Table (3) : Chemical analysis for the soils of old alluvial terraces.

Profile No.	Depth (cm)	pH	EC (dS/m)	Soluble cations (me/l)				Soluble anions (me/l)			O.M %	Gypsum %	$CaCO_3$ %
				Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}	$SO_4^{=}$			
6	0-20	7.5	5.61	20.60	11.00	28.5	2.24	1.4	30	30.94	0.107	1.22	46.98
	20-45	7.5	13.77	56.60	32.30	66.0	2.85	1.8	124	31.95	0.053	17.25	26.32
	45-150	7.4	26.88	68.95	67.65	340.0	6.25	1.5	362	119.35	0.232	28.36	13.92
7	0-10	7.4	5.51	29.55	11.82	28.80	1.20	1.2	35	35.17	0.246	0.80	48.29
	10-25	7.6	4.18	27.58	12.82	16.05	1.00	1.2	26	30.25	0.372	3.48	43.50
	25-45	7.5	8.36	41.37	29.82	41.00	1.08	1.5	85	26.77	0.258	11.94	27.41
	45-75	7.4	13.26	66.98	40.76	79.50	2.10	1.3	168	20.04	0.220	8.10	35.67
	75-150	7.5	12.75	49.25	46.95	88.50	2.40	1.4	152	33.70	0.144	8.42	32.63

Table (4) : Particle size distribution for the soils of old alluvial terraces.

Profile No.	Depth (cm)	Gravel %	Sand %						Silt %	Clay %	Textural class
			vc	c	m	f	vf	Total			
6	0-20	4	0.4	5.52	17.59	42.89	11.04	77.44	9.26	13.30	Fine sandy loam
	20-45	0	3.21	17.48	20.53	33.60	5.87	80.69	9.73	9.58	Loamy coarse sand
	45-150	75	9.34	31.95	18.95	24.02	4.87	89.13	7.31	3.56	Extremely gravelly loamy coarse sand
7	0-10	0	0.49	6.24	15.01	41.74	14.81	78.29	10.18	11.53	Fine sandy loam
	10-25	4	3.76	16.18	23.48	36.41	6.77	86.60	5.17	8.23	Loamy sand
	25-45	20	9.21	41.32	24.34	13.84	0.99	89.70	5.50	4.80	Gravelly coarse sand
	45-75	45	6.72	38.66	32.66	12.73	0.93	91.70	3.90	4.40	Very gravelly coarse sand
	75-150	10	9.34	37.06	28.54	12.47	0.89	88.30	5.50	6.20	Slightly gravelly loamy coarse sand

EC = **Electrical conductivity (dS/m)**
O.M = **Organic matter**
vc = **very coarse**
c = **coarse**
m = **medium**
f = **fine**
vf = **very fine**

Table (5) : Cation exchange capacity (CEC) and the exchangeable cations for the soils of old alluvial terraces.

Profile No.	Depth (cm)	CEC (me/100g soil)	Exchangeable cations (me/100g soil)				ESP
			Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	
6	0-20	8.98	4.8	2.82	0.80	0.56	8.91
	20-45	5.13	3.11	1.22	0.54	0.26	10.53
	45-150	3.88	1.82	1.4	0.47	0.19	12.11
7	0-10	8.76	5.04	2.60	0.92	0.20	10.50
	10-25	6.55	3.06	2.60	0.67	0.22	10.23
	25-45	3.31	1.80	1.06	0.35	0.10	10.57
	45-75	3.25	1.90	0.91	0.35	0.09	10.77
	75-150	4.73	3.51	0.59	0.49	0.14	10.36

4.2.1.2. Young alluvial terraces :

They have gently undulating surface, covered with many fine to coarse dark gravel, few stones and few scattered desert shrubs and weeds mainly in rills and gullies.

Soil colour is very pale brown, light yellowish brown, yellow, reddish yellow or strong brown, where colour hue is 10YR or 7.5YR, value is 5-7 and chroma is 4-6. Soil texture is fine sandy loam to sandy clay loam in the top soil and slightly gravelly, gravelly, or very gravelly coarse sand, or loamy coarse sand in the subsoil and substratum. Gravel content is less than 5% in the surface layer, and ranges from 10% to 60% in the subsoil and substratum. Soil structure is massive, except for the topsoil of soil profile No.9 which has moderate fine and medium subangular blocky. Consistence is soft, slightly hard or hard. Gypsum is found as soft, hard or crystals.

Soils are strongly effervescent with diluted hydrochloric acid. Full morphological description of soil profiles 9 and 11 that represent this physiographic unit is given hereafter.

Pedon : 9 **date : 7/8/97**

Classification : Leptic Haplogypsid, sandy skeletal, carbonatic, hyperthermic.

Location : South Sinai, about 7 km north-east of Ras Sudr.

Physiographic position: Young alluvial terraces.

Topography : Gently undulating (3%).

Slope : Nearly level, less than 1%, west-facing.

Drainage : Excessively drained, slow run off; rapid internal drainage.

Vegetation : Few scattered desert shrubs and weeds in rills.

Surface : Many fine to coarse subrounded gravel.

Parent material: Alluvium derived from mixed sedimentary rock sources.

Erosion : Few rills.

Horizon **Description**

A 0—10 cm : Reddish brown (7.5YR 7/6) fine sandy loam, strong brown(7.5YR 5/6) moist; moderate fine and medium subangular blocky; slightly hard (dry), friable (moist), slightly sticky and slightly plastic(wet); few hard gypsum accumulations; few fine gravel(4%); strongly effervescent, clear wavy boundary.

Cy 10—60 cm : Reddish yellow (7.5YR 6/6) gravelly loamy coarse sand, strong brown (7.5YR 5/6) moist; massive;slightly hard (dry), very friable(moist), slightly sticky and non plastic (wet); many hard gypsum accumulations; many fine and medium gravel(30%); strongly effervescent; clear smooth boundary.

C 60—150cm : Brownish yellow (10YR 6/6) very gravelly loamy coarse sand; yellowish brown (10YR5/6)moist; massive; hard (dry), very friable(moist), slightly sticky and nonplastic(wet), abundant medium and coarse gravel(60%); strongly effervescent.

Pedon : 11 **date : 7/8/97**

Classification : Leptic Haplogypsid, sandy, carbonatic, hyperthermic.

Location : South Sinai, about 9.5km. north-east of Ras Sudr.

Physiographic position: Young alluvial terraces.

Topography : Gently undulating (4%).

Slope : Gently sloping (4%) straight, west-facing.

Drainage : well drained; slow run off; rapid internal drainage.

Vegetation : Few scattered desert shrubs and weeds.

Surface : Many fine to coarse gravel and few stones.

Parent material : Alluvium derived from mixed sedimentary rock sources.

Erosion : Many rills and gullies.

Horizon	Description
A 0—15 cm	: Very pale brown (10YR 7/4) sandy clay loam, brownish yellow(10YR 6/6) moist; massive; soft (dry), firm (moist), sticky and plastic(wet); few fine to coarse gravel(4%); strongly effervescent; clear wavy boundary.
Cy1 15—30 cm	: Very pale brown (10YR 7/4)gravelly coarse sand, light yellowish brown (10YR 6/4) moist; massive; soft (dry), loose (moist), nonsticky and nonplastic (wet);common hard gypsum crystals; many fine gravel(16%); strongly effervescent; gradual wavy boundary.
Cy2 30—70cm	: Very pale brown (10YR 7/4) slightly gravelly coarse sand, light yellowish brown (10YR6/4)moist; massive; soft (dry), loose(moist), nonsticky and nonplastic (wet); few soft and hard gypsum; common fine and medium gravel (10%);strongly efferevescent; clear smooth boundary.
Cy3 70—150cm	: Very pale brown (10YR 7/4) gravelly coarse sand; light yellowish brown (10YR6/4)moist; massive; slightly hard (dry), loose(moist), nonsticky and nonplastic(wet); few hard gypsum; many fine to coarse gravel(30%); strongly efferevescent.

Concerning soil chemical characteristics, data in Table (6) show that the soils have mildy alkaline reaction, as pH values range from 7.4 to 7.5. The soils are strongly to very strongly calcareous as calcium

carbonate varies between 33.93% and 50.9% with irregular distribution with depth. Organic matter content is low and ranges from 0.17% to 0.358 %. Gypsum content varies from 1.28% in the topsoil to 17.2% in the subsoil layers, where gypsic horizon is formed (Cy from 10 to 60 cm in profile No.9 and Cy1 and Cy2 from 15 to 70 cm in profile No.11). The soils are moderately to strongly saline, and salinity increases with depth, as EC values vary between 15.3 (topsoil) and 27.63 dS/m (subsoil and substratum). Soluble cations are dominated by Na^{+} followed by Ca^{+2} and Mg^{+2}, while K^{+} ions are the least abundant soluble cations. The soluble Cl^{-} is the predominant anion followed by $SO_4^{=}$, while HCO_3^{-} is the least dominant soluble anion.

With regard to the particle size distribution, data in Table (7) show that sand is the main fine earth fraction, it ranges from 66.87% in the topsoil to 93.7% in the subsoil and substratum, while the highest value of silt (14.4%) was found in the topsoil of profile 9, and the lowest one (3%) was observed in the subsoil and substratum of profile 11.
The relatively high clay content (23.25%) was recorded in the topsoil of profile 11, and the lowest one (3.3%) in the subsoil and substratum of the same profile.

Cation exchange capacity values (Table 8) range from 9.65 me/100g soil in the topsoil of profile 11 to 2.08 me /100g soil in the subsoil and substratum of the same profile. The dominant exchangeable cation is Ca^{+2}, followed by Mg^{+2} and Na^{+}, while K^{+} is the least dominant exchangeable cation. Exchangeable sodium percentage (ESP) values range from 12.68% to 13.95 %, which indicate that there is no sodicity.

Table (6) : Chemical analysis of the soils of young alluvial terraces.

Profile No.	Depth (cm)	pH	EC (dS/m)	Soluble cations (me/l)				Soluble anions (me/l)			O .M %	Gypsum %	Ca CO_3 %
				Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}	$SO_4^{=}$			
9	0-10	7.4	16.32	63.04	30.27	150	1.5	1.5	195	48.31	0.258	2.71	44.37
	10-60	7.5	19.38	66.98	58.08	165	1.5	1.0	281	9.56	0.346	17.20	33.93
	60-150	7.5	27.63	80.30	64.40	270	1.5	1.6	360	54.60	0.346	3.88	42.20
11	0-15	7.4	18.36	83.73	37.48	159	1.5	1.4	222	58.31	0.358	1.28	45.68
	15-30	7.5	15.30	54.18	49.72	159	1.0	1.0	196	66.90	0.258	9.83	43.94
	30-70	7.4	20.40	87.67	68.17	230	1.5	1.0	314	72.34	0.170	8.62	50.03
	70-150	7.4	21.42	84.71	40.35	250	1.0	1.5	290	84.58	0.232	2.30	50.90

Table (7) : Particle size distribution of the soils of young alluvial terraces.

Profile No.	Depth (cm)	Gravel %	Sand %						Silt %	Clay %	Textural class
			vc	c	m	f	vf	Total			
9	0-10	4	2.00	6.4	10.82	32.15	17.53	68.90	14.40	16.70	Fine sandy loam
	10-60	30	6.97	32.77	18.08	18.68	4.90	81.40	10.80	7.80	Gravelly loamy coarse sand
	60-150	60	13.78	28.26	16.71	19.59	5.92	84.26	6.52	9.22	Very gravelly loamy coarse sand
11	0-15	4	0.72	5.87	19.32	31.78	9.18	66.87	9.88	23.25	Sandy clay loam
	15-30	16	8.17	42.25	23.41	14.19	3.19	91.21	2.64	6.15	Gravelly coarse sand
	30-70	10	3.43	42.43	31.24	13.50	2.52	93.12	3.47	3.41	Slightly gravelly coarse sand
	70-150	30	4.09	35.71	36.18	16.26	1.46	93.70	3.00	3.30	Gravelly coarse sand

Table (8): Cation exchange capacity and exchangeable cations of the soils of young alluvial terraces.

Profile No.	Depth (cm)	CEC (me/100g soil)	Exchangeable cations (me/100g soil)				ESP
			Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	
9	0-10	8.44	5.6	1.50	1.07	0.27	12.68
	10-60	4.40	2.4	1.26	0.60	0.14	13.64
	60-150	5.80	3.5	1.34	0.80	0.16	13.79
11	0-15	9.65	5.6	2.34	1.33	0.38	13.78
	15-30	3.40	1.8	1.06	0.44	0.10	12.94
	30-70	2.15	1.05	0.70	0.30	0.10	13.95
	70-150	2.08	1.0	0.70	0.28	0.10	13.46

4.2.2. Soils of alluvial deltaic plain :

4.2.2.1. Upper alluvial deltaic plain :

The soils of upper alluvial deltatic plain have almost flat to gently undulating surface with level to gently sloping towards the west direction. The surface is covered with many fine to coarse gravel, few to common stones, few to many low to high hummocks, and common to many desert shrubs and weeds. The surface is strongly dissected with many rills and gullies.

Soil colour is very pale brown, light yellowish brown, or brownish yellow, where colour hue is 10YR, value is 5-7, and chroma is 3-6. The texture commonly is very gravelly to extremely gravelly coarse sand, or slightly to gravelly fine sand, sand or sandy loam. Gravel content commonly range from 10% to 85%. Soil structure is structureless massive or single grains, consistence is loose, slightly hard, or hard. Gypsum is found as gypsic horizon within profile No.1 in different forms as soft accumulations in the topsoil and hard spongy or hard accumulations in subsoil.

Soils are strongly effervescent with diluted hydrochloric acid. Full morphological description of profiles 1,3,5,and 10 which represent this physiographic unit is given below.

Pedon : 1 **Date : 6/8/97**

Classification : Typic Haplogypsid, sandy skeletal, carbonatic, hyperthermic.

Location : South Sinai, about 12 km south-east of Ras Sudr.

Physiographic position: Upper deltaic plain of Wadi Wardan.

Topography : Almost flat, less than 2%.

Slope : Level,less than 0.5%, straight, west-facing.

Drainage : Excessively drained; slow run off; rapid internal drainage.

Vegetation : Many desert shrubs and weeds.

Surface : Many fine and medium gravel, few stones, many low sand hummocks.

Parent material: Alluvium derived from mixed sedimentary rock sources.

Erosion : Many rills and gullies

Horizon	Description
A 0—10 cm :	Brownish yellow (10YR 6/6) gravelly sandy loam, yellowish brown(10YR 5/6) moist; weak medium and coarse subangular blocky; soft (dry), friable (moist), slightly sticky and slightly plastic(wet);few fine soft gypsum accumulations; many medium and coarse gravel (25%); strongly effervescent; clear wavy boundary.
C 10—35 cm :	Very pale brown (10YR 7/4)very gravelly coarse sand, light yellowish brown (10YR 6/4) moist; single grain; loose (dry), loose(moist), nonsticky and non plastic (wet); abundant medium and coarse gravel(50%),common stones (10%); strongly effervescent; clear smooth boundary.
Cy1 35—55cm :	Yellow (10YR 7/6) slightly gravelly coarse sand; brownish yellow(10YR6/6)moist; massive; hard

(dry), loose(moist), nonsticky and nonplastic(wet); abundant hard spongy gypsum ; common fine and medium gravel(10%); weathered shiny mica; strongly efferevescent; clear smooth boundary.

Cy2 55—70cm : Very pale brown (10YR 7/4)gravelly coarse sand; brownish yellow (10YR6/6) moist; massive ; hard (dry), loose (moist), nonsticky and nonplastic (wet); many hard spongy gypsum ; many fine to coarse gravel(25%);few stones(50%);strongly efferevescent; clear wavy boundary.

Cy3 70—110cm : Very pale brown (10YR 7/4) very gravelly coarse sand; light yellowish brown (10YR6/4) moist;single grains; loose (dry), loose (moist), nonsticky and nonplastic (wet); common hard gypsum accumulations; abundant fine to coarse gravel (50%); strongly efferevescent; abrupt smooth boundary.

C 110—150cm : Very pale brown (10YR 7/4) slightly gravelly fine sand; light yellowish brown (10YR6/4)moist; massive; soft (dry), loose(moist), nonsticky and nonplastic(wet); common fine and medium gravel(10%); strongly efferevescent.

Pedon : 3 **Date : 6/8/97**

Classification: Typic Torriorthent, sandy skeletal, carbonatic, hyperthermic.

Location : South Sinai, about 8 km south-east of Ras Sudr.

Physiographic position: Upper deltaic plain of Wadi Wardan.

Topography : Gently undulating (3%).

Slope : Very gently sloping (3%), west-facing.

Drainage : Excessively drained, slow run off; rapid internal drainage.

Vegetation : Common desert shrubs and weeds.

Surface : Many medium and coarse gravel, common dark stones, common low and medium and few high hummocks.

Parent material: Alluvium derived from mixed sedimentary rock sources.

Erosion : Many rills and gullies.

Horizon **Description**

C1 0—65 cm : Very pale brown (10YR 7/3) extremely gravelly coarse sand, light yellowish brown(10YR 6/4) moist; massive; hard(dry), loose(moist), nonsticky and nonplastic(wet); abundant medium and coarse gravel (70%),common stones(15%); strongly effervescent; abrupt smooth boundary.

C2 65—80 cm : Very pale brown (10YR 7/4) very gravelly coarse sand, light yellowish brown (10YR 6/4) moist; massive; soft (dry), loose(moist), nonsticky and non plastic (wet); many fine to coarse gravel in pockets (40%); strongly effervescent ; abrupt smooth boundary.

C3 80—150cm : Very pale brown (10YR 7/4) sand; light yellowish brown (10YR6/4)moist; massive; hard (dry), loose(moist), nonsticky and nonplastic(wet); weathered mica; moderately efferevescent.

Pedon : 5 **Date : 6/8/97**

Classification :Typic Torriorthent, sandy skeletal, carbonatic, hyperthermic.

Location : South Sinai, about 13 km south-east of Ras Sudr.

Physiographic position: Upper deltaic plain of wadi Wardan.

Topography : Gently undulating (3%).

Slope : Gently sloping (3%).

Drainage : Excessively drained, slow run off; rapid internal drainage.

Vegetation : Common desert shrubs and weeds and few trees.

Surface : Many medium and coarse gravel, common stones, few boulders; common low and medium and few high hummocks.

Parent material: Alluvium derived from mixed sedimentary rock sources.

Erosion : Many rills and gullies.

Horizon **Description**

C1 0—20 cm : Very pale brown (10YR 7/3) gravelly fine sand, light yellowish brown(10YR 6/4) moist;stratified layers, massive; soft (dry), loose (moist), nonsticky and nonplastic(wet); many fine gravel (20%);strongly effervescent; clear smooth boundary.

C2 20—150 cm : Very pale brown (10YR 7/4) extremely gravelly coarse sand, yellowish brown (10YR 6/4) moist; massive;slightly hard (dry),loose(moist), nonsticky and non plastic (wet); abundant fine to coarse gravel(55%); common stones (15%),common boulders(10%); strongly effervescent.

Pedon : 10 **Date : 7/8/97**

Classification :Typic Torriorthent, sandy skeletal, carbonatic, hyperthermic.

Location : South Sinai, about 8 km north-east of Ras Sudr.

Physiographic position: Upper deltaic plain of Wadi Sudr.

Topography : Almost flat, less than 2% .

Slope : Nearly level, less than 1%, straight, west-facing.

Drainage : Excessively drained, slow run off; rapid internal drainage.

Vegetation : Common desert shrubs and weeds.

Surface : Many fine and medium and common coarse gravel,few stones, few low and medium hummocks.

Parent material : Alluvium derived from mixed sedimentary rock sources.

Erosion : Many rills and gullies.

Horizon **Description**

C1 0—20 cm : Very pale brown (10YR 7/4) very gravelly coarse sand, light yellowish brown(10YR 6/4) moist; massive; soft (dry), loose (moist), nonsticky and nonplastic(wet); abundant fine to coarse gravel (40%), few stones (5%); strongly effervescent; clear wavy boundary.

C2 20—50 cm : Very pale brown (10YR 7/4) gravelly sand, light yellowish brown (10YR 6/4) moist; single grain; loose (dry), loose(moist), nonsticky and non plastic (wet); many fine to coarse gravel(20%); few stones (5%); strongly effervescent; clear wavy boundary.

C3 50—150cm : Very pale brown (10YR 7/4)very gravelly coarse sand; light yellowish brown (10YR6/4)moist; single grains; loose (dry), loose(moist), nonsticky and nonplastic(wet);abundant fine to coarse gravel(50%); few stones(5%); strongly efferevescent.

Concerning chemical characteristics, data inTable (9) show that the soils have mildly to moderatly alkaline,as pH values range from 7.5 to 8.1. Soils are strongly to very strongly calcareous,as calcium carbonate varies between 26.75% and 51.33% with irregular distribution with depth. Organic matter content is very low and ranges from 0.026% to 0.445%, where the lowest content is observed in subsoil and substratum of profile 5, and the highest one in topsoil of profile 1.

Gypsum content is very low and ranges from 0.31% to 0.56%, except the subsoil (35—110 cm) of profile 1 where it is 7.98 - 27.34% and forms gypsic horizons.

The soils are non to moderately saline (EC 1.63—8.26 dS/m) in profiles 3,5,and 10, and moderately to strongly saline (EC 12.75-25.5 dS/m) in profile No.1, where the topsoil is strongly saline, and subsoil and substratum are moderately saline.

Soluble cations are dominated by Na^{+} followed by Ca^{+2} and Mg^{+2} and K^{+} ions are the least dominant soluble cations in profile 1, while in

profiles 3,5 and 10 the soluble cations follow the descending order : $Ca^{+2} > Na^{+} > Mg^{+2} > K^{+}$.

The dominant soluble anions are Cl^{-} and/or SO_4^{-2}, and the least dominant soluble anion is HCO_3^{-}.

Table (9):Chemical analysis of the soils of the upper part of alluvial deltaic plain

Profile No.	Depth (cm)	pH	EC (dS/m)	Soluble cations (me/l)				Soluble anions (me/l)			O .M %	Gypsum %	Ca CO_3 %
				Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	HCO_3	Cl^{-}	$SO_4^{=}$			
1	0-10	7.5	17.07	61.07	31.76	142.1	1.20	1.2	185.50	49.73	0.445	1.70	46.76
	10-35	7.5	25.50	122.14	51.02	259.5	2.50	1.5	354.00	88.66	0.256	4.14	44.81
	35-55	7.7	12.75	68.95	34.95	97.5	0.75	1.5	166.00	34.65	0.175	27.34	28.06
	55-70	7.9	12.75	39.40	33.71	110.0	0.50	1.5	137.24	44.87	0.178	15.30	26.75
	70-110	8.0	13.77	35.46	29.96	141.5	0.75	2.0	139.12	66.55	0.053	7.98	34.37
	110-150	8.1	13.26	33.49	26.15	144.5	0.50	2.0	135.36	67.28	0.107	3.82	34.15
3	0-65	7.7	3.47	19.70	6.27	17.83	0.50	2.0	20.68	21.62	0.067	0.50	47.20
	65-80	7.9	1.73	9.85	2.66	8.90	0.25	1.5	13.16	7.00	0.053	0.35	47.85
	80-150	8.1	1.53	7.88	2.70	7.13	0.25	3.0	10.50	4.46	0.040	0.35	47.85
5	0-20	7.8	1.63	8.87	2.67	7.49	0.45	1.5	7.00	10.98	0.040	0.39	44.37
	20-150	7.6	5.20	32.51	13.67	20.85	0.88	1.5	35.00	31.41	0.026	0.46	46.55
10	0-20	7.9	2.35	12.80	3.07	8.90	1.16	2.0	13.00	10.93	0.135	0.56	49.59
	20-50	7.8	6.73	32.51	10.40	46.25	1.25	1.3	48.00	41.11	0.258	0.31	46.98
	50-150	7.8	8.26	34.48	27.09	65.25	1.25	1.0	76.00	51.07	0.284	0.49	51.33

With regard to the particle size distribution, data in Table (10) show that sand is the main fine earth fraction, where its percentage ranges from 71.04% to 94.9%, while silt ranges from 1.8% to 9.16%,

Table (10) : Particle size distribution of the soils of upper part of alluvial deltaic plain.

Profile No.	Depth (cm)	Gravel %	Sand %						Silt %	Clay %	Textural class
			vc	c	m	f	vf	Total			
1	0-10	25	2.78	13.42	18.41	27.72	8.71	71.04	9.16	19.80	Gravelly sandy loam
	10-35	60	7.23	42.65	21.74	14.82	3.28	89.72	2.80	7.48	Very gravelly coarse sand
	35-55	10	8.29	37.77	17.06	21.44	3.98	88.54	6.47	4.99	Slightly gravelly coarse sand
	55-70	30	3.17	23.49	25.14	36.56	2.51	90.87	4.32	4.81	Gravelly coarse sand
	70-110	50	9.39	37.24	25.78	20.43	1.06	93.90	1.80	4.30	Very gravelly coarse sand
	110-150	10	2.02	10.05	21.03	56.57	2.83	92.50	2.70	4.80	Slightly gravelly fine sand
3	0-65	85	5.40	33.70	28.30	21.90	2.30	91.60	3.10	5.30	Extremely gravelly coarse sand
	65-80	40	4.12	24.20	33.96	25.76	3.16	91.20	3.20	5.60	Very gravelly coarse sand
	80-150	--	0.96	9.84	43.60	36.32	0.98	91.70	3.10	5.20	Sand
5	0-20	20	4.20	4.43	10.32	50.47	23.27	92.69	2.61	4.70	Gravelly fine sand
	20-150	80	11.50	42.52	23.31	13.18	1.39	91.90	1.90	6.20	Extremely gravelly coarse sand
10	0-20	45	8.56	19.60	29.26	26.69	5.19	89.30	5.90	4.80	Very gravelly coarse sand
	20-50	25	0.87	9.93	46.55	34.56	0.89	92.80	4.40	2.80	Gravelly sand
	50-150	55	4.02	23.42	42.53	23.52	1.41	94.90	2.40	2.70	Very gravelly coarse sand

and clay from 2.7% to 19.8%, where the highest values of silt and clay are found in the topsoil of profile No. 1.

Cation exchange capacity commonly is low, its values range from 1.71 to 4.6 me/100 g soil, it tends to increase in the upper 35 cm of profileNo.1 (6.99 - 9.44 me/100 g soil). The dominant exchangeable cation is Ca^{+2} followed by Mg^{+2} and Na^{+}, while K^{+} is the least dominant exchangeable cation. ESP values range from 8.87 to 13.67%, indicate no sodicity (Table 11).

4.2.2.2. Lower alluvial deltaic plain

Soils of lower alluvial deltaic plain have flat to almost flat topography with flat to nearly level slope. Most of the area is cultivated, and the bare areas are covered with silt crust and common desert shrubs and weeds.

Concerning the morphological characteristics, soil colour is very pale brown, light yellowish brown, yellowish brown, or brownish yellow, where hue is 10YR, value is 5-7 and chroma is 3-6.

Texture commonly is stratified layers of sand, find sand, very fine sand, fine sandy loam, or very fine sandy loam, and sometime coarse sand or gravelly coarse sand. Gravel content does not exceed 4%, except the lower part of profile 13 where gravel content reaches 20%. Structure is massive, and consistence is soft, or slightly hard. Secondary accumulations were not observed, and soils are strongly effervescent with diluted hydrochloric acid.

Full morphological description of profiles 2, 12 and 13 which represent this physiographic unit is given hereafter.

Table (11) : Cation exchange capacity and exchangeable cations of the soils of upper part of alluvial deltaic plain.

Profile No.	Depth (cm)	CEC (me/100g soil)	Exchangeable cations (me/100g soil)				ESP
			Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	
1	0-10	9.44	5.2	2.81	1.07	0.36	11.33
	10-35	6.99	3.6	2.55	0.70	0.14	10.01
	35-55	1.97	1.1	0.60	0.19	0.08	9.64
	55-70	2.03	1.2	0.53	0.18	0.12	8.87
	70-110	3.49	2.1	0.93	0.37	0.09	10.60
	110-150	3.95	2.2	1.12	0.54	0.09	13.67
3	0-65	3.62	1.68	1.44	0.40	0.10	11.05
	65-85	4.16	2.4	1.19	0.47	0.10	11.30
	85-150	3.69	1.7	1.47	0.43	0.09	11.65
5	0-20	3.09	1.34	1.20	0.33	0.22	10.68
	20-150	4.60	2.57	1.37	0.56	0.10	12.17
10	0-20	2.91	1.6	0.74	0.35	0.22	12.03
	20-50	1.83	0.81	0.65	0.21	0.16	11.48
	50-150	1.71	0.89	0.51	0.22	0.09	12.87

Pedon : 2 **Date : 6/8/97**

Classification : Typic Torrifluvent, sandy, carbonatic, hyperthermic.

Location : South Sinai, about 5 km south-east of Ras Sudr.

Physiographic position: Lower deltaic plain of Wadi Wardan.

Topography : Flat, less than 0.5%.

Slope : Flat, less than 0.2%,straight, west-facing.

Drainage : Well drained, slow run off; rapid internal drainage.

Land use : Olives cultivation.

Parent material: Alluvium derived from mixed sedimentary rock sources.

Horizon **Description**

Ap 0—15 cm : Very pale brown (10YR 7/4) fine sand, light yellowish brown(10YR 6/4) moist; massive; soft (dry), loose (moist), nonsticky and nonplastic(wet); strongly effervescent; clear wavy boundary.

C1 15—25 cm :Very pale brown (10YR 7/3)fine sandy loam, light yellowish brown (10YR 6/4) moist; massive; slightly hard (dry), friable(moist), slightly sticky and slightly plastic (wet); strongly effervescent; clear wavy boundary.

C2 25—40cm : Light yellowish brown (10YR 6/4) fine sand; yellowish brown (10YR5/6)moist; massive; soft (dry), loose (moist), nonsticky and nonplastic (wet); few fine gravel (4%); strongly efferevescent; gradual smooth boundary.

C3 40—70cm : Brownish yellow (10YR 6/6) fine sand; yellow (10YR7/6)dry; massive; loose (moist), nonsticky and nonplastic (wet); strongly efferevescent; clear smooth boundary.

C4 70—150cm : Light yellowish brown (10YR 6/4) fine sandy loam; very pale brown (10YR7/4)dry; massive; friable (moist), slightly sticky and slightly plastic(wet); common medium roots; strongly efferevescent.

Pedon : 12 **Date : 7/8/97**

Classification : Typic Torripsamment, carbonatic, hyperthermic.

Location : South Sinai, about 5.5 km north of Ras Sudr.

Physiographic position: Lower deltaic plain of Wadi Sudr.

Topography : Almost Flat, less than 2%.

Slope : Nearly level, less than 1%,straight, west-facing.

Drainage : Excessively drained, slow run off; rapid internal drainage.

Land use : Olives cultivation.

Parent material: Alluvium derived from mixed sedimentary rock sources.

Horizon **Description**

Ap 0—15 cm : Very pale brown (10YR 7/4) fine sand , light yellowish brown(10YR 6/4) moist; massive; soft (dry), loose (moist), nonsticky and nonplastic(wet); few fine gravel(4%); strongly effervescent; gradual wavy boundary.

C1 15—30 cm :Very pale brown (10YR 7/4)coarse sand ,light yellowish brown (10YR 6/4) moist; massive; soft (dry), loose (moist), nonsticky and nonplastic (wet); few fine and medium gravel (4%), thin layer of gravel between the second and third layers; strongly effervescent; abrupt smooth boundary.

C2 30—150cm : Brownish yellow (10YR 6/6) sand; very pale brown (10YR7/4)dry; single grains; loose(moist), nonsticky and nonplastic (wet); strongly efferevescent.

Pedon : 13 **Date : 7/8/97**

Classification :Typic Torrifluvent, coarse loamy, carbonatic, hyperthermic.

Location : South Sinai, about 5 km north of Ras Sudr.

Physiographic position: Lower deltaic plain of Wadi Sudr.

Topography : Flat, less than 2%.

Slope : Nearly level, less than 1%,straight, west-facing.

Drainage : Well drained, slow run off; rapid internal drainage.

Vegetation : Common desert shrubs and weeds.

Parent material: Alluvium derived from mixed sedimentary rock sources.

Erosion : Few rills.

Horizon **Description**

C1 0—20 cm : Very pale brown (10YR 7/4) fine sandy loam , light yellowish brown(10YR 6/4) moist; massive; soft

(dry), friable (moist), slightly sticky and slightly plastic(wet); strongly effervescent; gradual smooth boundary.

C2 20—35 cm :Very pale brown (10YR 7/4)fine sandy loam,light yellowish brown (10YR 6/4) moist; massive; soft (dry), firm(moist), sticky and plastic(wet); strongly effervescent; diffuse smooth boundary.

C3 35—80cm : Very pale brown (10YR 7/4)very fine sandy loam, light yellowish brown (10YR6/4)moist; massive; slighty hard (dry), firm (moist), sticky and plastic (wet); strongly efferevescent; abrupt smooth boundary.

C4 80—150cm : Very pale brown (10YR 7/3)gravelly coarse sand; light yellowish brown (10YR6/4)moist; massive; soft (dry), loose (moist), nonsticky and nonplastic(wet); many fine to coarse gravel (20%); strongly efferevescent.

With regard to chemical characteristics, data in Table (12) show that the soils have neutral to moderately alkaline reaction as pH values range from 7.1 to 8.0 . Soils are slightly to strongly saline (EC 6.83-24.48 dS/m) in the topsoil, and very slightly to moderately saline (EC 3.01-10.71dS/m) in the subsoil and substratum. Calcium carbonate contents (43.72-54.38%) indicate that the soils are very strongly calcareous. Organic matter content is very low, where its values vary between 0.053 and 0.509%, and gypsum content is very low too (0.37 – 0.72%).

Soluble cations are dominated by Na^+ and /or Ca^{+2}, followed by Mg^{+2}, and the least prominant soluble cations are K^+. Soluble anions are dominated by Cl^- and/or $SO_4^=$ and the least dominant soluble aions are HCO_3^-.

Table (12) : Chemical analysis of the soils of lower part of alluvial deltaic plain.

Profile No.	Depth (cm)	pH	EC (dS/m)	Soluble cations (me/l)				Soluble anions (me/l)			O.M %	Gypsum %	$CaCO_3$ %
				Ca^{+2}	Mg^{+2}	Na^+	K^+	HCO_3^-	Cl^-	$SO_4^=$			
2	0-15	7.1	24.48	86.68	76.86	240.00	1.50	2.5	355.36	47.18	0.120	0.61	45.24
	15-25	7.6	6.12	23.64	12.92	43.75	0.50	3.0	30.00	47.81	0.187	0.37	47.20
	25-40	7.9	4.08	10.84	10.32	32.63	0.38	1.5	26.32	26.35	0.067	0.37	44.81
	40-70	8.0	3.57	11.82	11.27	22.90	0.50	1.5	25.38	19.61	0.053	0.41	43.72
	70-150	7.7	10.71	36.45	32.81	76.00	0.75	1.5	100.00	44.51	0.162	0.41	45.46
12	0-15	7.6	6.83	29.55	18.17	46.25	0.38	1.5	66.00	26.85	0.270	0.66	46.55
	15-30	7.9	3.01	17.24	10.66	16.05	0.25	1.8	12.00	30.40	0.346	0.49	51.33
	30-150	7.9	3.26	13.79	9.30	19.60	0.38	1.4	18.00	23.67	0.246	0.37	50.46
13	0-20	7.1	9.49	44.33	25.90	53.80	1.00	2.2	93.00	29.83	0.483	0.72	51.33
	20-35	7.4	4.90	29.55	12.78	22.25	0.38	1.2	34.00	29.76	0.509	0.37	54.38
	35-80	7.5	7.34	28.07	20.99	46.50	0.38	1.4	49.50	45.04	0.384	0.60	54.38
	80-150	7.7	4.59	21.67	12.96	25.00	0.38	1.2	36.00	22.81	0.232	0.40	53.07

Particle size distribution data in Table (13) show that sand is the main fine earth fraction, where its amounts range from 58.39 to 95.22%, while silt ranges from 0.58 to 25.5% and clay 4.2-16.11%.

Concerning the cation exchange capacity, data in Table (14) show that CEC values range from 2.68 to 7.96 me/100g soil. The dominated exchangeable cations are Ca^{+2} and/or Mg^{+2}, followed by Na^+ and K^+. ESP values range from 7.25 to 13.1%

Table (13) : Particle size distribution of the soils of lower part of alluvial deltaic plain.

Profile No.	Depth (cm)	Gravel %	Sand %						Silt %	Clay %	Textural class
			vc	c	m	f	vf	Total			
2	0-15	--	0.04	2.52	17.64	53.66	14.39	88.25	4.56	7.19	Fine sand
	15-25	--	0.65	4.75	16.53	46.59	12.62	81.14	6.94	11.92	Fine sandy loam
	25-40	4	0.32	3.07	19.77	60.22	8.41	91.79	3.65	4.56	Fine sand
	40-70	--	0.48	5.22	20.46	57.65	8.39	92.20	3.50	4.30	Fine sand
	70-150	--	0.62	6.18	13.34	41.55	13.51	75.20	10.63	14.17	Fine sandy loam
12	0-15	4	0.52	4.69	12.76	49.79	19.34	87.10	6.40	6.50	Fine sand
	15-30	4	3.43	21.97	33.39	32.53	3.90	95.22	0.58	4.20	Coarse sand
	30-150	--	1.59	10.47	29.95	39.99	10.43	92.43	2.46	5.11	Sand
13	0-20	--	0.46	3.14	10.65	41.03	21.98	77.26	11.62	11.12	Fine sandy loam
	20-35	--	0.10	2.00	7.94	27.94	26.63	64.61	20.60	14.79	Fine sandy loam
	35-80	--	0.17	1.67	2.69	24.48	29.38	58.39	25.50	16.11	Very fine sandy loam
	80-150	20	4.41	24.96	26.30	25.55	8.38	89.60	4.40	6.00	Gravelly coarse sand

Table (14) :Cation exchange capacity and exchangeable cations of the soils of lower part of alluvial deltaic plain.

Profile No.	Depth (cm)	CEC (me/100g soil)	Exchangeable cations (me/100g soil)				ESP
			Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	
2	0-15	4.63	2.0	2.00	0.50	0.13	10.80
	15-25	6.67	2.6	3.18	0.77	0.12	11.54
	25-40	2.90	0.8	1.60	0.38	0.12	13.10
	40-70	2.89	1.7	0.70	0.37	0.12	12.80
	70-150	7.00	3.1	2.92	0.84	0.14	12.00
12	0-15	3.73	1.8	1.43	0.38	0.12	10.19
	15-30	2.68	1.6	0.69	0.30	0.09	11.19
	30-150	3.24	2.0	0.72	0.42	0.10	12.96
13	0-20	6.48	4.0	1.72	0.47	0.29	7.25
	20-35	7.12	4.8	1.56	0.53	0.23	7.44
	35-80	7.96	4.6	2.34	0.80	0.22	10.05
	80-150	3.63	2.1	1.09	0.35	0.09	9.64

4.2.3. Soils of playa :

Soils of playa have almost flat topography, and nearly level slope. The surface is covered with many fine and medium white gravel, few low hummocks and few scattered desert shrubs and weeds. The surface is slightly dissected with few rills.

Soil colour is brownish yellow, yellowish brown, light olive brown, or olive brown, where hue is 10YR or 2.5Y, value and chroma 4 - 6. Soil texture is sandy clay loam, coarse sandy loam or gravelly coarse sandy loam.

Gravel content dose not exceed 16%. Structure is massive, and consistence is soft and hardness tends to increase with depth (very hard).

Gypsum is found as soft and hard accumulations in the uppermost layers and crystals below a depth of 60 cm. Soils are strongly effervescent in the topsoil and moderately to weakly effervescent in subsoil and substratum with diluted hydrochloric acid. Full morphological description of profile No.8 which represents this physiographic unit is given below.

Pedon : 8 **Date : 7/8/97**

Classification : Leptic Haplogypsid, fine loamy,mixed, hyperthermic
Location : South Sinai, about 2.5 km south-east of Ras Sudr.
Physiographic position: Playa.
Topography : Almost flat, less than 2%
Slope : Nearly level, less than 1%, straight, south-west-facing.

Drainage : Well drained, slow run off; rapid internal drainage.

Vegetation : Few scattered desert shrubs and weeds.

Surface : Many fine and medium white gravel, few low hummocks.

Parent material: Alluvium derived from mixed sedimentary rock sources

Erosion : Few rills.

Horizon	**Description**
A 0—15 cm :	Brownish yellow (10YR 6/6) sandy clay loam, yellowish brown(10YR 5/6) moist; massive; soft (dry), friable (moist), slightly sticky and slightly plastic(wet); strongly effervescent; clear wavy boundary.
Cy1 15—40 cm :	Brownish yellow (10YR 6/6) gravelly coarse sandy loam , yellowish brown (10YR 5/6) moist; massive; slighty hard (dry), friable(moist), slightly sticky and slightly plastic (wet); few soft and hard gypsum; many fine gravel (16%); moderately effervescent; clear wavy boundary.
Cy2 40—60cm :	Light olive brown (2.5Y 5/4) coarse sandy loam;olive brown (2.5Y4/4)moist; few very dark gray mottles (10YR 3/1); massive; hard (dry), fraible (moist), slightly sticky and slightly plastic(wet); many soft and hard gypsum ;weakly efferevescent; gradual smooth boundary.

Cy3 60—150cm : Light olive brown (2.5Y 5/4) sandy clay loam; olive brown (2.5Y4/4) moist; common very dark gray mottles (10YR 3/1); massive; very hard (dry), firm (moist), sticky and plastic(wet); abundant gypsum crystals; weakly efferevescent.

Concerning chemical characteristics, data in Table (15) show that the soils have neutral to moderately alkaline reaction, as pH values range from 6.8 to 7.9. Soils are moderately, strongly or very strongly calcareous, where calcium carbonate contents vary between 13.05 and 54.38% with irregular distribution with depth. Organic matter content is very low and ranges from 0.372% in topsoil to 0.284% in the subsoil and substratum.

Gypsum content is very low in topsoil (1.89%), and it increases with depth to reach 27.11% in the subsoil and substratum which is enough to form gypsic horizon. Soils are strongly to extremely saline, where EC is 66.3 dS/m in topsoil and decreases with depth to 18.7 dS/m in subsoil and substratum. The soluble cations are dominated by Na^{+} followed by Ca^{+2} and /or Mg^{+2}, while K^{+} is the least dominated cation. Soluble anions follow the descending order : $Cl^{-} > SO_4^{=} > HCO_3^{-}$.

With regard to the particle size distribution, data in Table (16) show that soil fraction percentages 48.56 - 69.7%, 17.3-29.99% and 7.5-32.1% for sand, silt and clay, respectively.

Table (15) : Chemical analysis of the soils of playa.

Profile No.	Depth (cm)	pH	EC (dS/m)	Soluble cations (me/l)				Soluble anions (me/l)			O .M %	Gypsum %	Ca CO_3 %
				Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}	$SO_4^{=}$			
8	0-15	6.8	66.30	364.45	231.99	750	10.00	1.3	1300	55.14	0.372	1.89	54.38
	15-40	7.2	51.00	145.78	160.14	726	10.00	1.5	880	160.42	0.346	9.71	25.23
	40-60	7.9	36.72	61.07	69.76	595	7.50	1.5	692	39.83	0.296	15.48	13.05
	60-150	7.9	18.70	47.70	45.20	185	1.56	1.4	238	91.06	0.284	27.11	17.40

Table (16) : Particle size distribution of the soils of playa.

Profil No.	Depth (cm)	Gravel %	Sand %						Silt %	Clay %	Textural class
			vc	c	m	f	vf	Total			
8	0-15	--	1.13	4.95	18.92	22.18	14.62	61.80	17.30	20.9	Sandy clay loam
	15-40	16	11.27	26.26	10.13	15.46	6.58	69.70	16.20	14.1	Gravelly coarse sandy loam
	40-60	--	7.84	25.99	10.76	15.61	2.79	62.99	29.99	7.5	Coarse sandy loam
	60-150	--	7.32	21.08	7.28	10.64	2.24	48.56	19.34	32.1	Sandy clay loam

Table (17): Cation exchange capacity and exchangeable cations of the soils of playa.

Profile No.	Depth (cm)	CEC (me/100g soil)	Exchangeable cations (me/100g soil)				ESP
			Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	
8	0-15	9.78	5.2	3.06	1.24	0.28	12.68
	15-40	8.56	6.0	1.53	0.70	0.33	8.18
	40-60	4.44	2.5	1.45	0.33	0.16	7.43
	60-150	13.89	7.6	3.99	1.98	0.32	14.25

Concerning cation exchange capacity, data in Table (17) show that CEC values range from 4.44 to 13.89 me/100g soil, and coincide with clay content, the dominated exchangeable cation is Ca^{+2} followed by Mg^{+2}, Na^{+} and K^{+}. ESP values range from 7.43 to 14.25% , indicate that there is no sodicity in these soils.

4.2.4. Soils of sabkhas:

Soils of sabkhas have almost flat relief, and nearly level slope. Surface is covered with thin to thick salt crust and pseudo sand, common medium to high hummocks, and many halophytes.

The morphological characteristics observed in profile No.15, which represents this physiographic unit show that the soil colour is yellowish brown, dark grayish brown, light brownish gray, or light gray, where hue is 10YR, value is 7-4, and chroma is 2-4. Texture is loam in topsoil, and silty clay loam or clay loam in subsoil and substratum. Structure is massive and consistence is friable in topsoil and firm in subsoil and substratum when moist.

Accumulation of salts found in the topsoil and subsoil, and it is enough to form a salic horizon. Soils are strongly effervescent with diluted HCl.

Soil description of profile No. 15 is given below.

Pedon : 15 **Date : 7/8/97**

Classification : Typic Haplosalid,fine loamy, carbonatic, hyperthermic.

Location : South Sinai, about 6 km north west of Ras Sudr.

Physiographic position: Sabkha.

Topography : Almost flat.

Slope : Nearly level.

Drainage : Poorly drained, slow run off; moderately slow internal drainage.

Vegetation : Many halophytes.

Surface : Thin to thick salt crust, pseudosands and common medium to high hummocks.

Parent material: Alluvium derived from mixed sedimentary rock sources

Horizon	**Description**
Az 0—15 cm :	Yellowish brown (10YR 5/4) loam, yellowish brown(10YR 6/4) dry; massive; friable (moist), sticky and plastic (wet); many salt accumulations; strongly effervescent; clear smooth boundary.
Cz 15—50 cm :	Dark grayish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; massive; firm (moist), very sticky and very plastic (wet); many salt accumulations; strongly effervescent; gradual smooth boundary.
C 50—150cm :	Light brownish gray (10YR 6/2) clay loam; light gray (10YR7/2)dry; massive; firm (moist); sticky and plastic (wet); strongly efferevescent.

Concerning chemical characteristics, data in Table (18) show that the soils have neutral to mildly alkaline reaction as pH values range from 6.6 in topsoil to 7.8 in subsoil and substratum. Calcium carbonate

Table (18) : Chemical analyses of the soils of sabkha.

Profile No.	Depth (cm)	pH	EC (dS/m)	Soluble cations (me/l)				Soluble anions (me/l)			O .M %	Gypsum %	Ca CO_3 %
				Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}	$SO_4^{=}$			
15	0-15	6.6	136.05	130	1285.0	2140	43.0	2.0	3280	316	2.20	1.86	40
	15-50	7.7	90.7	100	157.31	1120	25.0	3.5	940	458.8	0.55	2.68	48
	50-150	7.8	22.68	55	45.07	225	4.3	1.5	310	17.87	0.29	1.00	54

Table (19) : Particle size distribution of the soils of sabkha.

Profil No.	Depth (cm)	Gravel %	Sand %						Silt %	Clay %	Textural class
			vc	c	m	f	vf	Total			
15	0-15	--	0.01	0.33	0.48	9.89	25.59	36.3	41.8	21.8	Loam
	15-50	--	0.01	0.39	0.34	2.21	5.95	8.9	59.5	31.6	Silty clay loam
	50-150	--	0.06	1.12	1.00	7.44	14.88	24.5	46.4	29.4	Clay loam

Table(20): Cation exchange capacity and exchangeable cations of the soils of sabkha.

Profile No.	Depth (cm)	CEC (me/100g soil)	Exchangeable cations (me/100g soil)				ESP
			Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	
15	0-15	10.45	4.4	4.37	1.36	0.32	13.01
	15-50	12.51	5.5	5.08	1.46	0.47	11.67
	50-150	12.78	5.3	4.94	1.64	0.90	12.83

contents vary between 40% in topsoil and 54% in subsoil and substratum which indicate that the soils are very strongly calcareous. Organic matter content is very low in subsoil and substratum (0.29-0.55%) while increases in the topsoil to 2.2% due to the effect of salinity. Gypsum content is low and varies between 1% and 2.68%. Soils are extremely saline in the top and subsoil and strongly saline in subsoil and substratum, as indicated by EC values 136.05 in the topsoil and 90.7 dS/m in subsoil, which are enough to form salic horizons,and 22.68 dS/m in the lower part of subsoil and substratum.

Soluble cations are dominated by Na^{+}, followed by Mg^{+2} and Ca^{+2}, and the least prominent soluble cation is K^{+}, while soluble anions are dominated by Cl^{-}, followed by $SO_4^{=}$, and the least dominated anion is HCO_3^{-}.

Particle size distribution data in Table (19) show that silt is the main fine earth fraction, followed by clay and /or sand, where the percentages of soil fractions are 41.8 - 59.5%, 21.8-31.6% and 8.9-36.3% for silt, clay and sand, respectively.

With regard to cation exchange capacity, data in Table (20) show that CEC values range from 10.45 to 12.78 me/100g soil and coincide with clay amounts. The prominent exchangeable cation is Ca^{+2}, followed by $Mg^{+2,}$ Na^{+}, K^{+}, with a descending order $Ca^{+2} > Mg^{+2,} > Na^{+} > K^{+}$. ESP values range from 11.67% to 13.1%.

4.2.5. Soils of oolitic sand dunes:

Soils of oolitic sand dunes have undulating to rolling topography with convex sloping slope. The surface is covered with few scattered desert shrubs. Concerning the morphological characteristics, soil colour

is yellow or brownish yellow, where hue is 10YR, value is 6-7 and chroma is 6-8. Soil texture is sand, structure is single grains and consistence is loose. Soils are strongly effervescent with diluted HCl. Full morphological description of profile No.14 which represents this physiographic unit is given below.

Pedon : 14 **Date : 7/8/97**

Classification : Typic Torripsamment, carbonatic, hyperthermic.

Location : South Sinai, about 7 km north west of Ras Sudr town.

Physiographic position: Oolitic sand dunes.

Topography : Undulating.

Slope : Convex sloping .

Drainage : Excessively drained, moderate run off and rapid internal drainage.

Vegetation : Few scattered desert shrubs.

Parent material : Aeolian deposits derived from sedimentary rock.

Horizon	**Description**
C1 0—30 cm :	Yellow (10YR 7/8) sand, brownish yellow(10YR 6/6) moist;single grains;loose (dry and moist), nonsticky and nonplastic(wet);strongly effervescent; diffuse smooth boundary.
C2 30—80 cm :	Yellow (10YR 7/8) sand, yellow (10YR 7/6)moist; single grains; loose(dry and moist), nonsticky and nonplastic (wet); strongly effervescent; diffuse smooth boundary.

C3 80—150cm : Yellow (10YR 7/6) sand; brownish yellow (10YR6/6)moist; single grains; loose(dry and moist), nonsticky and nonplastic(wet); strongly efferevescent.

With regard to chemical characteristics, data in Table (21) show that the soils have neutral to mildly alkaline reaction, as pH values range from 7.2 to 7.6. Calcium carbonate content ranges from 94 to 97%, which indicates that the soils are extremely calcareous. Organic matter content is low, where values vary between 0.24 and 0.55%. Gypsum content is very low too, where values range from 0.35 to 0.6%. Soils are very strongly saline in the topsoil, where EC is 36.28 dS/m and strongly saline in subsoil and substratum, where EC values range from 22.68 to 23.58 dS/m. Soluble cations are dominated by Na^{+}, followed by Mg^{+2} and /or Ca^{+2} , while the least dominated is K^{+}. Soluble anions follow the descending order: $Cl^{-} > SO_4^{=} > HCO_3^{-}$ .Particle size distribution data in Table (22) show that sand is main fine earth fraction, where its amounts range from 94.5 to 95.3%, and the dominant size is medium sand, while clay and silt are 3.9-5.1% and 0.4-0.8%, respectively.

Concerning the cation exchange capacity, data in table (23) show that CEC values is very low and vary between 2.41 and 3.62 me/100 g soil. Exchangeable cations are dominated by Ca^{+2} , followed by Mg^{+2} , Na^{+} , and K^{+}. ESP values range from 13.55 to 14.94%.

Table (21) : Chemical analysis of the soils of oolitic sand dunes.

Profile No.	Depth (cm)	pH	EC (dS/m)	Soluble cations (me/l)				Soluble anions (me/l)			O .M %	Gypsum %	$CaCO_3$ %
				Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}	$SO_4^{=}$			
14	0-30	7.2	36.28	80	82.01	410	10.0	2.5	570	9.51	0.24	0.35	96
	30-80	7.6	22.68	55	54.60	215	4.3	2.0	320	6.90	0.55	0.47	94
	80-150	7.2	23.58	60	82.95	210	4.5	3.0	310	44.45	0.45	0.60	97

Table (22) : Particle size distribution of the soils of oolitic sand dunes.

Profile No.	Depth (cm)	Gravel %	Sand %						Silt %	Clay %	Textural class
			vc	c	m	f	vf	Total			
14	0-30	--	0.03	5.51	85.26	3.47	0.23	94.5	0.4	5.1	Sand
	30-80	--	0.03	9.56	82.36	2.57	0.18	94.7	0.4	4.9	Sand
	80-150	--	0.03	19.65	74.67	0.92	0.03	95.3	0.8	3.9	Sand

Table(23) : Cation exchange capacity and exchangeable cations of the soils of oolitic sand dunes.

Profile No.	Depth (cm)	CEC (me/100g soil)	Exchangeable cations (me/100g soil)				ESP
			Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	
14	0-30	3.62	1.6	1.30	0.5	0.22	13.81
	30-80	3.32	1.5	1.15	0.45	0.22	13.55
	80-150	2.41	1.0	0.84	0.36	0.21	14.94

4.2.6. Soils of coastal sand beach:

Soils of coastal sand beach have almost flat topography, and nearly level slope. The surface is covered with thin salt crust, few shell fragments and few scattered halophytes.

Concerning morphological characteristics, soil colour is very pale brown, or light yellowish brown, where hue is 10YR, value 6-7, and chroma is 3-4. The topsoil is dry, subsoil down to 70cm is moist,and is wet where water table is found at depth of 70cm from the surface. Texture is sand throughout the profile layers, structure is massive and the consistence is slightly hard (dry) in the topsoil, loose(moist) in subsoil, and non sticky and non plastic (wet) in lower part of subsoil and substratum. Common salt accumulations were observed in topsoil. Soils are strongly effervescent with diluted HCl. Full morphological description of profile No. 4 which represents this physiographic unit is given below.

Pedon : 4 **Date : 6/8/97**

Classification : Typic Torripsamment, carbonatic, hyperthermic.

Location : South Sinai, Ras Matarma, about 16 km south-east of Ras Sudr .

Physiographic position: Coastal sand beach.

Topography : Almost flat, less than 2%.

Slope : Nearly level, less than 1%, west-facing .

Drainage : Excessively drained, slow run off and rapid internal drainage.

Vegetation : Few halophytic shrubs and weeds.

Surfac : Thin salt crust and few shells.

Parent material: Marine deposits derived from mixed sedimentary rock sources.

Ground water : Moderately deep saline water table (70cm).

Horizon	Description
Az 0—20 cm :	Very pale brown (10YR 7/4) sand, light yellow brown (10YR 7/4) moist; massive; slightly hard (dry), loose (moist), nonsticky and nonplastic (wet); common coarse hard salt accumulations;strongly effervescent; clear smooth boundary.
C1 20—70 cm :	Light Yellowish brown (10YR 6/4) sand, very pale brown (10YR7/4) dry; massive; loose (moist), nonsticky and nonplastic (wet);moderately effervescent; clear smooth boundary.
C3 80—150cm :	Light Yellowish brown (10YR 6/4) sand; very pale brown (10YR7/3) dry; massive; nonsticky and nonplastic(wet); strongly efferevescent.

With regard to chemical characteristics, data in Table (24) show that the soils have moderately alkaline reaction as pH values range from 8.0 to 8.2. Soils are extremely calcareous in the topsoil and very strongly calcareous in subsoil, where calcium carbonate content is 84.83% in topsoil, and 54.38% in subsoil. Organic matter content is very low (0.053—0.067%) and gypsum content is very low too (0.4-0.61%). Soils are strongly saline in the topsoil (EC 27.54dS/m), and moderately saline in subsoil (EC 13.77dS/m). Soluble cations are dominated by Na^+,

followed by Mg^{+2} and Ca^{+2} and the least prominent soluble cation is K^{+}. Soluble anions are dominated by Cl^{-}, followed by $SO_4^{=}$ and the least dominant soluble anion is HCO_3^{-}.

Particle size distribution data in Table (25) show that soils are sandy throughout the profile layers. Sand is the main fine earth fraction, where its percentage ranges from 89.9 to 93.27%, and medium sand is the abundant size. Silt ranges from 2.13 to 3.1%, and clay from 4.6 to 7.3%, the high amounts of silt and clay are found in topsoil, while low amounts in subsoil.

Concerning cation exchange capacity, data in Table (26) show that CEC values range from 5.78 me/100g soil in topsoil to 2.99 me/100g soil in subsoil, and coincide with clay content. The dominant exchangeable cations are Mg^{+2}, followed by Ca^{+2}, Na^{+} and K^{+}. The dominance of Mg^{+2} cations may be due to the contamination with sea water. ESP values are relatively high and range from 14.71% in topsoil to 15.05% in subsoil, which reflect a tendency to sodicity.

Table (24) : Chemical analysis of the soils of coastal sand beach.

Profile No.	Depth (cm)	pH	EC (dS/m)	Soluble cations (me/l)				Soluble anions (me/l)			O .M %	Gypsum %	Ca CO_3 %
				Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}	$SO_4^{=}$			
4	0-20	8.0	27.54	49.25	75.81	365	5.0	2	425	68.06	0.053	0.61	84.83
	20-70	8.2	13.77	9.85	32.48	175	2.3	2	190	27.63	0.067	0.40	54.38

Table (25) : Particle size distribution of the soils of coastal sand beach.

Profile No.	Depth (cm)	Gravel %	Sand %						Silt %	Clay %	Textural class
			vc	c	m	f	vf	Total			
4	0-20	--	1.55	13.78	70.73	3.09	0.45	89.6	3.10	7.3	Sand
	20-70	2	0.08	6.75	83.90	2.46	0.08	93.27	2.13	4.6	Sand

Table (26): Cation exchange capacity and exchangeable cations of the soils of coastal sand beach.

Profile No.	Depth (cm)	CEC (me/100g soil)	Exchangeable cations (me/100g soil)				ESP
			Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	
4	0-20	5.78	1.56	3.15	0.85	0.22	14.71
	20-70	2.99	1.04	1.4	0.45	0.10	15.05

4.3. Grain size analysis:

Grain size analysis is used for different purposes such as description of texture, testing the behavior of sediments during transportation and deposition and interpretation the depositional environments under which the sediments were deposited.

In the present work, 53 soil samples taken from 15 soil profiles which represent the different physiographic units were prepared for dry sieving to determine sand separates,i.e., very coarse sand, coarse sand medium sand, fine sand and very fine sand, using set of 5 sieves with mesh openings1.25, 0.4, 0.25, 0.1, 0.045 mm, while silt and clay separates were determined using pipette method. Fraction percentages were calculated, cumulative percentages were plotted against phi-diameter of the fraction on arithmatic probability paper and seven percentiles, ø5, ø16, ø 25, ø 50, ø 75, ø 84, and ø 95 were estimated. The statistical grain size parameters were then determined according to the formula given by Folk and Ward (1957). ø is calculated from the formula:

$ø = -\log(d) / \log(2)$, where (d) is a diameter in mm.

Grain size parameters:

Grain size parameters include : graphic mean size, inclusive graphic standard deviation, inclusive graphic skewness and graphic kurtosis

Mean size (Mz ø):

The mean size (Mz ø) was calculated using the following proposed formula by Folk and Ward (1957).

$Mz\ \phi = (\phi\ 16 + \phi\ 50 + \phi\ 84) / 3$

The following proposed scale was used to describe the mean size.

Mean size ø scale

Grade limits ø	Nomenclature
-1.0 to 0.0	Very coarse sand
0.0to 1.0	Coarse sand
1.0 to 2.0	Medium sand
2.0 to 3.0	Fine sand
3.0 to 4.0	Very fine sand
4.0 to 7.0	Coarse silt
7.0 to 9.0	Fine silt
>9.0	Clay

The mean size meaning the diameters that half way between extremes, is regarded to prime importance in characterizing the distribution pattern.

The inclusive graphic standard deviation (ó 1) :

Folk and Ward (1957) introduced the inclusive graphic standard deviation (ó 1) to represent the degree of sorting. It is calculated by the following formula :

$$ó\,1 = (\phi\ 84 - \phi\ 16)/4 + (\phi\ 95 - \phi\ 5) / 6.6$$

The same authors gave the following scale to describe the sorting:

Sorting scale

ó 1 grade limits	Nomenclature
<0.35	Very well sorted
0.35 to 0.5	Well sorted
0.5 to 0.7	Moderately well sorted
0.7 to 1.0	Moderately sorted
1.0to 2.0	Poorly sorted
2.0 to 4.0	Very poorly sorted
>4.0	Extremely poorly sorted

For clarifying the results, it is well known that the sediments transported by wind are well sorted, while sediments transported by water or weathered in situ are usually poorly sorted, Inman (1952). Folk and Ward (1957) stated that sorting is a function of mean size, so the values increase with transportation owing to the decreases in the mean size of sediments. Thus, it is possible to get well sorted sediments transported by water across long distances.

Skewness (SK_1) :

Skewness measures the symmetry of the central part of the distribution. Skewness must equal zero in normal curves obtained from homogneous distribution, in which the mean size coincides with the median. Positive values of skewness indicate that the studied sample has tails of fine grains which are contraindicated by the negative ones.

Skewness (SK_1) is calculated by the following formula :

$$SK_1=[(ø16+ø84-2\ ø50)/2(ø84-\ ø16)]+[(ø5+\ ø95-\ 2ø50)\ /\ 2(ø95-\ ø5)]$$

Folk and Ward (1957) gave the following scale to describe the asymmetry of sediments when using SK_1 as the skewness measure.

Skewness scale

SK_1 grade	Nomenclature
-1.0 to –0.3	Strongly coarse skewed
-0.3 to –0.1	Coarse skewed
-0.1 to 0.1	Near symmetrical
0.1to 0.3	Fine skewed
0.3 to 1.0	Strongly fine skewed

Kurtosis (KG)

Kurtosis measures the ratio of sorting in the extremes of the distribution compared with the sorting in the centeral portion. For normal distribution, graphic kurtosis should equal one. Excessive peakness is indicated by values larger than one, whereas excessive flatness is evidenced by smaller values. Folk and Ward (1957) gave the graphic kurtosis (KG) calculated by the formula :

$KG = (ø95 - ø5) / 2.44(ø75 - ø25)$

The same authors suggested the following scale to describe the kurtosis of sediments :

Kurtosis scale

KG grade	Nomenclature
< 0.67	Very platy kurtic
0.67 - 0.9	Platy kurtic
0.9 - 1.11	Mesokurtic
1.11 – 1.5	Leptokurtic
1.5 – 3.0	Very leptokurtic
> 3.0	Extremely leptokurtic

The data of statistical size parameters and measures are presented in Table (27) and figures from 5 to 12 and discussed as follows:

Soils of old alluvial terraces :

Cumulative curves of the soil profiles 6&7 which represent the old alluvial terraces are illustrated in Fig. (5). Computed statistical size parameters, given in Table (27), show that the graphic mean size of the topsoil vary between 2.2 ø and 2.22 ø and fall within the range of fine sand. Whereas, the values of subsoil range from 1.28 ø to 1.57 ø and fall within the range of medium sand, while values of lower subsoil and substratum range from 0.2 ø to 0.55 ø and fall within the range of coarse sand. The grain size distribution reflects the normal deposition pattern of alluvial material in vertical direction within the soil profile, where the coarser sediments are deposited first in the bottom, underlying the finer ones.

Sorting values range from 1.36 to 1.93, indicating poorly sorted sediments, suggest that water is responsible for transportation and deposition of these soil materials.

Values of skewness range from 0.12 to 0.62, indicate fine skewed, to strongly fine skewed ,except the second layer of profile No.7 (10—25cm), which has skewness value of 0.05(near symmetrical). These skewness values indicate that the soils have a tail of fineness.

Data of kurtosis indicate that the soils are leptokurtic, except the lowest layer of profile No.6 (45—-150cm) which attains mesokurtic. Data indicate the involvement of wind and water action in the formation of these soils. This suggestion does not coincide quite well with sorting values already mentioned.

Soils of young alluvial terraces :

Statistical size parameters of soil proifiles 9&11 representing the young alluvial terraces are illustrated in Fig.(6) and Table(27).

The calculated mean size values of the topsoil vary between 2.43 and 2.45 ø and fall within the range of fine sand, while values of subsoil and substratum (0.22 to 0.9 ø) fall in the range of coarse sand, except the subsoil at a depth of 10—50cm within profile No.9, where Mz value is 1.12, which falls in the range of medium sand.

Sorting values range from 1.26 to 2.3 ø and indicate poorly to very poorly sorted, point to the action of water in transport and deposition of soil materials.

Values of skewness range from 0.3 to 0.67 ø , indicate strongly fine skewed, and in turn these soils have a tail of fineness.

Table (27) : Ø values and statistical grain size parameters of the studied soil profiles according to Folk and Ward (1957)

Physio-graphic unit	Pro. No.	Depth (cm)	Ø 5	Ø 16	Ø 25	Ø 50	Ø 75	Ø 84	Ø 95	MzØ	Indicator	σ1	Indication	Sk1	Indication	KG	Indication
Old alluvial terraces	6	0-20	-0.35	0.85	1.35	1.75	3.00	4.05	5.35	2.22	f. sand	1.66	p.s	0.35	s.f.sk	1.42	l. k.
		20-45	-0.90	-0.45	0.15	1.50	2.15	3.65	5.05	1.57	m. sand	1.93	p.s	0.12	f.sk	1.22	l. k.
		45-150	-1.15	-0.80	-0.60	0.45	1.65	2.00	4.05	0.55	c. sand	1.49	p.s	0.25	f.sk	0.95	m. k.
	7	0-10	-0.35	0.95	1.40	1.80	2.95	3.85	5.30	2.20	f. s.	1.58	p.s.	0.33	s.f.sk.	1.49	l. k.
		10-25	-0.90	-0.40	0.15	1.40	1.90	2.85	4.95	1.28	m. s.	1.70	p.s.	0.05	n.s.	1.37	l.k.
		25-45	-1.15	-0.85	-0.65	-0.30	1.30	1.75	4.40	0.20	c. s.	1.50	p.s.	0.62	s.f.sk.	1.17	l.k.
		45-75	-1.05	-0.70	-0.55	-0.05	1.10	1.55	4.20	0.27	c. s.	1.36	p.s.	0.52	s.f.sk.	1.30	l.k.
		75-150	-1.20	-0.80	-0.65	-0.15	1.30	1.70	4.75	0.25	c. s.	1.53	p.s.	0.56	s.f.sk	1.25	l. k.
Young alluvial terraces	9	0-10	-0.6	0.95	1.45	1.95	3.75	4.45	5.55	2.45	f. s.	1.81	p.s.	0.30	s.f.sk	1.10	m. k.
		10-50	-1.1	-0.75	-0.55	0.60	1.90	3.50	4.85	1.12	m. s.	1.96	p.s.	0.40	s.f.sk	1.00	m. k.
		50-150	-1.2	-0.95	-0.70	0.45	1.85	3.20	5.05	0.90	c. s.	1.98	p.s.	0.40	s.f.sk.	1.00	m. k.
	11	0-15	-0.4	0.65	1.25	1.85	4.15	4.80	5.80	2.43	f. s.	2.30	v.p.s	0.35	s.f.sk	0.88	p. k
		15-30	-1.1	-0.80	-0.65	-0.30	1.35	1.75	4.70	0.22	c. s.	1.53	p.s	0.67	s.f.sk	1.19	l. k.
		30-70	-0.9	-0.65	-0.50	-0.05	1.15	1.60	3.80	0.30	c. s.	1.27	p.s	0.55	s.f.sk.	1.17	l. k.
		70-150	-0.95	-0.65	-0.45	0.15	1.25	1.60	3.65	0.37	c. s.	1.26	p.s.	0.41	s.f.sk.	1.10	m. k.

Table (27): cont.

Physio-graphic unit	Pro. No.	Depth (cm)	Ø 5	Ø 16	Ø 25	Ø 50	Ø 75	Ø 84	Ø 95	MzØ	Indication	σ1	Indication	Sk1	Indication	KG	Indication
Upper alluvial deltaic plain	1	0-10	-0.80	-030	0.55	1.70	3.75	4.70	5.70	2.03	f.s	2.23	v.p.s	0.32	s.f.sk	0.83	p.k.
		10-35	-1.10	-0.75	-0.60	-0.25	1.45	1.85	4.80	0.28	c.s	1.54	p.s	0.71	s.f.sk	1.18	l.k.
		35-55	-1.15	-0.75	-0.60	0.15	1.70	2.00	4.40	0.47	c.s	1.53	p.s	0.44	s.f.sk	0.99	m.k.
		55-70	-0.85	-0.50	-0.30	1.25	1.70	1.90	4.30	0.88	c.s	1.38	p.s	-0.14	c.sk.	1.06	m.k.
		70-110	-1.15	-0.85	-0.65	-0.05	1.35	1.60	3.95	0.23	c.s	1.39	p.s	0.46	s.f.sk.	1.05	m.k.
		110-150	-0.70	0.10	0.75	1.45	1.75	1.85	4.30	1.13	m.s	1.20	p.s	-0.20	c.sk.	2.05	v.l.k.
	3	0-65	-1.05	-0.70	-0.50	0.35	1.45	1.75	4.50	0.47	c.s	1.45	p.s	0.32	s.f.sk	1.17	l.k.
		65-80	-0.95	-0.55	-0.35	0.70	1.55	1.85	4.55	0.67	c.s	1.43	p.s	0.18	f.sk.	1.19	l.k.
		80-15	-0.55	0.00	0.35	1.15	1.65	1.85	4.45	1.00	c.s	1.22	p.s	0.04	n.s.	1.58	v.l.k.
	5	0-20	-0.85	1.00	1.45	1.75	2.25	2.65	4.40	1.80	m.s	1.21	p.s	0.05	n.s.	2.69	v.l.k.
		20-150	-1.20	-0.90	-0.75	-0.35	1.10	1.60	4.70	0.12	c.s	1.52	p.s	0.64	s.f.sk	1.01	m.k.
	10	0-20	-1.15	-0.65	-0.35	0.90	1.70	2.00	4.35	0.75	c.s	1.50	p.s	0.04	n.s. .	1.10	m.k
		20-50	-0.55	0.00	0.45	1.10	1.60	1.75	3.75	0.95	c.s	1.09	p.s	-0.01	n.s.	1.53	v.l.k.
		50-150	-0.95	-0.50	-0.35	0.55	1.40	1.60	3.35	0.55	c.s	1.18	p.s	0.15	f.sk	1.01	m.k.

Table (27): cont.

Physio-graphic unit	Pro. No.	Depth (cm)	Ø 5	Ø 16	Ø 25	Ø 50	Ø 75	Ø 84	Ø 95	MzØ	Indication	σ1	Indication	Sk1	Indication	KG	Indication
Lower alluvial deltaic plain	2	0-15	0.15	1.10	1.40	1.70	2.15	2.85	4.85	1.88	m.s.	1.15	p.s.	0.33	s.f.sk.	2.57	v.l.k.
		15-25	-0.35	0.95	1.40	1.75	2.65	3.70	5.25	2.13	f.s.	1.54	p.s.	0.33	s.f.sk.	1.84	v.l.k.
		25-40	0.00	0.95	1.35	1.60	1.85	2.20	4.20	1.58	m.s.	0.95	m.s.	0.10	f.sk.	3.44	e.l.k.
		40-70	-0.35	0.70	1.25	1.55	1.85	2.15	4.10	1.47	m.s.	1.04	p.s.	-0.01	n.s.	3.04	e.l.k.
		70-150	-0.40	0.95	1.45	1.85	3.25	4.20	5.40	2.33	f.s.	1.69	p.s.	0.34	s.f.sk.	1.32	l.k.
	12	0-15	-0.35	1.15	1.45	1.80	2.40	3.15	4.70	2.03	f.s.	1.27	p.s	0.25	f.sk.	2.18	v.l.k.
		15-30	-0.90	-0.45	-0.30	0.90	1.55	1.80	3.25	0.75	c.s.	1.19	p.s.	-0.03	n.s.	0.92	m.k.
		30-150	-0.65	-0.05	0.50	1.45	1.85	2.20	4.45	1.20	m.s.	1.34	p.s.	-0.07	n.s.	1.55	v.l.k.
	13	0-20	0.05	1.35	1.50	1.90	3.15	3.90	5.20	2.38	f.s.	1.42	p.s.	0.43	s.f.sk.	1.28	l.k.
		20-35	0.50	1.50	1.75	2.55	3.75	4.30	5.45	2.78	f.s.	1.45	p.s.	0.21	f.sk.	1.01	m.k.
		35-80	1.35	1.75	1.95	2.95	3.95	4.45	5.55	3.05	v.f.s.	1.31	p.s.	0.17	f.sk.	0.86	p.k.
		80-150	-0.95	-0.55	-0.40	0.95	1.80	2.40	4.65	0.93	c.s.	1.59	p.s.	0.15	f.sk.	1.04	m.k.
playa	8	0-15	-0.40	0.70	1.30	2.30	4.10	4.70	5.75	2.57	f.s.	1.93	p.s.	0.16	f.sk.	0.90	m.k.
		15-40	-1.20	-0.80	-0.55	1.45	3.60	4.25	5.45	1.63	m.s.	2.27	v.s.	0.16	f.sk.	0.66	v.p.k.
		40-60	-1.15	-0.65	-0.45	1.60	3.60	3.90	4.80	1.62	m.s.	2.04	v.s.	0.04	n.s.	0.60	v.p.k.
		60-150	-1.05	-0.60	-0.35	3.35	4.7	5.20	6.10	2.65	f.s	2.53	v.s.	-0.30	c.sk	0.58	v.p.k.

Table (27): cont.

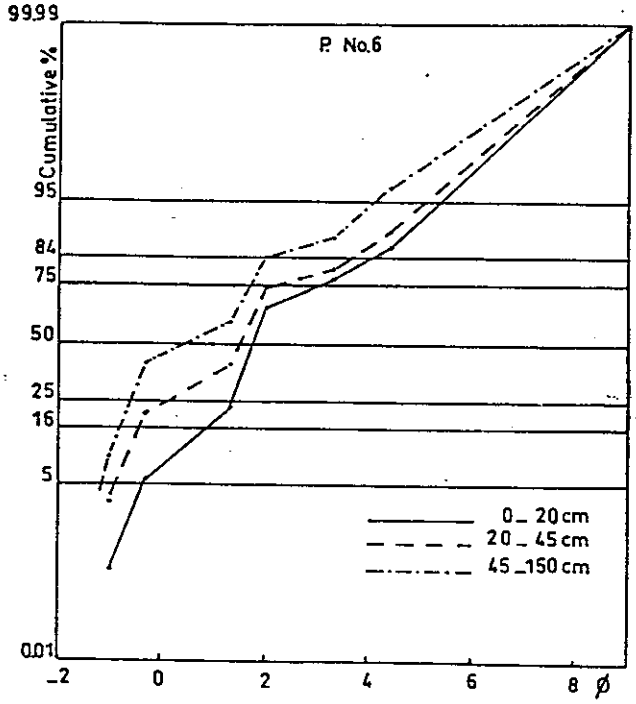
Physio - graphic unit	Pro. No.	Depth (cm)	Ø 5	Ø 16	Ø 25	Ø 50	Ø 75	Ø 84	Ø 95	MzØ	Indication	σ1	Indication	Sk1	Indication	KG	Indication
Sabkha	15	0-15	1.75	2.35	2.80	3.60	4.30	4.70	5.75	3.55	v.f.s	1.19	p.s.	0.01	n.s.	1.09	m.k.
		15-50	2.65	3.55	3.75	4.15	4.70	5.15	6.05	4.28	c.si.	0.92	m.s.	0.18	f.sk.	1.47	l.k.
		50-150	1.65	2.70	3.35	3.90	4.55	5.05	6.00	3.88	v.f.s.	1.25	p.s.	-0.03	n.s.	1.49	l.k.
Oolitic sand dunes	14	0-30	-0.30	0.05	0.20	0.55	0.95	1.10	4.45	0.57	c.s.	0.98	m.s.	0.34	s.f.sk.	2.60	v.l.k.
		30-80	-0.40	-0.15	0.05	0.45	0.85	1.05	3.80	0.45	c.s.	0.94	m.s.	0.30	f.sk.	2.15	v.l.k.
		80-150	-0.50	-0.35	-0.15	0.25	0.70	0.90	1.85	0.27	c.s.	0.67	m.w.s.	0.20	f.sk.	1.13	l.k.
Coastal sand beach	4	0-20	-0.65	-0.25	-0.05	0.45	0.95	1.20	4.85	0.47	c.s.	1.20	p.s.	0.32	s.f.sk.	2.25	v.l.k.
		20-70	-0.35	0.00	0.20	0.55	0.90	1.10	4.15	0.55	c.s.	0.96	m.s.	0.30	f.sk.	2.63	v.l.k.

Mz: Mean size
c.s. coarse sand
m.s medium sand
f.s. fine sand
v.f.s. very fine sand.
c.si. coarse silt.
f.si. fine silt.

σ : Sorting
v.w.s . very well sorted
w.s. well sorted
m.w.s moderately well sote
p.s. poorly sorted
v.p.s. very poorly sorted
e.p.s. extermely poorly sorted.

sk1: Skewness
s.c.sk. strongly coarse skewed
c.sk. coarse skewed
n.s. near symmetrical
f.sk. fine skewed
s.f.sk. strongly fine skewed.

kG: Kurtosis
v.p.k. very platy kurtic
p.k. platy kurtic
m.k. meso kurtic
l.k. lepto kurtic
v.l.k. very lepto kurtic
e.l.k. extremely lepto kurtic



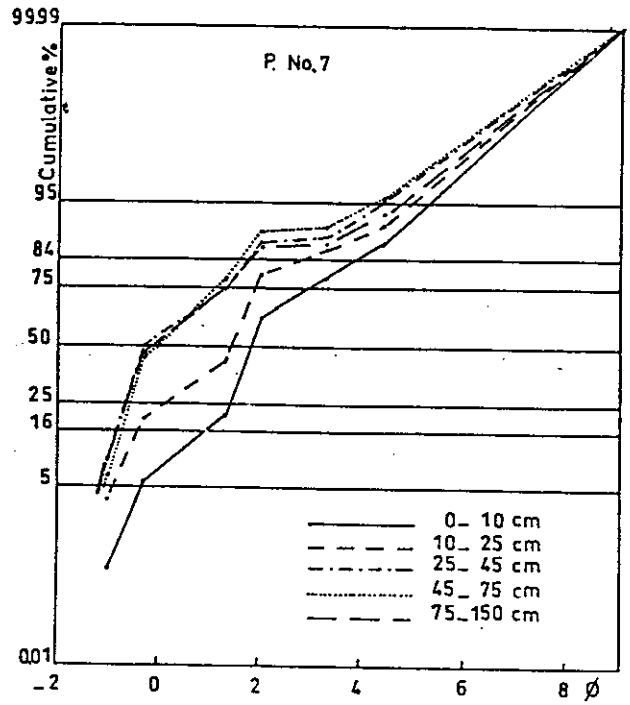
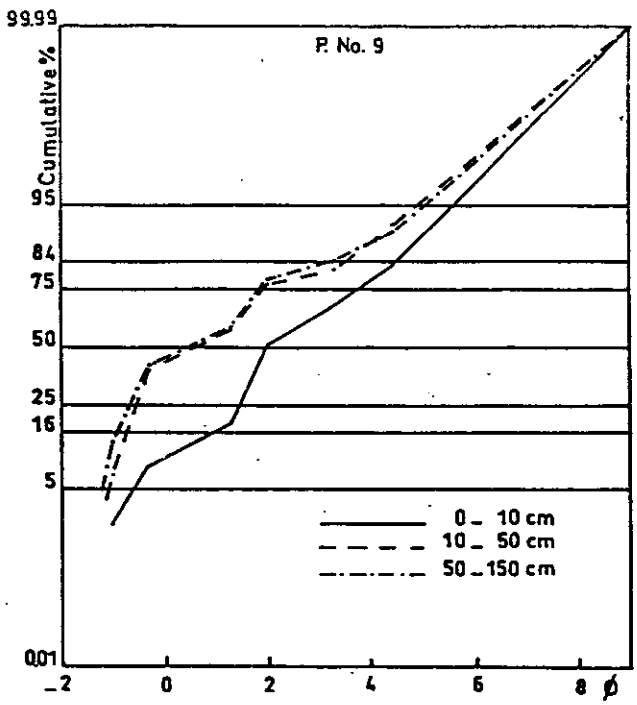


Fig.(5):Cumulative curves for the soils of old alluvial terraces



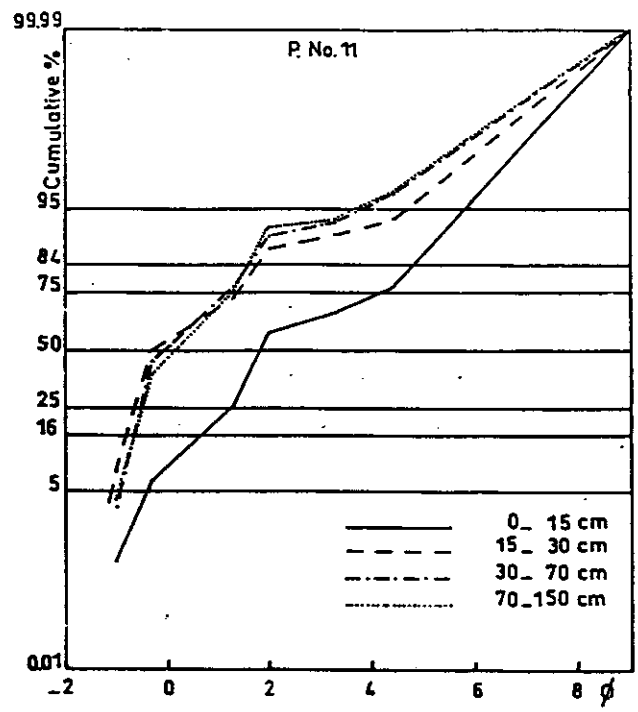


Fig.(6):Cumulative curves for the soils of young alluvial terraces

Kurtosis values range from 1.0 to 1.19 ø, indicating mesokurtic to leptokurtic, except the surface layer of profile No.11 (0—15cm) which has a value of 0.88 ø (platy kurtic). That means the combination of water and wind action in transportation and deposition of these soils, with exceptional case of surface layer of profile No.11 (0—15cm) where water action is responsible for transportation and deposition. This suggestion does not coincide quite well with sorting values.

Soils of upper alluvial deltaic plain :

Computed statistical size parameters of profiles 1,3,5,and 10 representing the soils of upper alluvial deltaic plain are illustrated in Table (27), and cumulative curves are given in Fig.(7).

The graphic mean size values (Mz ø) range from 0.12 to 1.0 ø and fall within the range of coarse sand, with exception of surface layer of profile No.1 (0—10cm) where its value is 2.03 ø and indicates fine sand. In addition, the surface layer of profile No.5(0—20cm) and the substratum of profile No.1 (110—150cm), where their values are 1.8 ø and 1.13 ø and fall within the range of medium sand.

Sorting values range from 1.09 ø (poorly sorted) to 2.23 ø (very poorly sorted), and indicate that sediments are transported and deposited by water action.

Values of skewness indicate that the majority of soil possess fine or very fine skewed, except the deepest layers of profile No.3 (80—150cm), surface layers of profiles 5 and 10, which are near symmetrical, in addition to subsoil (55—70cm) and substratum (110—150cm) layers of profile No.1, which are coarse skewed. This stratified pattern

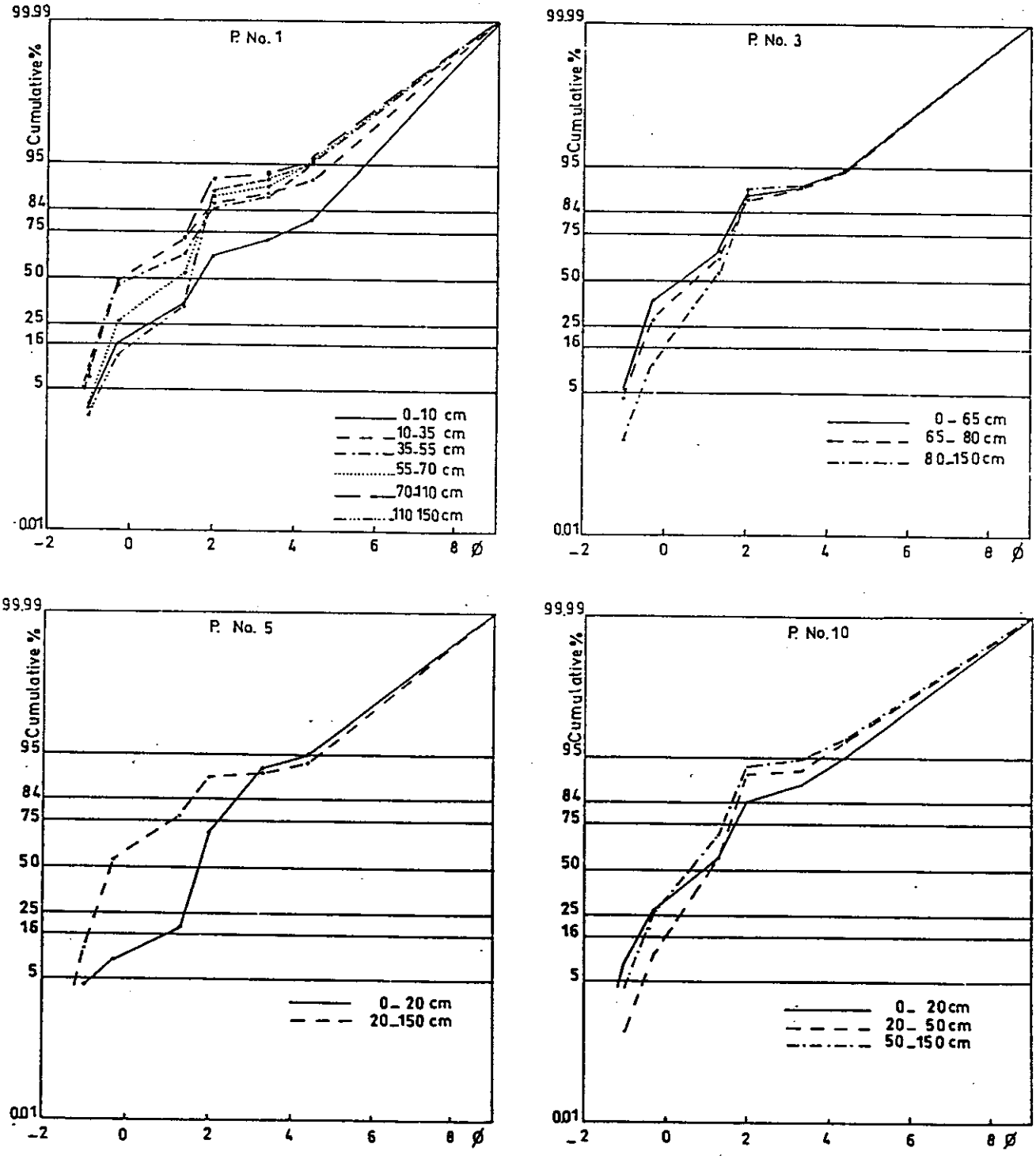


Fig.(7): Cumulative curves for the soils of upper deltaic plain

suggests the contribution of water and wind in the formation of these soils.

Kurtosis values indicate mesokurtic or leptokurtic, and point to the contribution of both water and wind in soil formation, except the topsoil (0—10cm) of profile No.1, which is platy kurtic and indicates that water is the main factor responsible for transportation and deposition of its soil material. Substratum layers of profiles No. 1 and 3, topsoil of profile No.5 and subsoil of profile No.10 are very leptokurtic, indicate that wind is the main factor responsible for their formation. This suggestion dose not coincide quite well with sorting values.

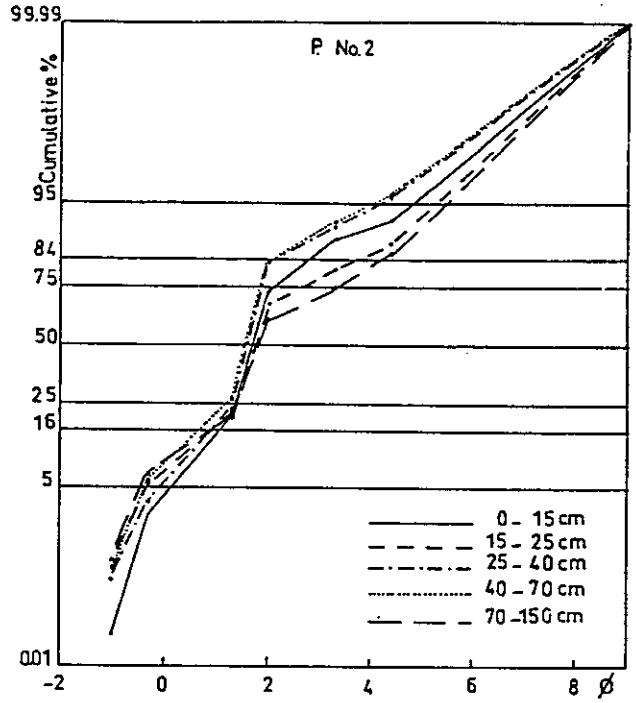
Soils of lower alluvial deltaic plain

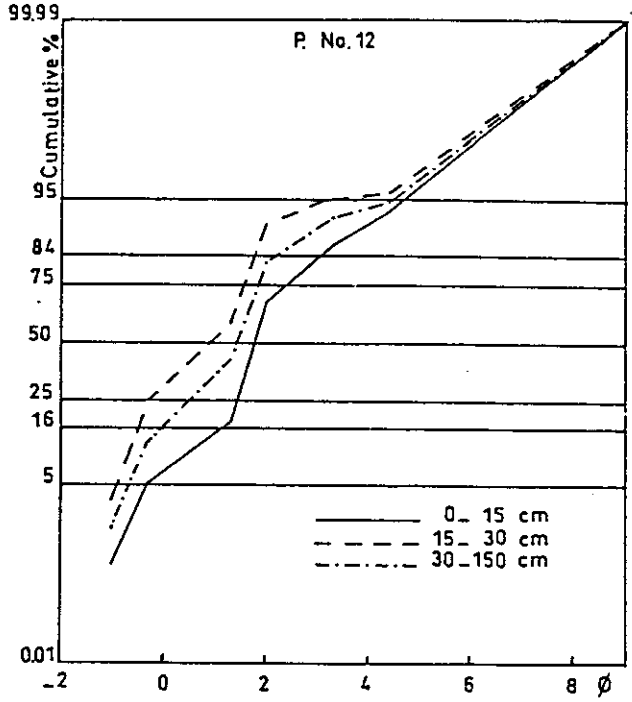
Computed statistical size parameters of profiles 2, 12, and 13,which represent soils of lower alluvial deltaic plain are given in Table (27), and cumulative curves are illustrated in Fig.(8).

Calculated Mz values are found in a wide range 0.75 ø - 3.05 ø (coarse sand to very fine sand), indicate a stratified pattern within the soil profiles.

Sorting values range from 1.04 ø to 1.69 ø indicating poorly sorted, except the layer 25—40 cm in soil profile No.2, which has a sorting value of 0.95 ø, indicating moderately sorted. This suggests that the sediments constituting these soils are transported and deposited under the water action, except the layer 25-40 cm in profile No.2,where a combination of water and wind actions is expected to be responsible for soil formation.

The skewness values indicate that the soils are generally fine to strongly fine skewed, except for the layers 40—70 cm (profile2), 15—30 cm and 30—150 cm (profile 12), which are near symmetrical.





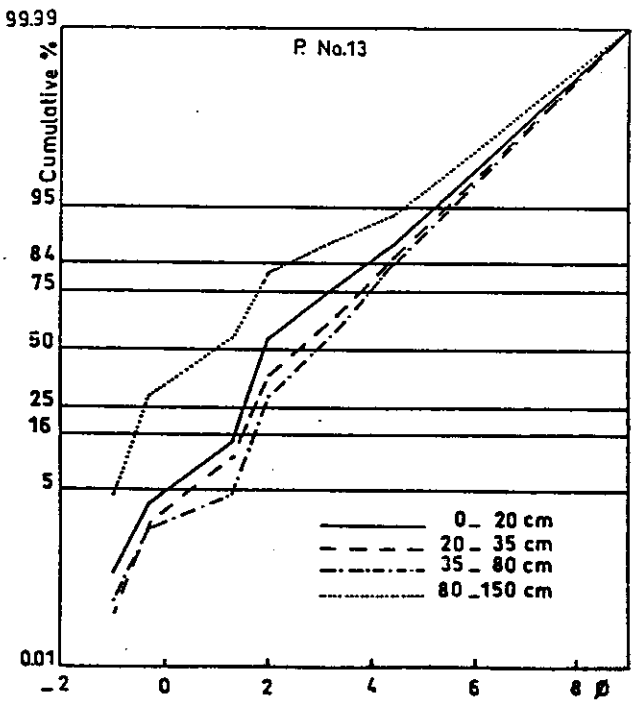


Fig (8): Cumulative curves for the soils of lower deltaic plain

Values of kurtosis indicate that the soils are characterized by alternative pattern, i.e., leptokurtic, mesokurtic, very leptokurtic, extermely leptokurtic and platy kurtic. This pattern suggests a combination of water and wind actions in the formation of the soils with leptokurtic or mesokurtic values, water action for platy kurtic and wind action for very or extremely leptokurtic. This suggestion dose not coincide quite well with sorting values.

Soils of playa :

Statistical size parameters illustrated in Table (27), and cumulative curves of the soils of playa, given in Fig.(9), show that the calculated Mz ø values are 2.57 ø and 2.65 ø for the topsoil (0—15 cm) and substratum (60—150 cm) in profile No.8, indicating fine sand, while they are 1.62 ø and 1.63 ø for the subsoil (15—60 cm), indicating medium sand.

Sorting values range from 1.93 ø to 2.53 ø indicating poorly sorted to very poorly sorted sediment, which suggest that water is the main action responsible for transportation and deposition of these soils.

Values of skewness are 0.16 ø for the surface layers (0—40 cm),indicating fine skewed deposits, 0.04 ø for the subsoil (40—60 cm) indicating near symmetrical, and –0.3 ø for the deepest layers (60—150cm), indicating coarse skewed sediments. That mean the soils have a tail of fineness in the upper layers, and a tail of coarser materials in the deepest layers.

Values of kurtosis range from 0.58 ø to 0.66 ø indicating very platy kurtic and mean that soils are transported and deposited by water action, which coincide quite well with the sorting values, except for the

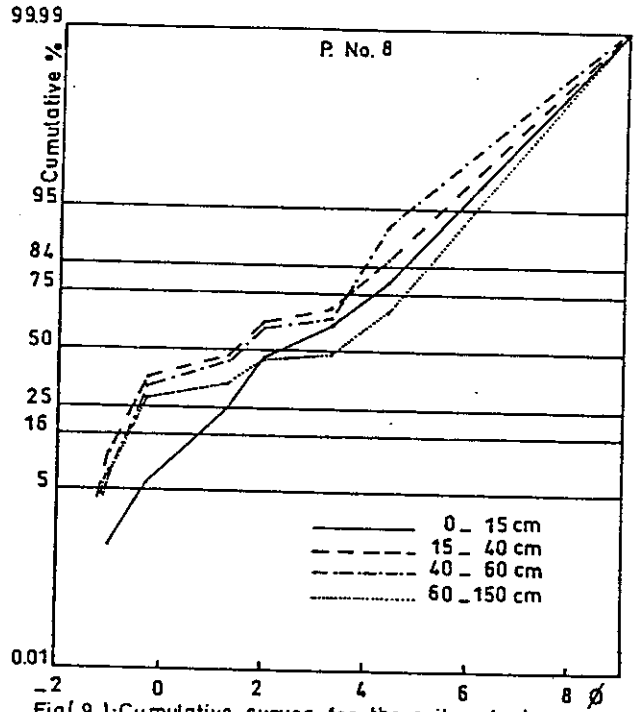


Fig.(9):Cumulative curves for the soils of playa

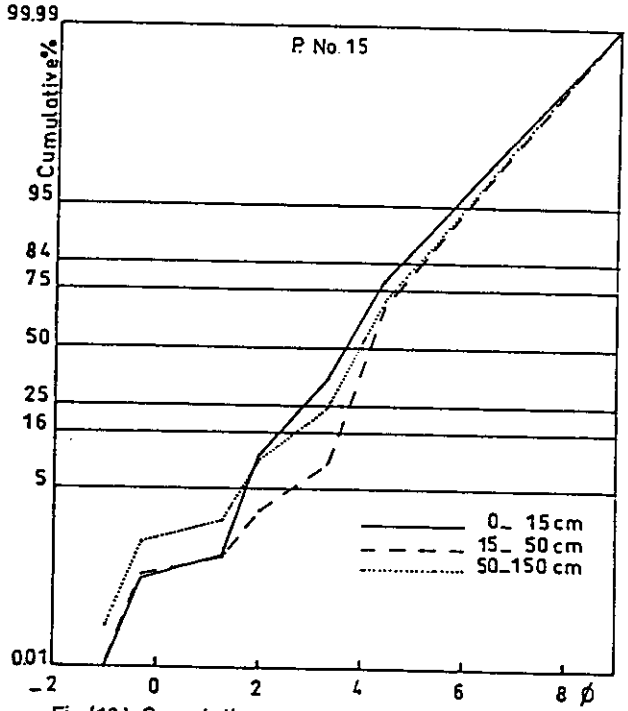


Fig.(10):Cumulative curves for the soils of sabkha

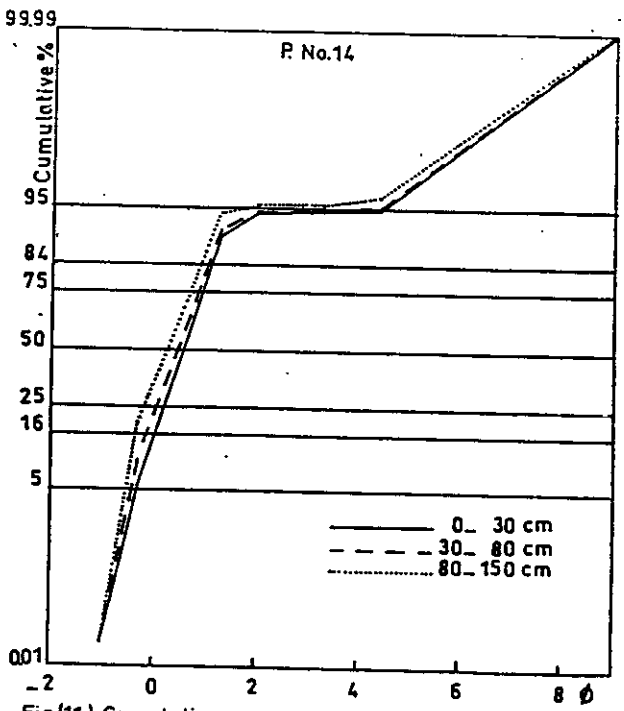


Fig.(11):Cumulative curves for the soils of sand dunes

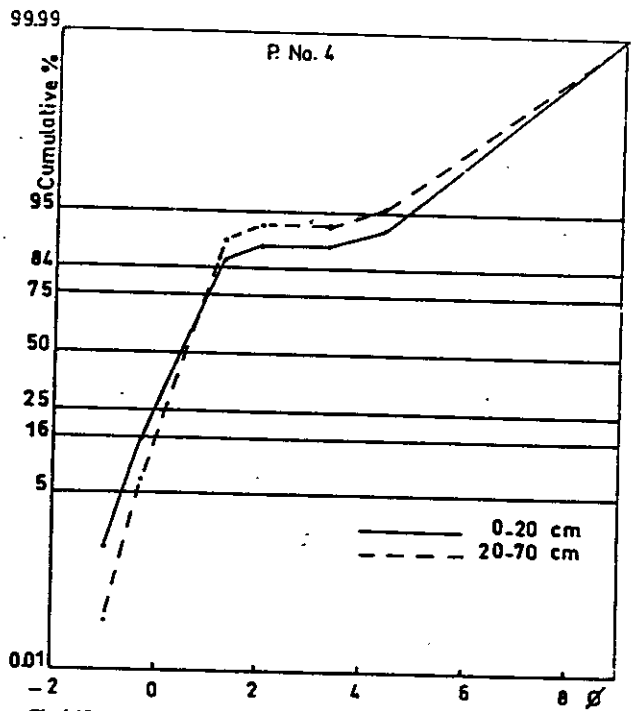


Fig.(12):Cumulative curves for the soils of coastal beach