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# Climatic conditions effects on formation and development status of some soils in northern part of Iraq/Kurdistan region

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## Abstract

Two biolit areas were selected within different climatic conditions in northern Iraq (Kurdistan region). Four pedons located in Ibraheemawa and five pedon in Salehaga areas. The two locationswere used for rain feed crop production. The two areas was covered with a detailed soil survey. Mapping units were obtained from Al-Agidi proposed soil classification at the series level for the Iraqi alluvial & zonal soils.Nine pedons representing the most extensive dominant soil series within the two locations were selected. A complete soil characterization was made for each soil series which include, PSD, ECe, Lime, O.M, active lime, PH, C.E.C, B.S.P, and C.E. to reveal their genesis (formations & development). Characterization was made preceded by morphological studies .The results show that a great effects of climatic conditions on the status of soil development reflected by horizons type , soil thickness and type of diagnostic horizons including surface and sub surface horizons . Also the results clearly showed the effects of climatic conditions on the amount and pattern of distribution for most soil components .The studied pedons at Ibrahimawa region were more developed than those at Salehaga region due to the difference in climatic conditions.

## Introduction

In Iraq, little attention has been paid to pedological studies including soil survey and classification for Iraqi soils. However, there are many agricultural projects, covered by different type of soil survey, but Iraqi/ Kurdistan region soils need more detailed works to cover its lands with different type of soil survey. Climate is one of the important factors of soil formation & development. The importance of climate as a soil forming factor has been appreciated by pedologists for more than decaite/100 years, starting with Dukochaeve (1883) and emphasized by jenny (1941) since that time there have been many soil clime sequence studies. Jenney (1941) considered temperature and rainfall as a most important climatic elements, because both have a high role in weathering of rocks and parent materials. But Birkeland, (1999) and Mush et al, (2001) they are asummed in their studies in soil chimosequence that in region with higher rainfall, there should be greater depletion of primary minerals. Also Al-ani, (1980) mentioned that freezing and thowing have a role in soil formation as climate factors. Marbut, (1928) stated that the well developed soils in regions of low rainfall have a layer of carbonate concentration that contains more $CaCO_3$ and $MgCO_3$ in their profil , than the horizon above as below. Baldwin et al., (1938) mphasized that the calcification is an important process in brown developed soils under arid – semi arid region climate. Also, Blackburn and baker (1973) stated that the brown soils formed under climate which has average annual rainfall 255 mm/yr. and long summer. Buol et al.,(1973) pointed that the important distinctive apparels for arid region soils which developed from parent materials rich with carbonate, is accumulation of carbonate transfers from upper horizons to lower horizons, and the important pedogenic processes which occur in arid and semi arid soils are calcification and decalcification. On other hand he indicated that the pedologenic processes which expected to occur in semi arid-sub humid regions are: eluviations, illuviation, salts removal, and accumulation of calcium carbonate, mechanical immigration of mineral particles from **A** horizon to **B** horizon to form argillic horizon. As well as physical and biological mixing of soil materials as a result of subsequence of wetness and dryness, freezing and thawing. Throp and Smith (1949) observed that there is a relation between soils development and climatic condition in distinction of soil horizons in semi arid-sub humid regions. Buringh (1960) stated that the soils of northern Iraq distinct as: absence of salinization, leaching processes in upper horizons, accumulation of lime in depth near the soil surface, the depth of carbonate increase with increasing of rainfall, and increasing of organic matter in upper horizon give its dark colore for mineral soils. Manchanda and Hilwig (1983)when they studied soil in sub humid regions, pointed that one of the main factors of soil materials translocation, is the mean annual precipitation, which increase soil development and increases clay skins formation in soil pedons, Essa and AL-Sheikhly (2000) showed that the increase of precipitation caused leaching factor in Chamchamal and Bakrajw in Sulaimania and assisted the movement of iron oxides and clay, where these region are situated through rain lines of 500-800 mm/yr. Marbut (1928) stated that in well-drained and highly developed soils of humid regions, the carbonate horizon usually is missing.Buol and Hole (1959) pointed that there is another indicator of soil development occurrence through soil pedon, represented by clay skins formation through translocation of clay and organic materials from surface to subsurface with water.Southward and Southard (1985) stated that the knowledge of soil development can be explained by losing of carbonate from upper horizon, the transformation of mica to semictate and accumulation of transferred colloidal clay in middle horizon through soil profile.Francois and Fartovsky (2000) emphasized that the present of Bk horizon indicates to arid climate conditions which the soil developed under it, there for the nodules of carbonate appears and some time, oxides of iron and manganese will grow with it.This paper deals briefly with study the effects of mean annual rainfall on soil development, and determining the most effective pedogenic processes on the development of the soil with in each region.

## Materials and methods

Two regions represent different climatic conditions were selected in northern Iraq. These regions include penjween in Kustan - Sulaimania governorate and khanaqeen in Garmian-Diala governorate. (Fig.1).The means rainfall during the period of 2001-2003 Salehaga was 360.99 mm/yr. while in Ibraheemawa was 1303-44 mm/year.The two regions are covered with a detail soil survey by using Topographic* and cadastral** maps. Freelance soil survey procedure was used. Delinations were made according to micro variation in soil form forming factors. More than 200 Auger holes were morphologically described in both regions, for mapping units according to (U.S.D.A) soil survey standard, (1951) and classified according to Al-Agidis (1981) proposed soil classification at the series level for Iraqi soils.According to the field work five pedons in Salehaga site and four pedons in Ibraheemawa, which representing most extensive mapping units in each region, were chosen for our study (figs.2&3 ). Upon characterization both mapping and taxonomic units were further evaluated and perfected.The following determination were carried out on samples collected from all horizons (Table 1,2,3,4). Mechanical analysis was made by the pipette method (kilmer and Alexander 1949). Bulk density, particle density and porosity were measured and calculated according to methods described by (Black 1965) The methods of walkley-Black and piper (1950) as described by Hesse, (1972) , was used in determined organic matter and total lime respectively. The method of analysis used for the ECe & PH is recommended by U.S. Regional salinity laboratory (1954). Active lime measured according to (Galet, 1972) . Cation exchangeable capacity (CEC) was measured according to

Papanicolaou (1976) which was a special method for calcareous soils. Exchangeable calcium and magnesium was measured in soil extract described by (chapman and pratt, 1961 and yoseef, 1999) [26]. Exchangeable sodium and potassium was measured by flame photometer according to method described by Kelley, (1948) . Iron oxides (total iron oxides, free iron oxides and amorphous iron oxides were measured by using X-Ray, method which described in (Mehra and Jackson, 1960) , by using method of schwertman ,(1964) ( then measured by using Atomic absorption spectrophotometer. The total elements analysis were done for $Fe_2O_3$, $SiO_2$, CaO, MgO, and Al2O3 directly from the soil powder by using X-Ray fluorescence analyzer.

*Obtained from genera survey office
**Obtained from Salehaga and penjwin agricultural office.

## Result and Discussion

From the result of soil survey and morphological study indicate that twelve soils were identified in each region. Figure(3) , (soil map units) three most extensive series in Ibraheemawa including 433 FCE, 433 FCE and DE 45, and four most extensive series area in Salehaga including 133FCE, 133FCM, 143FCM, and 153 FCE are chosen for the detailed study. Figures (3) and (4) .The results showed that developed soils are dominate at Ibraheemawa region and consist of more than 90% of the studied area, while undeveloped soils which represented by DE45 series consist of a bout less than 10% of the studied area, which was an old dried river Pattern. Results of morphological properties of all pedons at studied region as in general, pedons of Ibraheemawa indicated a greater degree of soil development than pedons in Salehaga. This situation represented by soil thickness and the degree of soil horizon differentiations, except pedon (4) at Ibraheemawa represent undeveloped soils in the region due to its location near the drainage flow of nezar stream. Thickness of surface and subsurface horizons for pedons of Ibraheemawa ranged between78-85cm. and 78-180 cm. respectively, while they ranged between20-30cm. and 59-108 cm. respectively for pedons in Salehaga region. These differences due to climatic conditions especially annual rainfalls which affect the activity of pedogenic process especially eluviations and, illuviation processes in Ibraheemawa region in comparison to Salehaga region. The dominated color of Ibraheemawa horizons was very dark Grayish brown (10 YR 3/2 ), while in Salehaga was dark brown (10 YR 3/3 to 4/3). Texture classes ranged from clayey to sand loam for pedons at Ibraheemawa, while they were silty clay loam to sandy loam at Salehaga region. These differences may be due to the effect of weathering and clay formation in situe especially in Ibraheemawa soils. The dominant soil structure for all pedons were moderate medium sub angular to angular blocky especially for surface horizon . The consistency Ranged from slightly sticky (M) and slightly plastic (W) to very sticky to strong plastic.The dominate type of horizons boundary was diffused to gradual , which means that there is some interaction between soil horizons due to the gradual changes within soil properties with depth as a result of pedogenic processes, include leaching, decalcification, eluviations and desalinization, especially in Ibraheemawa pedons, but Salehaga pedons show some evidence of calcification including accumulation of $CaCO_3$ in soil solum.The particle size distribution data for all studied pedons are shown in Table (3) and (4). Compared with of these data indicates a difference between pedons of Ibraheemawa and those of Salehaga in the amounts of soil particles and the pattern of their distribution within each pedon. In general, silt was the dominant fraction in all pedons followed by clay then sand in the pedons of Ibraheemawa region, while sand showed higher amount than clay in all pedon of Salehaga region. This may reflects of climatic conditions which caused difference in the amounts of soil fraction between the two regions. The mean average of total sand in all pedons at Ibraheemawa and salehaga was 239.36 g/ kg and 357.40 g/kg respectively. This fact reflects that most the amount of' soil fractions was inherited from their parent materials. In general, the amount of total clay in all pedons were at its maximum in the Bt horizon except pedon 4 which represents undeveloped soil. The total clay value ranged from 177 g/kg in E horizon of pedon 1 to 519.5 g/kg in Bt horizon of pedon 2. The data of total clay distribution decreases with depth then increase in Bt horizon then decreases in C horizon. This type of clay distribution with depth may be due to the effect of different type processes mainly pedogenic and to some extent to geomorphic processes. The increment of total clay in B horizon of pedons 1, 2 and3 may be due to one or more of the following reasons. First, the increment due to the high activity of eluviation and illuviation processes which took place in these pedons, as there was a sufficient amount of annual rainfall about 1303.47 mm/year, to bring about intensive eluviation and leaching of soil materials including clay minerals.Second reason for increment clay in subsurface horizon may duo to the insitue formation of clay duo to weither and accumulation of primary materials involved in clay formation.The distribution of clay in the solum is influenced by the depth of leaching, by the amount and distribution of rainfall, and by the natural drainage class , of the soil .The distribution of fine clay (<0.2μ) within all pedons in Ibraheemawa region are showen in Table (1). In general, the distribution of fine clay in all pedons follows the same pattern of total clay. The value of average amount of total clay in B horizon to the average amount of total clay in A horizon are 1.78, 1.43 and 1.57 of pedons I,2 and 3 respectively, while it is nil in pedon 4. The value of average clay in B horizon to average clay in A horizon in all pedons is greater than 1.2 table (1), this value meets the criteria required for formation of argillic horizon (Soil survey staff, 1999) in all pedon at Ibraheemawa region except pedon 4. These data indicate the effect of climatic conditions and older age of parent material causing an intensive activity of some pedogenic processes including decalcification, eluviation and illuviation processes and forming developed soils in this region. Amount and distribution of total clay within all pedons at Salehaga region are shown in Table (2). In general, the amount of total clay in all pedons is at its maximum in the Bt horizon, and increases with depth at B horizon and decreases at C horizon. This type of clay distribution could be due to the paleoeffect of pedogenic processes responsible for the formation of these soils. The amount of total clay in the surface horizon ranged between 207.3 g/kg in pedon7 to 215.5 g/kg in pedon 6, While,they ranged from 221.2 g/kg in $Bk_2$ horizon of pedon 5 to 363.3 g/kg in $Bt_1$ horizon of pedon 6.This status would be greatly related to the past climatic conditions, which were more humid than the dominant condition of the present climatic conditions. Results indicate that the distribution of fine clay (<0.2μ) follows the same path as that of total clay within all pedons. The amount of fine clay increases with depth at B horizons then decreases at C horizon. Increasing of clay in B horizon for all pedons in Salehaga region may be attributed to the conglomerate parent materials which allow the fine particles to move toward the lower horizons by sedimentation processes of Serwan River through past time in addition to the rainfall which caused the weathering of surface particles, and down to subsurface horizons, which the mean annual rainfall arrived to 360.99 mm/year (Agriculture extensional office of Sulaimania).The main pedogenic processes took place within pedons of Ibraheemawa areas including melanization, leaching, decalcification,eluviations and illuviation . This fact was reflected by deep dark colored of surface horizon, thick soil solum, non-calcareous soil solum as well as high accumulation of clay materials at Bt horizons. The actions of geomorphic processes reflected by the accumulation of fine materials at the surface horizons of all pedons of this region While, pedons in Salehaga region, with lower amount of rainfall 360.99 mm/year indicate that the pattern of clay distribution was mainly due to either the effect of paleopedogenic processes, going with high accumulation $CaCO_3$ which may accumulate with time after soil development , or to the insitu clay formation in horizons. Also, may due to the removal of fine materials from the surface horizon by erosion Processes.The main pedogenic processes, took place in Salehaga soils, are eluviations, illuviation, calcification , ecalcification and sedimentation .From the results of particle size distribution (Tables 1 and 2), it is obvious that the distribution of clay in salehaga is more homogeneous than Ibraheemawa, because of first, Ibraheemawa region is older and has more rainfall, causing clay particles to move down with homogenous pattern of distribution and causing more weathering in surface horizon due to remaining of some water in surface horizon after the later rainfall. Second, the role of up lands near mountains, which made continuous sedimentation and accumulation of fine particles on soil surfaces, this emphasized by presence of high ratio of fine clay on soil surface.Results of chemical properties showed in Tables (3) and (4). All pedons show the same pattern for organic matter distribution with depth, but they show some difference in organic matter content. Organic matter content decreases with the depth in all pedons. In general, pedons of Ibraheemawa have a higher amount of organic matter than those of salehaga region, due to the effect of high amount of rainfall associated with high density of vegetation, which is suitable for organic matter accumulation with time. The mean average of organic matter content in all pedons in Ibraheemawa is 12.8 g/kg, while in Salehaga is 6.9 g/kg.All pedons in Ibraheemawa have the lowest values of total lime compared with pedons in Salehaga region. This related mainly to the effect of high amount of rainfall causing high activity of decalcification process in pedons in Ibraheemawa region, with moderate effect in soils in Salehaga regions representing by higher lime content.The amount of active lime increases with depth in Bk horizons then decreases in c horizons in all studied pedons. This type of distribution reflects the sequence of decalcification and calcification processes within each pedon.In general, pedons in Ibraheemawa show lower content of active lime than the pedons in Salehaga region due to the activity of decalcification associated with difference in the associated with amount of rainfall. In general, the PH around natural to slightly alkali due to the effectof calcareous parent material and type of climatic conditions. The results of PH value for all pedons do not show specific pattern with depth.In general, pedons in Ibraheemawa show lower value of electrical conductivity than pedons in Salehaga region due to the differences in the amount of rainfall The mounts of exchangeable cations in each horizon of all studied pedons are shown in Tables (3) and (4). The results indicate that amounts of $Ca^{+2}$ are higher than that of $Mg^{+2}$, $Na^{+}$ and $K^{+}$ in all horizons of the studied pedons.In general Exchangeable cations do not show specific pattern of distribution with depth for the studied pedons . Pedons in Ibraheemawa have higher amounts of $Ca^{+2}$ and $Mg^{+2}$ and lower amounts of $Na^{+}$ and $K^{+}$ than pedons in salehaga region. These results may be due to the difference in the amount and type of clay minerals and the nature of parent materials between the two regions.The values of CEC for all studied pedons in Ibraheemawa region have highest values than pedons in Salehaga region. These results reflect the difference in both clay and organic matter content. The values of CEC in all pedons in Ibraheemawa region range from 14.20 cmolc/kg soils in C1 horizon of pedon 4 due to high sand content in this horizon. While the highest value was 45.4 cmolc/kg soil in $Bt_1$ horizon of pedon 1. While they range in all pedons in Salehaga region, from 14.34 cmolc/kg soil in C horizon of pedon5 to 36.52 cmolc/kg soil in Ap horizon of pedon 6.Base saturation values within all studied pedons were more than 50% and don't show specific pattern of distribution with depth. This reflects the low leaching intensity as well as the effect of calcareous parent material with high clay content. Base saturation values within pedons in Ibraheemawa region range between 55.32% in Ap horizon of pedon 4 to 105.03% in C2 horizon of the same pedon While, they range between 72.49% in $Bt_1$ horizon of pedon 6 to 103 .53% in Bk horizon of pedon 9 in Salehaga region.

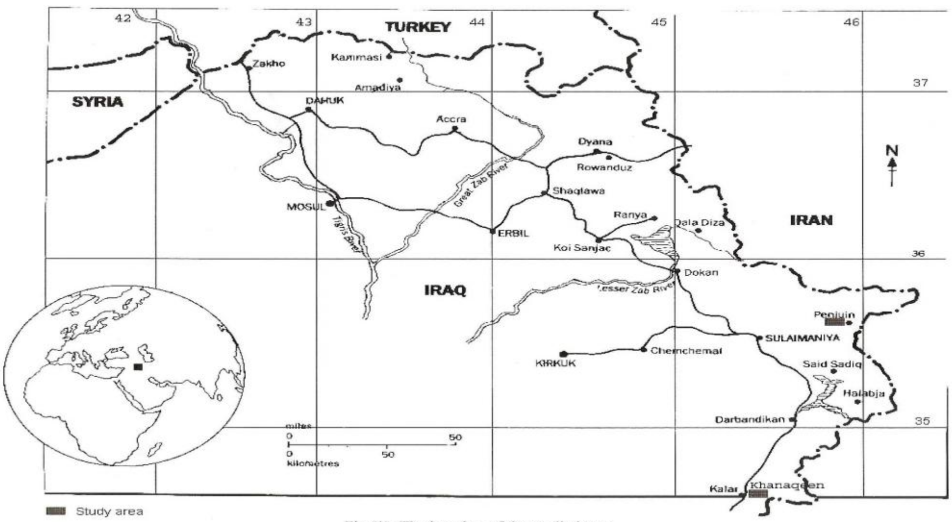


Fig (1): The location of the studied area

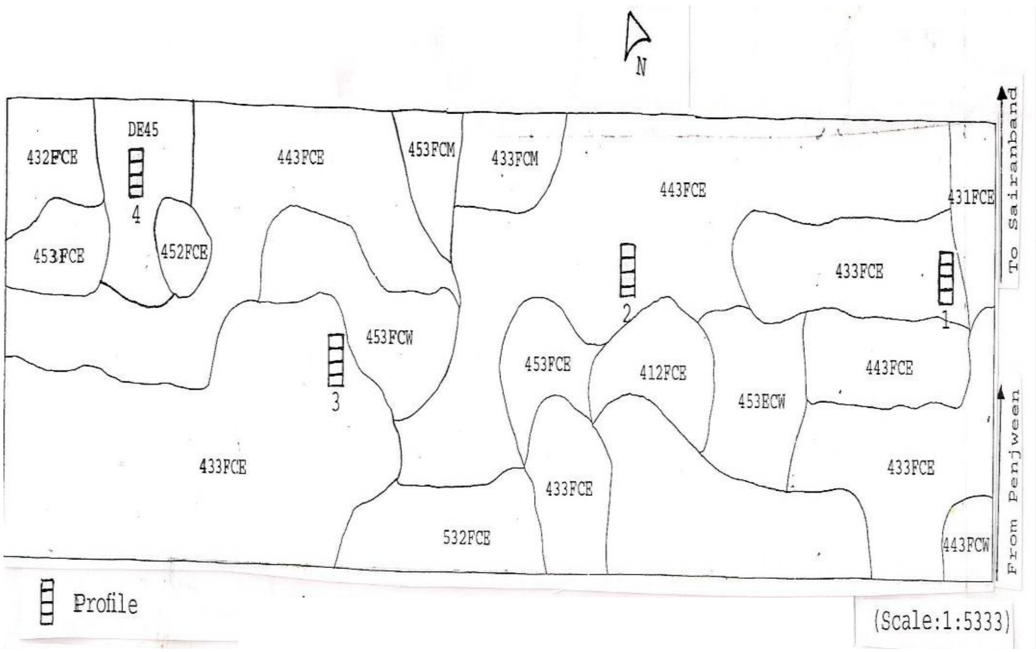


Fig.2:The identfing soil units in ibraheemawa region

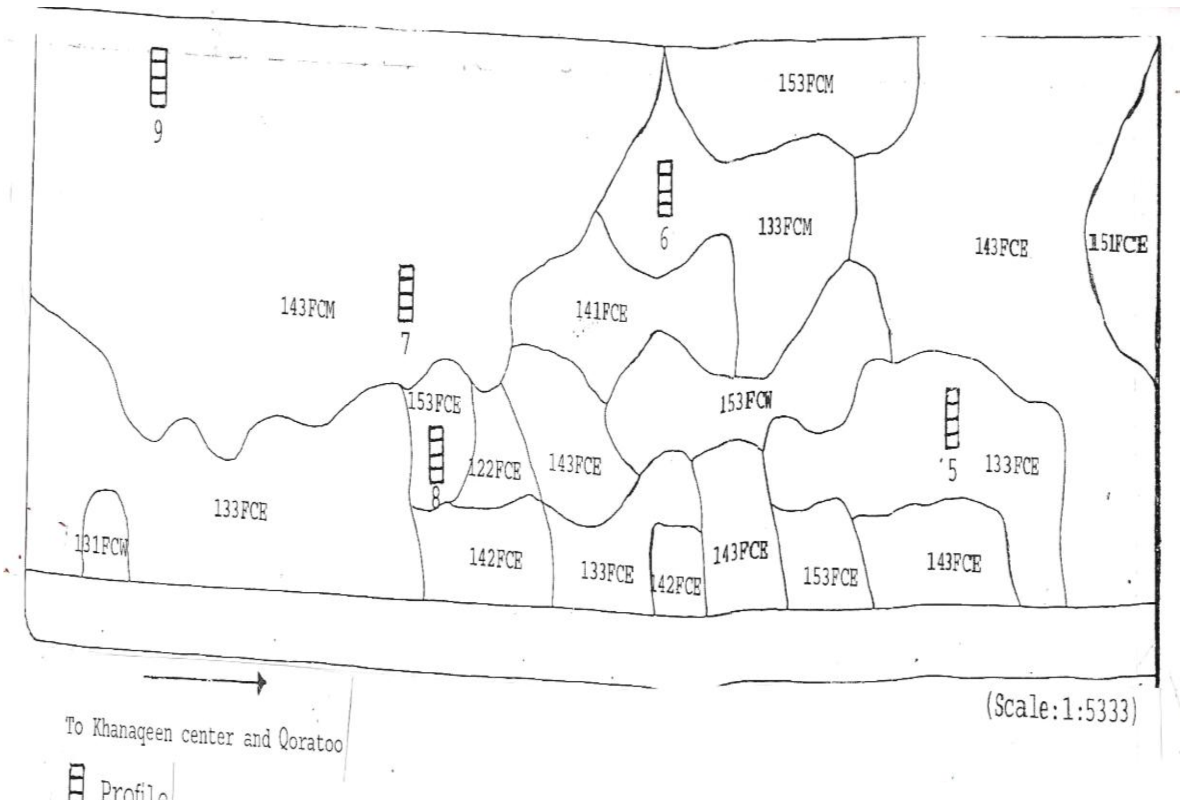


Fig .3: The identifying soil units in salehage region

Table (1): Some physical properies for the studied pedons in Ibraheemawa region

| Horizon | Depth (cm) | Totla sand (g/kg) | Total silt (g/kg) | Total clay (g/kg) | Fin clay (g/kg) | Fin clay/ total clay | Total clay (B/A) | Bulk density (Mg/M$^3$) | Particle density (Mg/M$^3$) | Porosity (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| Pedon (1) | | | | | | | | | | |
| Ap11 | 0-25 | 85.5 | 620.9 | 293.6 | 165.4 | 0.56 | 1.78 | 1.31 | 2.48 | 47.18 |
| A12 | 25-48 | 172.0 | 564.9 | 263.1 | 151.4 | 0.58 | | 1.36 | 2.52 | 46.03 |
| Pedon (2) | | | | | | | | | | |
| Ap | 0-30 | 76.6 | 501.6 | 421.8 | 274.8 | 0.65 | 1.43 | 1.12 | 2.49 | 55.02 |
| A3 | 30-80 | 373.1 | 324.1 | 302.7 | 168.5 | 0.56 | | 1.24 | 2.53 | 50.99 |
| Bt | 80-130 | 106.2 | 374.3 | 519.5 | 253.7 | 0.49 | | 1.38 | 2.81 | 50.89 |
| C | 130-180 | 109.5 | 538.3 | 352.2 | 173.3 | 0.49 | | 1.41 | 2.53 | 44.27 |
| Average | | 166.4 | 434.6 | 399.1 | 217.6 | 0.55 | | 1.29 | 2.59 | 50.29 |
| Pedon (3) | | | | | | | | | | |
| Ap1 | 0-28 | 126.7 | 590.1 | 283.2 | 156.6 | 0.55 | 1.57 | 1.38 | 2.55 | 45.88 |
| A3 | 28-80 | 366.4 | 467.8 | 165.8 | 115.8 | 0.70 | | 1.46 | 2.63 | 44.49 |
| B1 | 80-125 | 139.4 | 567.9 | 292.6 | 156.5 | 0.53 | | 1.54 | 2.71 | 43.17 |
| Bt2 | 125-180 | 41.1 | 546.2 | 412.7 | 227.6 | 0.55 | | 1.62 | 2.63 | 38.40 |
| C | 180>200 | 42.4 | 583.1 | 374.5 | 129.8 | 0.35 | | 1.68 | 2.61 | 35.63 |
| Average | | 143.2 | 551.0 | 305.8 | 157.3 | 0.54 | | 1.54 | 2.63 | 41.51 |
| Pedon (4) | | | | | | | | | | |
| Ap | 0-29 | 406.1 | 397.5 | 196.4 | 66.3 | 0.34 | …. | 1.41 | 2.49 | 43.37 |
| A3 | 29-78 | 701.4 | 204.9 | 93.6 | 41.7 | 0.45 | | 1.43 | 2.55 | 43.92 |
| C1 | 78-115 | 714.6 | 196.9 | 88.6 | 46.1 | 0.52 | | 1.43 | 2.55 | 43.92 |
| C2 | 115-175 | 352.4 | 386.3 | 261.3 | 141.5 | 0.54 | | 1.45 | 2.54 | 42.91 |
| Average | | 543.6 | 296.4 | 160.0 | 73.9 | 0.46 | | 1.43 | 2.53 | 43.53 |
| Region average | | 239.4 | 461.1 | 299.7 | 156.5 | 0.52 | 1.20 | 1.42 | 2.57 | 44.68 |

Table(2):Some physical properies for the studied pedons in Salehaga region

| Horizon | Depth (cm) | Totla sand (g/kg) | Total silt (g/kg) | Total clay (g/kg) | Fin clay (g/kg) | Fin clay/ total clay | Total clay (B/A) | Bulk density $Mg/M^3$) | Particle density ($Mg/M^3$) | Porosity (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| Pedon (5) | | | | | | | | | | |
| Ap | 0-20 | 324.7 | 467.0 | 208.3 | 29.7 | 0.14 | 1.10 | 1.32 | 2.54 | 48.03 |
| B1 | 20-80 | 315.5 | 449.1 | 235.4 | 39.2 | 0.17 | | 1.38 | 2.67 | 48.31 |
| Bk2 | 80-110 | 335.8 | 443.0 | 221.2 | 36.6 | 0.17 | | 1.44 | 2.64 | 45.45 |
| C | 110-180 | 765.7 | 131.3 | 103.0 | 26.9 | 0.26 | | 1.47 | 2.58 | 43.02 |
| Average | | 435.4 | 372.6 | 192.0 | 33.1 | 0.18 | | 1.40 | 2.61 | 46.21 |
| Pedon (6) | | | | | | | | | | |
| Ap | 0-30 | 252.8 | 531.7 | 215.5 | 22.4 | 0.10 | 1.63 | 1.41 | 2.55 | 44.71 |
| Bt1 | 30-85 | 150.5 | 486.2 | 363.3 | 54.3 | 0.15 | | 1.45 | 2.62 | 44.66 |
| Bt2 | 85-132 | 161.9 | 496.9 | 341.3 | 45.3 | 0.13 | | 1.57 | 2.57 | 38.91 |
| C | 132-180 | 256.3 | 416.6 | 327.1 | 1.3 | 0.0 | | 1.60 | 2.70 | 40.74 |
| Average | | 205.4 | 482.9 | 311.8 | 30.5 | 0.10 | | 1.51 | 2.61 | 42.25 |
| Pedon (7) | | | | | | | | | | |
| Ap | 0-30 | 327.5 | 465.2 | 207.3 | 31.8 | 0.15 | 1.33 | 1.38 | 2.52 | 45.24 |
| Bk1 | 30-105 | 189.5 | 518.5 | 292.0 | 60.1 | 0.21 | | 1.46 | 2.56 | 42.97 |
| Bk2 | 105-138 | 313.5 | 426.0 | 260.6 | 124.1 | 0.48 | | 1.50 | 2.58 | 41.86 |
| C | 138-160 | 475.0 | 329.8 | 195.2 | 41.7 | 0.21 | | 1.54 | 2.67 | 42.32 |
| Average | | 326.4 | 434.9 | 238.78 | 64.4 | 0.26 | | 1.47 | 2.58 | 43.10 |
| Pedon (8) | | | | | | | | | | |
| Ap | 0-30 | 322.8 | 465.6 | 211.6 | 31.5 | 0.15 | 121 | 1.35 | 2.65 | 49.06 |
| B | 30-90 | 413.1 | 331.9 | 255.0 | 115.1 | 0.45 | | 1.43 | 2.53 | 43.48 |
| C | 90-150 | 777.7 | 86.6 | 135.6 | 45.8 | 0.34 | | 1.4 | 2.63 | 46.77 |
| Average | | 504.53 | 294.7 | 200.7 | 64.1 | 0.31 | | 1.39 | 2.60 | 46.43 |
| Pedon (9) | | | | | | | | | | |
| Ap | 0-27 | 302.4 | 489.2 | 208.4 | 39.1 | 0.19 | 1.30 | 1.43 | 2.49 | 42.57 |
| Bk | 27-98 | 269.5 | 460.8 | 269.7 | 54.9 | 0.20 | | 1.47 | 2.58 | 43.02 |
| C1 | 98-130 | 314.3 | 457.0 | 228.7 | 1.4 | 0.00 | | 1.51 | 2.85 | 47.02 |
| C2 | 130-160 | 376.3 | 398.2 | 225.5 | 1.2 | 0.00 | | 1.51 | 2.73 | 44.69 |
| Average | | 345.6 | 451.3 | 233.1 | 23.5 | 0.10 | | 1.48 | 2.66 | 44.32 |
| Region average | | 357.4 | 407.3 | 235.1 | 43.1 | 0.19 | 1.31 | 1.45 | 2.61 | 44.46 |

Table (3): Some chemical properies for the studied pedons in Ibraheemawa region

| Horizon | Depth (cm) | O.M (g/kg) | Active L.* (g/kg) | Total L. (g/kg) | PH (extract) | ECe (ds/m) | Exchangable cation (cmol/kg soil) | | | | CEC (cmol/kg soil) | BSP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $Ca^{+2}$ | $Mg^{+2}$ | $Na^{+2}$ | $K^{+}$ | | |
| Pedon (1) | | | | | | | | | | | | |
| Ap11 | 0-25 | 16.5 | 5 | 10 | 7.32 | 0.54 | 25.76 | 2.20 | 0.63 | 0.19 | 37.20 | 82.74 |
| A12 | 25-48 | 12.5 | 10 | 20 | 7.51 | 0.41 | 26.81 | 2.63 | 0.76 | 0.11 | 39.56 | 76.62 |
| E | 48-85 | 2.5 | 5 | 75 | 6.94 | 0.32 | 21.55 | 2.61 | 0.63 | 0.06 | 34.89 | 71.22 |
| B1 | 85-150 | 9.0 | 20 | 70 | 7.12 | 0.50 | 29.59 | 5.78 | 0.82 | 0.13 | 45.48 | 79.23 |
| B2 | 150-170 | 7.5 | 20 | 65 | 7.21 | 0.26 | 31.79 | 6.31 | 0.95 | 0.16 | 44.26 | 88.59 |
| C | 170>200 | 6.7 | 10 | 65 | 7.39 | 0.51 | 21.55 | 10.78 | 1.26 | 0.23 | 41.10 | 82.23 |
| Average | | 9.1 | 12 | 50 | 7.25 | 0.42 | 26.18 | 5.39 | 0.84 | 0.15 | 40.42 | 80.11 |
| Pedon (2) | | | | | | | | | | | | |
| Ap | 0-30 | 38.6 | 20 | 30 | 7.39 | 0.51 | 30.26 | 3.17 | 0.82 | 0.20 | 36.35 | 94.77 |
| A3 | 30-80 | 34.1 | 25 | 40 | 7.47 | 0.28 | 23.67 | 4.72 | 0.70 | 0.09 | 31.50 | 92.63 |
| Bt | 80-130 | 15.5 | 30 | 75 | 7.08 | 0.67 | 31.9 | 4.20 | 0.89 | 0.14 | 39.52 | 93.95 |
| C | 130-180 | 11.0 | 25 | 75 | 7.32 | 0.20 | 27.33 | 5.26 | 0.89 | 0.09 | 37.10 | 90.49 |
| Average | | 24.8 | 25 | 55 | 7.32 | 0.42 | 28.29 | 4.34 | 0.83 | 0.13 | 36.12 | 92.96 |
| Pedon (3) | | | | | | | | | | | | |
| Ap | 0-28 | 18.1 | 10 | 30 | 6.98 | 0.37 | 23.65 | 2.11 | 0.82 | 0.23 | 38.53 | 69.58 |
| A3 | 28-80 | 13.0 | 5 | 20 | 6.99 | 0.48 | 14.72 | 4.73 | 0.63 | 0.09 | 27.08 | 74.48 |
| B1 | 80-125 | 6.5 | 10 | 60 | 7.00 | 0.38 | 21.02 | 5.79 | 0.63 | 0.11 | 43.47 | 63.38 |
| Bt2 | 125-180 | 4.7 | 20 | 50 | 7.05 | 0.19 | 29.06 | 2.63 | 0.76 | 0.15 | 41.10 | 79.23 |
| C | 180>200 | 4.5 | 15 | 55 | 7.07 | 0.29 | 17.82 | 9.37 | 0.82 | 0.18 | 41.23 | 68.37 |
| Average | | 9.36 | 12 | 43 | 7.02 | 0.34 | 21.25 | 4.93 | 0.73 | 0.15 | 38.28 | 71.01 |
| Pedon (4) | | | | | | | | | | | | |
| Ap | 0-29 | 13.0 | Nil | 5 | 7.03 | 0.48 | 12.09 | 2.63 | 0.51 | 0.16 | 27.82 | 55.32 |
| A3 | 29-78 | 8.0 | 5 | 10 | 7.40 | 0.21 | 12.09 | 2.10 | 0.32 | 0.05 | 15.17 | 95.98 |
| C1 | 78-115 | 3.5 | Nil | 5 | 7.47 | 0.19 | 13.14 | 1.05 | 0.44 | 0.08 | 14.20 | 103.59 |
| C2 | 115-175 | 8.0 | 15 | 20 | 7.22 | 0.26 | 20.13 | 3.21 | 0.76 | 0.14 | 23.08 | 105.03 |
| Average | | 8.1 | 5 | 10 | 7.28 | 0.29 | 14.36 | 2.25 | 0.51 | 0.11 | 20.20 | 89.98 |
| Region Average | | 12.8 | 14 | 40 | 7.22 | 0.37 | 31.43 | 4.23 | 0.73 | 0.14 | 33.73 | 83.52 |

* = Lime

Table(4):Some chemical properies for the studied pedons in Salehaga region

| Horizon | Depth (cm) | O.M (g/kg) | Active L.* (g/kg) | Total L. (g/kg) | PH (extract) | ECe (ds/m) | Exchangable cation (cmol/kg soil) | | | | CEC (cmol/kg soil) | BSP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $Ca^{+2}$ | $Mg^{+2}$ | $Na^{+2}$ | $K^{+}$ | | |
| Pedon (5) | | | | | | | | | | | | |
| Ap | 0-20 | 15.3 | 95 | 250 | 7.92 | 0.63 | 18.97 | 1.02 | 1.20 | 0.17 | 26.24 | 81.40 |
| $B_1$ | 20-80 | 8.1 | 105 | 305 | 7.45 | 0.50 | 17.87 | 1.90 | 1.14 | 0.09 | 22.92 | 91.62 |
| $Bk_2$ | 80-110 | 5.2 | 130 | 305 | 7.20 | 0.38 | 17.35 | 2.64 | 1.01 | 0.08 | 21.75 | 96.92 |
| C | 110-180 | 2.1 | 60 | 248 | 7.24 | 0.54 | 8.95 | 2.10 | 0.70 | 0.04 | 14.34 | 82.22 |
| Average | | 7.7 | 98 | 277 | 7.45 | 0.51 | 15.79 | 1.92 | 1.01 | 0.10 | 21.31 | 88.04 |
| Pedon (6) | | | | | | | | | | | | |
| Ap | 0-30 | 13.1 | 100 | 305 | 7.73 | 0.65 | 21.57 | 4.21 | 1.14 | 0.019 | 36.52 | 74.23 |
| $B_1$ | 30-85 | 10.2 | 145 | 295 | 7.40 | 1.38 | 21.04 | 4.21 | 1.01 | 0.09 | 36.35 | 72.49 |
| $B_2$ | 85-132 | 7.2 | 115 | 290 | 6.96 | 2.19 | 24.20 | 1.58 | 0.89 | 0.06 | 36.10 | 74.04 |
| C | 132-180 | 1.0 | 100 | 290 | 7.17 | 2.35 | 21.03 | 1.05 | 0.95 | 0.09 | 28.82 | 80.22 |
| Average | | 7.9 | 115 | 295 | 7.32 | 1.64 | 21.96 | 2.76 | 1.00 | 0.11 | 34.45 | 75.25 |
| Pedon (7) | | | | | | | | | | | | |
| Ap | 0-30 | 13.8 | 70 | 245 | 7.80 | 0.56 | 20.52 | 5.26 | 1.15 | 0.09 | 26.87 | 100.93 |
| $Bk_1$ | 30-105 | 9.1 | 105 | 320 | 7.10 | 0.50 | 18.94 | 4.21 | 1.03 | 0.05 | 26.87 | 90.17 |
| $Bk_2$ | 105-138 | 1.0 | 100 | 310 | 7.07 | .50 | 17.35 | 3.17 | 0.89 | 0.07 | 22.13 | 97.06 |
| C | 138-160 | 0.5 | 85 | 260 | 7.72 | 0.37 | 15.78 | 3.16 | 0.95 | 0.04 | 22.13 | 90.10 |
| Average | | 6.1 | 90 | 284 | 7.42 | 0.48 | 18.15 | 3.95 | 1.01 | 0.06 | 24.50 | 94.57 |
| Pedon (8) | | | | | | | | | | | | |
| Ap | 0-30 | 13.9 | 65 | 275 | 7.80 | 1.13 | 20.52 | 2.63 | 1.33 | 0.23 | 30.98 | 79.76 |
| B | 30-90 | 8.5 | 75 | 185 | 7.09 | 1.22 | 21.05 | 1.03 | 10.1 | 0.11 | 27.86 | 82.63 |
| C | 90-150 | 1.7 | 40 | 175 | 7.21 | 0.76 | 12.62 | 2.11 | 0.76 | 0.10 | 18.34 | 85.01 |
| Average | | 8.0 | 60 | 212 | 7.37 | 1.04 | 18.06 | 1.92 | 1.03 | 0.15 | 25.73 | 82.47 |
| Pedon (9) | | | | | | | | | | | | |
| Ap | 0-27 | 13.2 | 110 | 310 | 7.77 | 0.61 | 19.99 | 1.05 | 1.26 | 0.21 | 23.08 | 97.53 |
| Bk | 27-98 | 5.6 | 105 | 320 | 6.96 | 1.79 | 19.98 | 1.05 | 1.14 | 0.09 | 21.50 | 103.53 |
| $C_1$ | 98-130 | 0.7 | 100 | 250 | 7.39 | 2.30 | 15.82 | 1.04 | 1.33 | 0.08 | 18.34 | 99.62 |
| $C_2$ | 130-160 | 0.5 | 80 | 290 | 6.88 | 2.24 | 15.30 | 1.03 | 1.26 | 0.08 | 19.92 | 88.70 |
| Average | | 5.0 | 99 | 293 | 7.25 | 1.74 | 17.77 | 1.04 | 1.25 | 0.12 | 20.71 | 97.35 |
| Region Average | | 6.9 | 92 | 272 | 7.36 | 1.08 | 18.35 | 2.32 | 1.06 | 0.11 | 25.34 | 87.54 |

* = Lime

## Conclusion

According to the result of this study, we conclude that:- Climatic conditions have a greater effect on soil development reflected by the differences within the dominant type of diagnostic horizons. Soils in Ibraheemawa region show a greater degree of soil development than the soil in Salehaga region.The pedogenic processes for the soils formation in Ibraheemawa include melanization, decalcification, eluviations and illuviation which represent the effect of humid climate. But in Salehaga soil formation show two stages, the first stage includes formations of illuvial horizon (argillic horizon) in the past of more humid climate conditions.

The second stage include formation of calcic horizon which was took place during late dry climatic condition. Soils in the two regions show same difference in the amounts of some soil components Fe and other total elements due to the difference in the climatic condition and rate of weathering activity. Climatic conditions have greater effects on the amount and form of free iron oxides. The results indicate that free Iron oxides move together with clay minerals.

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# تأثير الظروف المناخية على حالات تكوين وتطور بعض الترب في شمال العراق / إقليم كوردستان

## الخلاصة

أختيرت مساحتين في منطقتين مختلفتين في الظروف المناخية في شمال العراق / إقليم كوردستان ، أحدهما في منطقة أبراهيم آوه الواقعة في بنجوين – محافظة السليمانية ، والاخرى في صالح اغا الواقعة في خانقين – محافظة ديالى ، والمساحتان تستخدمان في زراعة المحاصيل الديمية .مسحت الاراضي مسحا تفصيليا ، وحددت وحدات التربة أستنادا الى تصنيف العكيدي على مستوى السلاسل للترب الرسوبية والمناطقية . تم أختيار تسعة من البيدونات ضمن المساحتين ، أربعة منها في منطقة أبراهيم آوه ، وخمسة منها في منطقة صالح أغا . وصف البيدونات توصيفا مورفولوجيا اصوليا .تم تقدير بعض الخصائص الكيميائية والفيزيائية لنموذج التربة لكل بيدون متضمنا ( P.S.D. , ECe , Lime , OM , active Lime , PH , C.E.C. , BSP , C.E. ) لمعرفة كيفية نشوء وتطور التربة للمساحتين . أظهرت النتائج ان للظروف المناخية تأثير كبير على نشوء تطور التربة المبينة في نوع الافاق وسمك التربة ونوع الافاق التشخيصية متضمنا الافاق السطحية وتحت السطحية ، و أظهرت النتائج بأن محتوى مكونات التربة وشكل توزيعها كان بسبب الاختلاف في الظروف المناخية وأن البيدونات المدروسة أوضحت بأن ترب بيدونات منطقة ابراهيم اوه أكثر تطورا من ترب بيدونات منطقة صالح أغا.