiments, carried out in this version of the objects, having characterized above. Nevertheless, due to some peculiarities the results of the mentioned version differ from the results of above-stressed experiments. This difference is openly seen from table 28.

It becomes clear from the table that the dry remainder in half-meter upper layer of the soil was washed very much in the first irrigation norm. However, there was noticed the growth of salts in 50-75 *cm* layer of the soil. The amount of salts diminished for two times and chloride – for three times in half-meter upper layer.

After giving of the second irrigation norm, washing of salts in 75-*cm* layer of the soil, though very little, but went on. However, in this case, relatively growth of salts was observed in 0-10-*cm* layer. Washing of the upper layer of the soil caused the great growth of salts in its lower layer (75-100 *cm*).

Table 28

Washing of soils in drainage background in the first experimental field

Washing of chlorine after the second irrigation norm gave much better result. In fact, its amount diminished more than two times in one-meter upper layer.

The third irrigation norm couldn’t influence positively to the washing of salts. As it is seen from the table, salts not only were washed in this case, but there was observed their rise to the upper layer of the soil.

There were some changes in amount of HCO_3 ion in the process of washing. It grew very much in the soils after the first irrigation. The growth for HCO occurred in 10-25 *cm* layer after the second irrigation. This growth in that layer was two times, in 25-50-*cm* layer – more than three times and a half. The third irrigation norm influenced to diminishing of HCO_3 ions in half-meter upper layer of the soil, increasing in the lower layers.

Changing of salts in this order is explained in definite degree by changing of humidity regulations in the soil. As it is seen from table 29, amount of humidity grew very much in 75-*cm* upper layer of the soil after the first irrigation. In this case, irrigation waters could pass into 62-*cm* depth of the soil.

Table 29

The dynamics of humidity in washing of the soil of the first experimental field

The depth of water penetrating during of the second irrigation embraced the 84-*cm* layer of the soil. In this case, amount of humidity grew much more in the soil profile.
The third irrigation norm could influence very little to the growth of humidity in the soil profile. The amount of humidity diminished very much in 25-*cm* upper layer in this case. The depth of water penetrating into the soil mainly didn't change. As it is seen from the table, the amount of humidity after all irrigations was much more especially in half-meter upper layer of the soil. Humidity composed very little amount in lower layers. In its turn, this state caused the diffusion process, re-salting the soil.

c) *Washing of soils with giving of 15 tons of gypsum to each ha.* When washing of soils by this version, from the first sight it seems to us that as if there is going the process of salinity in the soil. This is really so for 10-*cm* upper layer of the soil. In fact, the amount of dry remainder after the first irrigation grew more than one and a half times. However, below it, up to 75-*cm* depth, the amount of dry remainder diminished very much. As it is seen from table 30, the amount of chlorine also diminished very much in 75-*cm* upper layer of the soil after the first irrigation. This diminishing was more than two times and a half in the depth of 50 *cm*. Being the result of washing of upper layers of the soil, the amount of salts in 75-100 *cm* layer increased in considerable degree. The process of washing made some changes in amount of HCO_3 ion. The growth of dry remainder went on increasing in 10-*cm* upper layer after the second irrigation. At the same time, the growth of salts covered 10-25-*cm* layer as well. Washing of salts went on in the lower layers.
It must be mentioned that both after the first and second irrigations, the growth of salts is not so dangerous for the development of agricultural plants. In fact, because o giving of gypsum to the soil, dissolving, it caused the growth of amount of dry remainder. It is seen from the table that, because of chlorine, the second irrigation norm made the soil un-saline sufficiently. This time, chlorine was washed more than five times in comparison with the first irrigation.
The third irrigation caused the washing of dry remainder and chlorine much more in the soil. It must be mentioned that because of chlorine the soil got properly un-saline in this case. However, the amount of salts because of dry remainder in the second half-meter layer didn't diminish sufficiently. Although of having subjected of washing of dry remainder in 10-*cm* upper layer, nevertheless, its amount reached the previous level again.

Table 30

Washing of soil with giving of 15 tons pf gypsum to each *ha*
in the first experimental field

Changing of salts according to this regulation in definite degree is explained by water permeability of the soil and the dynamics of humidity.
As we know, first of all gypsum having given to the soil causes the growth of its water permeability. At the same time, results of our experiments also defined it. In fact, in comparison with the control, water permeability of the soil grew for five times in having gypsum area. This state also influenced the increase of the depth of water permeability. If the first irrigation water could pass into 62-*cm* of depth in the field without gypsum, then in having of gypsum it covered 125-*cm* of depth. The same comparison was defined after the second and third irrigations as well.
Improving of agro-physical properties of the soil in the fields with gypsum, in its turn, influenced the growth of water capacity in the soil. It can be seen more openly when comparing of the figures in tables 29 and 31. However, the amount of humidity in the upper layer without gypsum is seen comparatively more than in the upper layer of having given

gypsum. It is explained by taking and analyzing of soil samples from the fields with gypsum for 3-4 days later.

d) *Washing of soils with giving of 10 tons of gypsum and 40 tons of manure to each ha.* In this version of the experiment, each water norm having given to the soil caused the systematic washing of salts. It is seen from the figures of table 32 that, dry remainder and chlorine were washed away in half- meter upper layer of the soil after the first irrigation. In this case, there was observed the growth of the amount of salts in the second half-meter layer.

Table 31

The dynamics of humidity in washing of the soils with gypsum in the first experimental field

Table 32

Washing of soils with giving of 10 tons of gypsum and 40 tons of manure to each *ha* in the first experimental field

Going on of washing of dry remainder in 75-*cm* upper layer of the soil after the first irrigation, diminished for two times in comparison with its amount before the washing. Ions of chlorine and HCO_3 were washed away very much. However, the amount of salts increased considerably in 75-100-*cm* layer.

The third irrigation norm practically caused the salinity of 75-*cm* layer of the soil. In this case, the amount of chlorine was averagely less than 0,013% in one-meter layer, which is not dangerous for normal growth of plants.

It must be mentioned that amount of HCO_3 considerably increased in the soil after the third irrigation. As we've mentioned above, this, obviously, is explained by dissolving and disappearing of gypsum having given to the soil, after the second irrigation and gradual rotting of organic remainders, forming of carbonate gas. As it is seen from table 33, there was observed properly diminishing of other ions in the process of washing.

Table 33

The results of analysis of water extract after the washing of soils with giving of 10 tons of gypsum and 40 tons of manure to each *ha* in the first experimental field

The dynamics of humidity in this version of the experiment was as in the first version. However, amount of humidity was relatively less than in the previous version after any irrigation (table 34). It is explained by rapid absorbing of water into the soil in comparison with other versions and by taking of soil-samples at the same time with late absorbing of water and by subjecting of evaporation of humidity of the soil for a long period.

Table 34

Dynamics of humidity in washing of soils with giving of 10 tons of gypsum and 40 tons of manure to each *ha* in the first experimental field

Experiments, carried out in the second field

Experiments, carried out in this area in order to define its melioration condition by the Institute of Projecting of Water Economy of the Republic in 1946, made clear that here had to be carry out melioration measures in order to use these lands. Nevertheless, the state farm began using these soils without carrying out of melioration measures. That's why, in order to learn the changes having occurred in melioration states of the soils in this territory, we carried out investigation works in that field in 10 years (in 1955) there. Before speaking about the results of the experiments connected with it, we want to note briefly the changes having occurred in the soil since the period of beginning of the use of these lands.

The territory was mainly used for vine growing and fruit growing in the conditions of irrigation during 10 years.

There were much salt in lower layers of these soils before making of vine and fruit gardens. The amount of salts reached 0,32-0,89% in averagely 30-70-*cm* depth layer of the soils of vine growing. Sodium-chlorine salt prevailed there. It is seen from the figures of tale 35 that, the soil of the fruit garden got saline approximately in the same degree. In fact, having accumulated in the lower layer of the soil, majority of salts grows gradually below 50-*cm* layer and sharply from the depth of 130 *cm*. The upper layers of the soil got less saline than in vine garden. The amount of sodium-chloride salt gradually grows in the vertical direction of the lower layers of the soil.

Table 35

Salts in the soils before the use of them for vine and fruit gardens in the second experimental field

It must be mentioned that, plants in the vine gardens were cultivated in high agro-technical basement. In this state, there occurred correct carrying out of irrigation rules. Namely because of this, washing of salts from one-meter layer of the soil caused normal growth of grapevines. Washing of salts from the soil, one can see from the figures of tables 35 and 36.

Table 36

Amount of salts after the use of the soil of vine and fruit gardens in the second experimental field

Vine gardens

Fruit gardens

However, the situation in the experimental fruit garden is vice-versa. Fruit trees (peach, apricot, plum, cherry, quince, apple, pear and others) having planted here grew well during 4-5 years since having planted. However, later on, gradually getting dry, majority of them perished. Their getting dry is explained by disordering of agro-technical rules. In fact, the soils of this area are not softened, the field is watered very much and very often waters are allowed torrentially. The amount of irrigation especially grows in summer. Usually, waters are given once in five days to the garden, not regulating the amount of waters. The soil is not softened after irrigations. As the territory is not evened, a lot of waters having given to the area, don't spread equally. As high places don't get wet, it gets dry very soon. In some days, as the result of appearing of salts on the surface of the soil, the lands are covered with grey spots.

This state caused of re-salting of the soil. Physics-chemical peculiarities of the soil also influenced to re-salting of the soil. In fact, lower layers, being saline of high degree, pass waters through them badly here. Majority of salts in these layers are sodium-chloride salts, moving vertically towards the lower layers of the soil, dissolve easily in water. Namely because of this, additional portion of waters, having given to the soil during the irrigation time, passed into the lower layers of the soil, dissolved salts there and thus, caused of formation of saline solution there. Coming out through the capillary pipes to the surface of the soil, that solution evaporated and accumulating of salts on the surface, caused salinity of the upper layers very much. In fact, if the amount of salts was about 0,1% in 25-*cm* upper layer of the soil before forming a garden there, then, during the period after the use of the soil it grew, reaching of 0,3%. The amount of salts in 20-25-*cm* layer from 0,27% reached 0,92%. This growth especially was because of sodium-chlorine salts.

a) *Natural soil condition of the experimental field.*

Experiments were located in grey-like-brown soil field having formed on clayey dealluvial deposits in the being characterized fruit garden. Morphological peculiarities of the soil are characterized as following:

A 0-18 *cm* – grey-like ashy, heavy clayey, the surface of the soil is covered by a number of clefts, pile-like, very hard, plants' roots, dry, gradual passage;

B 18-44 *cm* – brown-grey, clayey, not clear, pillar-like, hard, rootlets, weak humidity, clear passage;

C 44-60 *cm* – dark grey, heavy clayey, hard-like, with gypsum, humid, clear passage;

D_1 60-83 *cm* – ashy-grey, average clayey, without structure, soft-like, weak humidity, gradual passage;

D_2 83-130 *cm* – grey-like brown, average clayey, without structure, soft-like, gradual passage;

According to mechanical composition, 60-*cm* upper layer of the soil is heavy clayey, lower layers – average clayey (table 37).

Table 37

Mechanical composition of the soils before washing in the second experimental field

b) *Washing of soils in the background of drainage.*

It is seen from the figures of table 38 that, in this version of the experiments, each irrigation water having given to the soil, caused the gradual growth of salts instead of washing them. In fact, there was observed of the high growth of salts in all depths of the soil, but 10-25-*cm* layer. Sharp salinity appeared because of the amount of chlorine salt in this case. Its amount grew more than five times in 10-*cm* upper layer of the soil. Amount of HCO_3 ion mainly diminished in all of the soil profile.

Although of washing of salts in 10-*cm* upper layer of the soil after the second irrigation, nevertheless, their amount grew very much in 40-*cm* lower layer. There was observed diminishing of salts in considerable degree in the second half-meter layer, which created opportunity of accumulating of salts in the upper layer of the soil because of diffusion process. Going on of diffusion process again influenced in the dynamics of chlorine, being active in the soil (table 38)

Amount of HCO_3 ion in 25-*cm* upper layer grew very much. Its washing was continued in lower layer.

Table 38

Washing of the second experimental soils in drainage background

Giving of the third irrigation norm influenced of increasing of salts in 25-*cm* upper layer of the soil very much and diminishing – in lower layers. There wasn't relatively change in amount of HCO_3 ion.

Having subjected to diffusion process of salts in this version of experiments is especially explained by the dynamics of humidity. It is seen from the figures of table 39 that, each irrigation norm caused the sharp growth of the amount of humidity only in the upper layers of the soil. There wasn't significant change in the lower layers. In its turn, such state gave opportunity of gradual rising of salts to the upper layers and thus, going on of diffusion process.

Table 39

Dynamics of humidity in washing of soils in drainage background of the second experimental field

Thus, the results of the experiment once again prove that the soils having got saline by dealluvial way can't be used without carrying out of melioration measures. This causes of repeated salinity of the upper layer of the soil.

d)Washing of soils with giving of 15 tons of gypsum to each ha of the soil. As it is seen from table 40, the first irrigation norm couldn't considerably influence the washing of salts in the soil. In fact, salts in 50-*cm* upper layer not only washed away, in the contrary, their amount grew very much. The amount of dry remainder in 10-*cm* upper layer increased about four times. The growth of salts in definite degree occurred in some lower layers as well.

It must be mentioned that the first irrigation influenced greatly to washing of chlorine. However, as the amount of chlorine is little in half-meter upper layer, it was washed in little amount (half).

Table 40

Washing of soils with giving of 15 tons of gypsum to each *ha* in the second experimental field

The second irrigation norm influenced the washing of salts in all of the profile of the soil. In this case, although of washing of dry remainder more than two times in 10-*cm* upper layer of the soil in comparison with the first irrigation, it was again more than the initial amount of them.

The second irrigation caused a considerable washing of chlorine and HCO_3 away from the soil. In this case, washing of HCO_3 ion covered some deeper layer in comparison with the previous irrigation.

As it is seen from the table, the third irrigation norm continued the washing of salts from the soil. This time, the washing mainly covered of all having investigated depth. However, the amount of salts in half-meter upper layer was washed relatively more than in lower layers. It is explained by small amount of salts in the upper layer and more – in lower layers. It must be mentioned that the third irrigation norm made fit for normal growth of plants in 125-*cm* upper layer of the soil. Although of the growth of HCO_3 ion in all depths but 10-25 and 75-100-*cm* layers, nevertheless, it doesn't create danger for the growth of plants.

Giving of good results of washing of salts in the fields with gypsum is explained by the increase of water-permeability and water-preserving abilities, improving agro-physical property of the soil. In fact, in this version of the experiment, water permeability of the soil developed two times (0,008 *mm/sec*) in comparison with control (0,004 *mm/sec*). It is seen from table 41 that there was considerable change in the dynamics of humidity in the process of washing. Therefore, each irrigation norm having given to the soil caused the gradual increase of humidity in the soil. At the same time, the irrigation norm influenced passing of waters into the depth. In their turn, all of these created opportunity for easily washing of salts in the soil.

e) *Washing of soils with giving of 10 tons of gypsum and 40 tons of manure to each ha.* Results having got in this version of experiments indicate the significant washing of dry remainder and chlorine in one-meter depth of the soil in the first irrigation norm. The washing of salts in this case especially was much in the second half-meter layer of the soil. As it is seen from table 42, there was a considerable change in washing of HCO_3 ion.

Table 41

Dynamics of humidity in washing of soils with giving of 15 tons of gypsum to each *ha* in the second experimental field

The second irrigation norm continued the washing of salts in the soil. In this case, dry remainder diminished 50% in comparison with the first irrigation and an initial amount of salts more than two times. In comparison with the first irrigation, chlorine was washed away more than two and a half times. Some washing of HCO_3 ion was noticed in one-meter layer as well.

The third irrigation norm continued the washing of salts on all indicators. It can be seen from the results of analysis of water extract having given in table 43. As it is seen from the table, although of diminishing of all amounts of ions in washing process, nevertheless, prevailing in the soil profile was SO_4 ion.

It indicates that melting, gypsum spread in all layers of the soil. At the same time, such state influenced the growth of water capacity.

It is seen from the figures of table 44 that, every irrigation norm having given to the soil influenced gradual growth of humidity there. Sharp growth of humidity especially occurred after the first irrigation.

In this case, amount of humidity grew more than one time and a half in one-meter layer of the soil.

Comparing of the results having got in this version of experiments with the results of previous experimental versions indicates that when giving gypsum to the soil together with manure, water capacity of the soil grows very much.

Table 42

Washing of soils with giving of 10 tons of gypsum and 40 tons of manure to each *ha* in the second experimental field

Soil samples weren’t taken

Table 43

Results of analysis of water extract after washing of soils with giving of 10 tons of gypsum and 40 tons of manure in the second experimental field

Table 44

Dynamics of humidity in washing of soils with giving of 10 tons of gypsum and 40 tons of manure to each *ha* in the second experimental field

The comparison of the figures having given in table 45 indicates that in this version of experiments every irrigation norm having given to the soil gradually increased water capacity of the soils.

Table 45

Amount of humidity in experimental fields carried out in different versions

CONCLUSION

Thus, summarizing of the above-mentioned about saline lands of dealluvial form, we can show the following results.

Saline soils of dealluvial form carry a zonal character and spread in foothill part of Azerbaijan. Direct learning of such soils was investigated neither in our republic, nor of former Soviet Union. However, their learning has great economical importance.

Due to the results of our investigations having carried out during 1955-1958, we defined that saline soils of dealluvial kind are formed in dry climate condition without participation of subsoil waters under the influence of dealluvial currents. As these soils have bad physical-chemical property, weak water-permeability, high salinity and saltiness, heavy mechanical composition, naturally their fertility is very low.

Peculiarity of saline lands of dealluvial kind is their diversity in this or that part due to inclination of plates. In fact, soils are of very bad physical-chemical property, heavy mechanical composition, saline and sharply salty in the train zone of dealluvial plates.

Soils are clayey, saline and sharply salty in the middle zone of plates having got of passing physical-chemical property. Soils are clayey, saline-like, salty and relatively convenient physical-chemical property in the upper zone.

Having got settled salty profile of saline soils of dealluvial kind, the amount of salts in 20-40-*cm* upper layer is little and in lower layers is very much. These soils got saline mainly in sulfate-chloride and chloride-sulfate-sodium composition.

Due to the inclination of the territory and peculiarities of the soils, water-salt dynamics is different in this or that part of the plates. In fact, being in massive water regime in the upper zone of the plates, high salinity begins from 50-60-cm depth of the soils: being of changeable of water-salt dynamics is typical for very thick upper layer of soils of the middle zone; together with having of humidity and salinity of high degree of soils in the middle zone, they are very dynamic.

Although of getting saline of the upper layers of these lands with very bad physical-chemical property, having got of salinity of the lower layers demands their improving by melioration way. Having used ordinary washing process in the melioration of these lands doesn't give positive results. So, in this case, there goes on repeated salinity process in the soils by diffusion way. When giving of 15 tons of gypsum to each *ha*, the process of washing frees 75-*cm* upper layer from salts completely. When giving of 10 tons of gypsum and 40 tons of manure to the soil, one-meter layer becomes free of salts.

Thus, in order to use these lands we advise the following measures. As dealluvial currents were main factor of salinity of the having characterized soils, firstly, in order to bar those currents, it is necessary to dig canals along the mountain plates.

In order to improve these soils, it is necessary to plough in 35-40-*cm* upper layer, not turning over of the upper layer of the soil. It is necessary to give 15 tons of gypsum or 10 tons of gypsum and 40 tons of manure to each *ha* when washing of soils. It's convenient of giving of 12000 m^3 to each *ha* with high salinity (having of 2% of dry remainder) and relatively less saline soils – 8000 m^3 of water. Having defined water norm must be given two-three times. In order to take the water norm having used for washing away from the soil, tight drainage net having dug in 1,5-2 *m* of depth can give good results. In order to bar the repeated salinity of soils, their washing works must be carried out in autumn-winter months and after washing of soils, there must be planted perennial grass plants.

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