Cumhuriyet Üniversitesi Fen Fakültesi
Fen Bilimleri Dergisi (CFD), Cilt:36, No: 3 Özel Sayı (2015)
ISSN: 1300-1949

Cumhuriyet University Faculty of Science
Science Journal (CSJ), Vol. 36, No: 3 Special Issue (2015)
ISSN: 1300-1949

Physico-chemical , morphological and mineralogical properties of Bushehr-Borazjan's soil

Narges KHORMOUJİ[1,*], Ali ABTAHİ[2]

[1,2]*Soil Science Department, Agriculture Faculty of University of Shiraz, Iran*

Received: 01.02.2015; Accepted: 05.05.2015

Abstract. Formation, classification, morphological, physiochemical, and mineralogical characteristics of Bushehr-Borazjan soil was evaluated. The region soil was of calcic kind. Furthermore; the humidity regime and thermal regime were of Aridic and Hyperthermic respectively. The region is associated with average yearly rain of 234.85 mm. On the other hand, the average yearly temperature is 25.2. As mentioned earlier, the main purpose of this paper is to evaluate physical, chemical, morphological, and mineralogical characteristics of the region soils so that they could be classified; Hence, first , the physiography was determined .Then, several profiles were installed in different physiography units . Next, considering the chosen profiles, the samples are brought to the laboratory for further investigation. Considering the latter sentence, six samples, in hope of mineralogical analysis, were chosen. It is noteworthy that the soil formation, because of hot and dry climate, was weak. Furthermore; the sample pedons were of cambic, calcic, and salic diagnostic horizon. The main two soil order were: Entisol and Aridisol. The known minerals were as follow: Chlorite, Illite, Smectite, Kaolinite, and Polygorskite. Finally, there was a subtle difference between the pedons' mineral kinds..

Keywords: Classification, Profile, Bushehr, Aridic, Entisols

1. INTRODUCTION

Soil identification is of a great value. Furthermore; population growth, the need to increase the cultivation, and specially production increase per one unit, in addition to necessity to use lands in a stable beneficial way, have given rise to the importance of soil identification. Soil, without a doubt, is one of the most important natural resources which may be the most important factor in civilization of every country. This very point is due to the fact that not only does it provide the people's food but also it covers several requirements including living place, fuels, waste burial, wild life, promenade Etc.

Although water is of a great importance, soil is the living-place-determiner factor, so people tried to live where the soil was decent. This very fact is due to the possibility of directing water, thanks to aqueducts, to a specific place which cannot be done for soil [1]. Furthermore; soil quality, to a great deal, will determine the nature of vegetation and lands' capacity for supporting the animal life and mankind communities. Considering the civilization growth, the number of mankind communities that are closely associated with soil will be less; hence, people may forget the fact that their existence and happiness rely on soil. In addition, not only won't mankind's dependency on soil decrease but also it will increase. Finally, soil will provide a wide range of our requirements including food, clothes Etc [2].

Soil formation, through climate and living creatures on the main materials, will gradually take place under the influence of being low or high. These 5 factors will determine the formation of different developed soils. So, if these factors are the same in two areas, the soil

*Corresponding author. *Email address: N_khormouji@yahoo.com*

Special Issue: The Second National Conference on Applied Research in Science and Technology

kind should be equal. Abtahi [3], in his study about being low or high relation with soil and underground salinity, has identified three areas with different degree of salinity:

- Lands which doesn't face any salinity issue including alluvial cones, debris cones, upper terraces of rivers and high plateau.
- Lands facing low to moderate salinity issue which are highly under the influence of salinity.
- Lands facing high and extremely high salinity issue including alluvial plains and low lands (Located on new and old lake sediments). These lands doesn't have an appropriate natural drainage, so the underground water level associated with salinity and high alkalinity is 0.5 to 3 meter of the soil surface.

Abtahi [4], having studied the being low or high, and soil nature influence on main calcic materials in the dry weather of Iran, observed that the being low or high condition of Sarvestan plain has brought about a difference in structure and the soil salinity to the extent that the lower salinity and bigger structures are related to the higher lands, while the lower are associated with higher salinity and smaller structures. Rameshni [5], regarding the topography influence on soil formation in the tropical area of Kohgiloyeh, reported that after the main materials, physiography is closely related to the soils. Furthermore; some other similar studies done by Suny et al [6] showed that younger soils will be formed in unstable physiography such as flood plains and foothills while more completed soils will be found in more stable physiography including old terraces of Cambic horizon. Finally, the soils on the sedimentary old terraces of more completed horizons are found to contain Argilic. So, the researcher concluded that the soil formation and completion is directly related to weather, being low or high, and time.

Climate, through influencing the vegetation, will have impact on the soil formation indirectly, so it is the dominant factor by which soils' kind and degree are influenced; hence, it can determine the vegetation distribution and the Geomorphological processes which help classifying several natural phenomena including soil. In addition, exposure to air degree of the soils' main components and their characteristics completions are extremely dependent on climate; hence, even subtle change in climate will influence the soil kind [7, 8, 9].

Rameshti and Abtahi [10], studying the climate influence on soil, concluded that as it rains more and the temperature degree decreases, the soils will be profile completed, influencing more variety of horizons. So, in the region associated with the least rain and the highest temperature degree, the horizon is Calcic with weak structure. In the region associated with average rain and temperature, the horizons are of Calcic and Cambic with relatively strong structure. Finally, in the region associated with the highest rain, the horizons are of Calcic and Cambic with relatively strong to strong structure, Arjilic and surface horizons is Mollic.

The lands between Borazjan to Bushehr, in hope of investigation of topography's influence on the soil formation process and completion, were chosen to study the morphological, physiochemical, and clay minerals characteristics.

2. MATERIAL AND METHOD

A region of 41172 hectares, between east longitude 51° 7′ 53/04″, north latitude 16′ 47/32″ 29° of Bushehr, associated with 110 meter high from sea level, and east longitude 53′ 27/39″

50° and north latitude 28° 53′ 48/19″ of Borazjan was chosen. First, all the required information, such as Aerial pictures (1:50000), topography (1:50000) and geological maps (1:250000), was investigated. Then, some other information such as aerology, hydrology statistics, and region geological information were collected. Furthermore; among all the different weather-related factors, in hope of the determination of the dry months, two factors, rain and temperature, were chosen, so, after determining the monthly average related to each year, as it is shown in figure 1, according to p=2T, the Embrothermic temperature and humidity change curve is drawn and the temporal and humidity regime condition of region soil is investigated. Then, according to the results, the physiography unites were identified in the region. Finally, in each physiography unit, several profiles were dug among which six were chosen as sample so that after complete investigation they could be used in laboratory for physiochemical tests.

According to the results, using morphological characteristics and sample horizons location, pedons are evaluated by means of soil identification guide [11]; furthermore, soils are classified according to the American soil classification system [12] and FAO [13].

The tests are as follow: Tissue tests by means of hydrometer [14], moisture percentage in saturated paste, lime by means of neutralization with Acid Chlorhidric in the presence of phenolphthalein [15], organic Carbon by means of wet burning [16], electric conductivity (ECE) of saturated soil paste by means of electric conductivity meter, PH of saturated soil paste by means of PH meter, Carbonates and Bicarbonates tilting with Sulfuric acid, Calcium and Magnesium by means of making complex with EDTA, Sodium and Potassium by means of flame photometer in saturated paste, chlorine by means of tilting with silver nitrate and sulfate by means of EDTA. Tradable alkali cations by means of extraction with normal ammonium acetate (PH=7) [15]. The existing clay particles in the six samples, after being purified [16,17], are evaluated by x-ray device to determine the mineral kind.

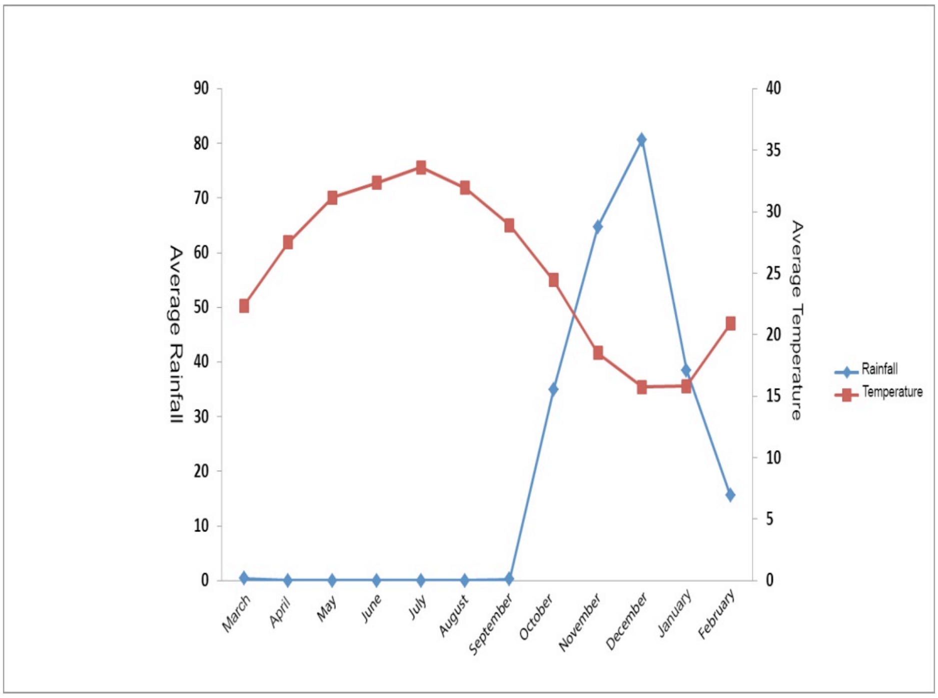

Figure 1. Bushehr's Embrothermic curve

3. RESULTS AND DISCUSSION

The temperature and humidity change curve is shown in figure 1. According to the present statistics, the studied region is associated with Hyperthermic and Aridic thermal and humidity regime respectively.

According to the results, topography and main materials are among the most important soil former factors in the area. Topography is related to gradient characteristics and the height change in comparison with sea level which influences several morphological and genetic characteristics, so the physical, chemical, and mineralogical characteristics of the soils are significantly under the influence of topography conditions. The soils former factors, helping us to distinguish different soils, are divided into two categories: Entistols, Aridisols. In these soils, the surface horizon is of Ochric and the subsurface horizons are of Cambic, Salic, and Calcic.

The soils are changed from salty-sodium to those soils associated with low salinity. So, in accordance with the change, the electric conductivity will change from 155.7ds/m in salty-sodium soils to 1.1ds/m in soils near Borazjan. The sodium is between 2.95 to 3 meq/lit. Since the rain is not decent to direct these minerals down, the surface layers of these soils are associated with sodium and other minerals accumulation.

The soil structure is either prismatic or plate form which differs from weak formed to the piles. The soils' color differs from 10YR4/2 to 10YR6/4 in weak formed to those more-completed-soils. As the soils get more completed, the color will be darker. In the studied region, the hue is equal in Entisols and Aridisols soils while the value and chroma are different. The calcification and salinization are among the most important phenomena in the profiles which were found as powdery, Calcic hard grain, white layers on the ground or salt solution piles. Regarding the more organic materials of surface soil in comparison with the depth, the microbial activities increases, so more organic materials are decomposed; hence, the organic acids will increase in surface soil which leads to the PH decrease. Also, due to lime watering, alkali elements, and Calcic main material in the lower horizons, PH of surface is lower in comparison to the depth. Generally, the alkali soil reaction and PH will differ from 7.3 to 8.3.

Table 1. Physico-chemical properties of soils.

Profile	Horizon	Depth cm	%Sand	%Silt	%Clay	pH	EC dSm^{-1}	CEC meq/100gr soil	%CaCO3	SAR
1	Az	0 25	3/4	86	10/6	7/3	155/7	8/6	53	191/2
	Bkz	25 100	5/4	86	8/6	7/6	54/14	10	55	66/3
2	A	0 5	11/4	76	12/6	7/9	123	12/8	50	150
	Bw	5 15	23/4	54	22/6	7/8	20/22	7/4	62	30/8
	Bk	15 31	9/4	44	46/6	8/1	17/73	24	47/5	29/5
3	A	0 12	7/4	48	44/6	7/4	36/28	8/6	51/5	39/1
	Bkz	12 35	9/4	56	34/6	7/7	17/89	9/4	56	20/4
	C	35 100	13/4	16	70/6	7/7	6/81	18	46/5	9/1
4	A	0 10	43/4	38	18/6	7/5	4/79	11/2	61	3/6
	C1	10 36	69/4	18	12/6	7/7	2/44	3/6	66/6	0/7
	C2	36 100	35/4	62	2/6	7/6	2/89	7/2	52/5	1/3
5	A	0 10	59/4	26	14/6	7/4	2/73	6/4	68/5	1/3
	C	10 60	63/4	18	18/6	7/7	1/10	5/6	67	1/2
6	A	0 15	41/4	38	20/6	7/6	1/74	5/2	59/5	1/3
	Bk	15 40	35/4	34	30/6	7/7	7/18	6	75	7/6
	C	40 100	87/4	4	8/6	8/3	10	2/8	67	14/6

3.1. How being low or high influences the soil formation and completion

Considering different physiography unites in the studied region, the variety of soils, the different physiochemical and mineralogical characteristics, and the equality of soil former factor, it is crystal clear that being high or low influences the soil formation and completion. Being low or high can significantly influence the appearance and diffusion of soil. The studied physiography unites in which the sample profiles are located are mostly salty low lands, flood plains, plateau, upper terraces, and piedmont plains. As the height from sea level increases, the subcategory of soil will differ from solids in salty-sodium soils to subcategory of Orthents and Calcids in Borazjan. In the terraces and upper plateau, regarding the more gradient in comparison with other physiography unites located in the studied region, the amount of waste water is high and the penetrated water and watering in low depth are low. These low depth soils are not profile completed; Furthermore, the subsurface horizons are not formed in these soils and the surface horizon is of Ochric. So, the Calcic horizons cannot be formed in these soils [Profiles 4, 5].

The piedmont plains, having lower gradient in comparison with plateau and upper terraces, are located along each other. The waste water which passes the upper terraces enter these soils and add lime and other minerals to them; Furthermore, low gradient brought about the water penetration increase which leaded in faster horizon formation. It is noteworthy that the subsurface horizon is of Calcic [Profile 6].

Flood plains, in comparison with piedmont plains, have lower gradient, so the received waste water and the penetrated water is higher; hence, the Calcic watering is mostly in the profile depth. Regarding the salty-sodium nature, weak drainage, calcification, and salinization, the subsurface horizons of these flood plains are of Salic and Calcic [Profiles 2,3].

Salty low lands of the studied region are associated with very low gradient and high alkalinity, so considering their deep soil and raised surface, they will receive a large amount of waste water in heavy rain seasons. These soils are also associated with Calcic and Salic subsurface horizons, showing being more completed in comparison with the soils located in upper terrace unites of higher gradient and height [Profile 1].

3.2. The process in which soils receive Calcium and Calcic horizon formation

The soils containing Calcic horizons are widespread specially in dry and semi-dry areas. Because the rain is not decent enough to move the carbonates out of the soil, so the carbonates will, till the humidity is decent, transfer and form sediments due to the humidity decrease. The studies done on formation and other physiochemical characteristics of soils represent that these soils are significantly under the influence of the high amount of lime in soils' profiles to the extent that the diffusion of this amount combined with the mostly Calcic main materials influence the soil formation and completion. Considering the above-mentioned conditions, carbonates activities are among the most important activities. Furthermore; lime accumulation and distribution is one of the most important criteria in Calcic soil studies which has been covered by several researchers. Generally Calcium Carbonates has two origins in soils:

Allogeneic origin: It includes those lime which has been existing in the soil and inherited to other soils.

Progenetic origin; Lime is formed through soil formation processes among which dissolution, transfer, and lime resedimentation in soil are of great importance in progenetic lime distribution and accumulation in soil .

In the studied region, almost in all profiles, there is a sign of secondary lime. In some of surface horizons of the studied region soils, the lime is higher in comparison with lower horizons. This very fact is due to additional sediments from other places which contain a significant amount of lime. Considering the lime amount in different horizons of profiles, it is crystal clear that in some of the profiles, calcium carbonates increases from surface to depth which shows the lime watering from surface horizons to the lower ones. According to the results, calcium carbonates in surface horizons will become calcium bicarbonates, a more soluble element, and move to lower surfaces, accumulating when the sediment conditions are met. The depth of accumulation is controlled by means of three factors:

- The beneficial rain penetration in soil
- Stone interruption
- Sudden change of soil structure which influences the velocity of water penetration in soil and brings about the carbonate sedimentation required conditions.

3.3. Salt addition to soil process and Salic horizon formation

The alkali salty soils, in more than half of the cultivable lands, are mostly discovered in dry and semi-dry areas. Most of these alkali salty soils, though not being used for planting, are associated with a variety of plants coverage which in combination with local animals can influence the biological variety.

The soils of dry and semi-dry areas are mostly alkali because the rain is not enough for watering the alkali cations (Ca^{+2}, Mg^{+2}, K^{+1}, Na^{+1},etc) . These cations are released by means of stones exposure to air, so the saturation percentage is high and the PH is mostly higher than 7. In some of the areas, the drainage is so weak that it prevents the salt solutions from watering; hence, it will lead in salinity and alkalinity salinization is a process in which excessive salt solutions are gathered in soil. These salts include : Na , K , Mg , Ca , Chloride , sulfate , carbonate , and bicarbonates (mostly NaCl and Na_2So_4) . The salinization process is of primary and secondary kind. The primary one, considering the upper components of the main mineral material or underground water, includes the salt accumulation through natural phenomena. The secondary is due to mankind interruption such as improper watering using salty water.

Sodification is a process in which the tradable Na increases. Na^+, the solid phase kind, or soil solution accumulates in the shape of crystals of Na_2CO_3 and $NaHCO_3$ which can be used as alkali former Ion or other tradable Ion in soil surface.

In the studied area, the salt solution accumulation has brought about Salic horizons. The white layers represent the salinity of these soils. EC is more than 4ds/m, SAR is more than 13, and PH is lower than 8.5, so the soils are salty-Sodium. The soil former factors of this area are as follow:

Main material, high level of underground water, low quality of the water, low rain, high vaporization.

3.4. Categories of the studied area

Entisols soils: These soils in which completion has stopped are fixed in terms of profile. These soils are associated with little or no genetic horizon change. Most of Entisols, except Ochric Epipedons, don't have any other horizons. These soils are young and don't have any sample identification horizons; Furthermore, these soils are made of new main materials which can be used for their identification. In addition these soils are found in every main materials, vegetation, and thermal and humidity regimes in steep lands. These soils, being located on the steeps, are exposed to extreme sedimentation and erosion. So they contain a lot of Calcium Carbonates and don't have enough time for profile completion.

Profiles 4 and 5 are put into the Typic Terriorthents category. Plateau and upper terrace's soils have a higher gradient in comparison with other physiography unites, so they have less completed profiles.

Aridisols soils: These soils are of Aridic humidity regime and form the main soils of the desert areas. These soils are the most seen kind in the earth which take up 20 %. The common coverage is widespread bushes that will change into desert weeds in the wet areas. Soil formation processes in the dry areas, except that they are slower, are similar to those of wet areas. Since the coverage is not dense, the organic materials are low. Wind is of a great importance in these soil formation. These Aridisol soils are associated with Ochric Epipedons which are mostly bright and contain low organic materials. In the dried areas, due to the weak rain, the watering and mineral movements are subtle. Another distinguishing factor of these soils is the presence of Calcic horizon. The studied area is mostly of Aridisols which contain Calcic, Salic, and Cambic horizons. The Aridisols in our studied area, regarding their Salic and Calcic horizons, are put into Salids and Calcids category that are of Haplosalids and Haplocalcids. This very fact is due to profile completion and lime accumulation.

Profiles 1 and 3 are put into calcic Haplosalids category. Soils of low salty lands, flood plains, with slow gradient, EC>4, SAR>13, and PH<8.5 are salty-Sodium. Salic horizon, Calcic horizon, and the presence of hard grain lime and powders are among these soils' characteristics. Profile 2 is put into Aqui Haplocalcids. The soil of flood plains, with slow gradient, EC>4, SAR>13, and PH<8.5 are salty-Sodium. These soils contain Calcic horizon associated with hard grain and powders. Since the water level is high, the subcategory is Aqui. Profile 6 is put into Sodic Haplocalcids. The soils of piedmont plains, gradient between 1 and 2 percent and 39 meter higher than sea level, contain a deep one associating with relatively heavy structure. The horizon of these soils are of Calcic with hard grain lime and powder. Since SAR is high, the subcategory is Sodic.

3.5. Clay mineral of the studied soils

The dominant clay minerals existing in the soils of studied area are: Chlorite, Illite, Smectite, Kaolinite, and Palygorskite. The origin of Chlorite, and Illite has led to their extreme appearance. Chlorite, and Illite, in exposure to air, can, through different actions, change to expansible minerals such as Smectite. There is, due to the strange and unstable condition of vermiculite, no evidence of vermiculite in the studied soil. So, there is a tendency to Smectite formation. Profiles and the clay mineral kind is shown in table 2.

Table 2. Classification of the soil profile and type of the clay minerals.

Mineral	WRB(2006)	USDA(2010)	Profile
Chlorite, Illite, Smectite, Kaolinite, Palygorskite	Episalic Solonochaks	Coarse-silty, carbonatic,superactive, hyperthermic, Calcic Haplosalids	1
Chlorite, Illite, Smectite, Kaolinite, Palygorskite	Calcic Solonochaks	Fine-loamy,carbonatic, superactive, hyperthermic,Aquic Haplocalcids	2
Chlorite, Illite, Smectite, Kaolinite, Palygorskite	Episalic Solonochaks	Clayey,carbonatic,semiactive,hyperthermic, Calcic Haplosalids	3
Chlorite, Illite, Smectite, Kaolinite, Palygorskite	Haplic Regosols	Coarse-loamy, carbonatic, superactive, calcareous, hyperthermic, Typic Torriorthents	4
Chlorite, Illite, Smectite, Kaolinite, Palygorskite	Haplic Regosols	Coarse-loamy,carbonatic, semiactive, hyperthermic, Typic Torriorthents	5

Chlorite, Illite, Smectite, Kaolinite, Palygorskite	Hypercalcic Calcisols	Fine-loamy,carbonatic, semiactive, hyperthermic,Sodic Haplocalcids	6

REFERENCES

[1] Bagheri, M. 1387. Applied land evaluation and land use planning. Publications Pelk. First edition.

[2] Brady, M. N and R.R, Will.1385. Translation Shahuy . The Nature and properties of Soils. Publications University of Kurdistan, First Edition.

[3] Abtahi,A.1978.Soil and ground water salinity and their relation to physiography.Iran J.Agric.Res. 6:21-32.

[4] Abtahi,A.1980.Soil genesis as affected by topography and time in highly calcareous parent material under semiarid conditions in Iran.Soil Sci.Sco. Am.J.44:329-336.

[5] Ramshny, Kh.1371. Climate impact on the formation, development, morphological characteristics, Classification of mineral soil of tropical Kohgiluyeh , Master's thesis, Department of Soil Science, College of Agriculture, Shiraz University.

[6] Sawhney,J.S.,V.K.V.Verma,B.D.Sharma,and P.K.Sharma. 1992. Pedogenesis in relation to physography in semi-arid condition of Punjab-Indian.Arid Soil Res.6(2):93-103.

[7] Boul,S.W.,F.D.Hole.,and R.J.Mc Craken.1997.Soil genesis and classification.4th ed.Iowa State Unvi.press,Ames.IA.446pp.

[8] Miles,J.1985.The pedogenic effects of different soecies and vegetation types and the implications of successions.J.Soil Sci.36:571-584.

[9] Miller, D. C. and P. W. Birkland. 1992. Soil catena variation along alpine climate transect, northern Peruvian Andes, Geoderma 55: 211-223.

[10] Rameshni,Kh.,and A. Abtahi. 1995.Effect of climate and topography on the formation of the soils of Kuhgiluye area.4th Congrees of Soil Science.Isfahan University of Technology, (In Persian).

[11] Soil Survey Staff.1993.Soil Survey Manual U.S.S.A.Handbook. No.18, Washington,D.C., USA.

[12] Soil Survey Staff.2010.Keys to soil taxonomy.USDA.NRCS.338pp.

[13] FAO-UNESCO-ISRIC.1988.Soil map of the world.Revised legend reprinted with correction world soil ressources report.No 60,FAO,Rome, 119pp.

[14] Bouyoucos,C.J.1962.Hydrometer method improved for making particle-size analysis of soils.Agron.J.54:464-465.

[15] Richards,L.A.(ed).1954.Diagnosis nd improvement of saline and alkaline soils.USDA Hand Book.No .60.US.Government Printing Office, Washingtone,DC.96pp.

[16] Jackson,M.L.1975.Soil chemical analysis-advanced course .Univ.Wis, Collage Agric,Dept. Soils,Madison,Wiscon-sin.211 pp.

[17] Kittrick,J.A.,and E.W.Hoppe.1963.A procedure for x-ray diffraction analysis.Soil Sci. 96:312-325.