Three Types of Sodic Soils in the United Arab Republic

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The first soil type I am going to report on is represented by the soils of Wadi Tumilat in the East part of the Nile Delta. They occupy an area of about 25.000 acres in a depression South of the Ismailia Canal. Before 1863 this area was irrigated from wells and no sign of alkalinity was observed. With the construction of the Ismailia Canal in 1863, which lies within a porous area at high level and had no drainage system established until 1893, seepage resulted in a rise of the highly mineralized water table in the lower parts of the depression. By 1897 about 50 per cent of the area was out of cultivation. Reclamation work started in 1903. The causes of continued alkalinization of this area are:

a) Excessive use of irrigation water (gravity)

b) Seepage from higher canals

c) Absence of adequate drainage

d) Highly mineralized ground water

e) In the beginning of the pleistocene period, the Mediterranean and Red Seas were connected and this area was submerged under saline water. A typical analysis of the surface layer of such Na_2CO_3 soil is given below along with an analysis of the drainage waters:

Depth, cm	Na_2CO_3 %	$NaHCO_3$ %	NaCl %	Na_2SO_4 %	total salts %
0—15	0.172	0.294	0.358	0.177	1.001

Composition of drainage water (p. p. m.): NaCl 402 Na_2SO_4 254

f) The composition of the Nile water used for irrigation shows an excess of HCO_3^- over Ca + Mg and may contribute to slow alkalinization.

The relationship between soil salinity and alkalinity and the composition of the ground water (sodium and HCO_3^- percentage) and the ground water level is shown in Maps I—IV of the area:

Map I soil salinity in relation to topography and ground water table;

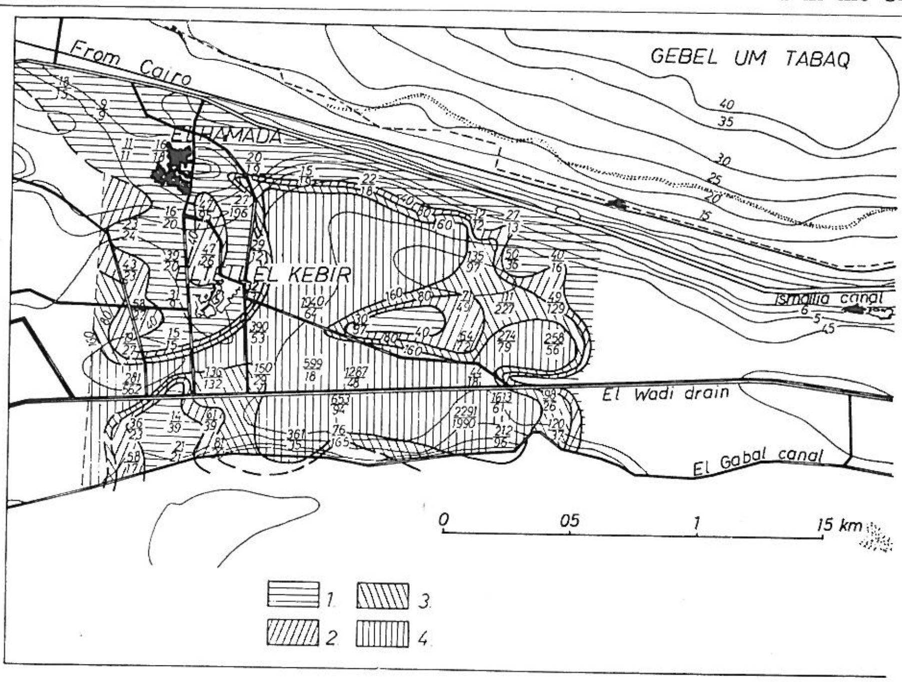
Map II soil alkalinity in relation to topography;

Map III the distribution of sodium in the ground water;

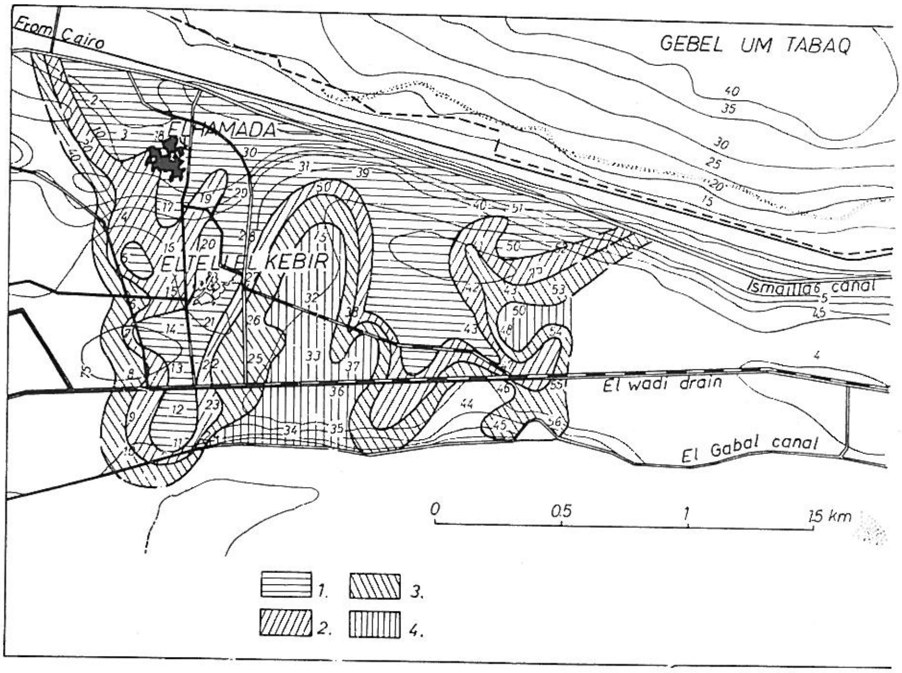
Map IV the distribution of HCO_3^- in the ground water.

Figure 1 shows the relation between relief and ground water depth across the area.

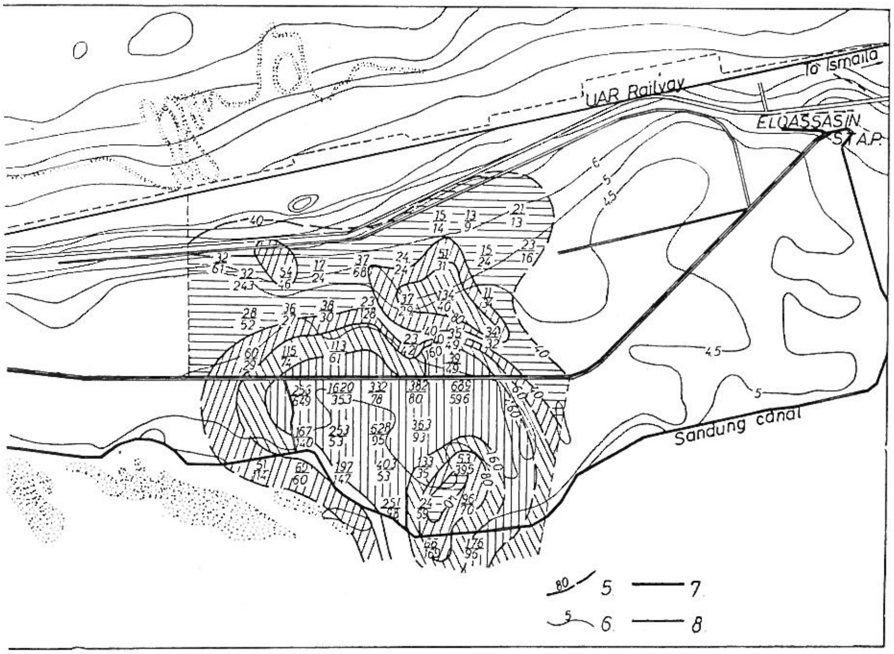
The analyses of the saturation extracts (presented in Table 1) relate salinization and alkalinization to the depth and composition of the ground water table.



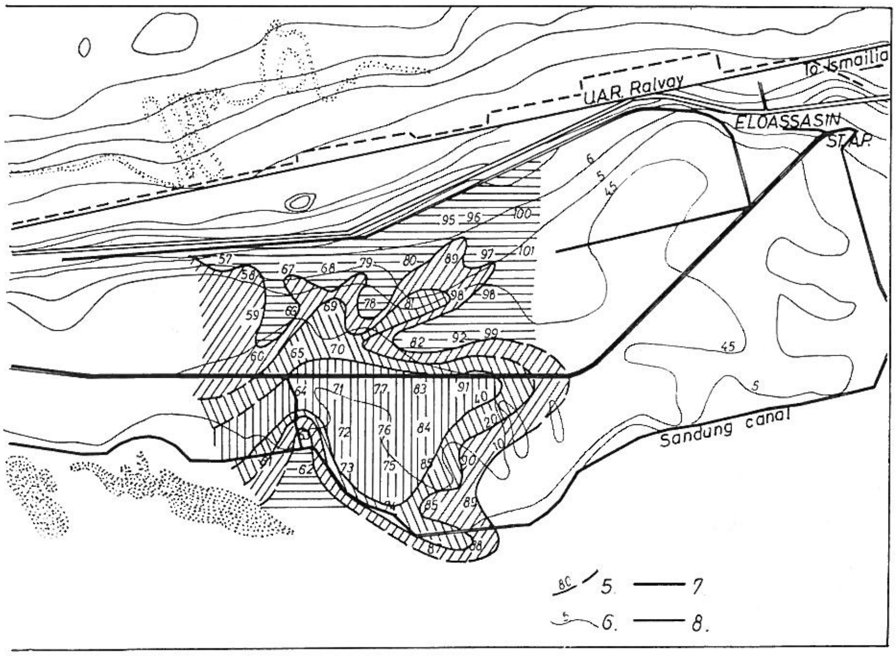
Map.
Soil Salinity. 1. Less than 40 m.e./l;2. From 40—80 m.e./l;3. From 80—100 m.e./l;4.
7. Canal and drain ;8.



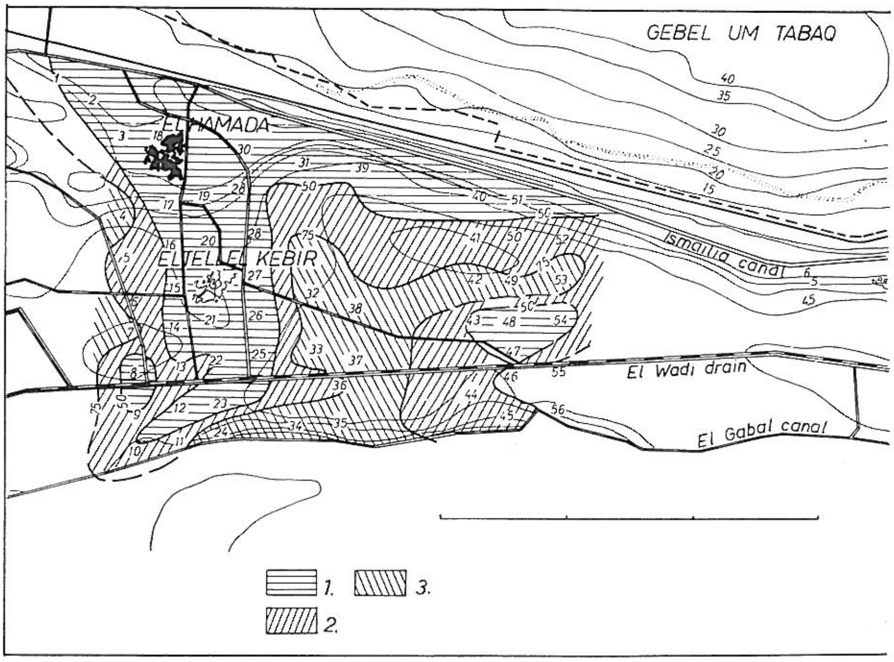
Map.
Soil Alkalinity. 1. Less than 10%;2. From 10—20%;3. From 20—40%;4. More than
8. UAR.



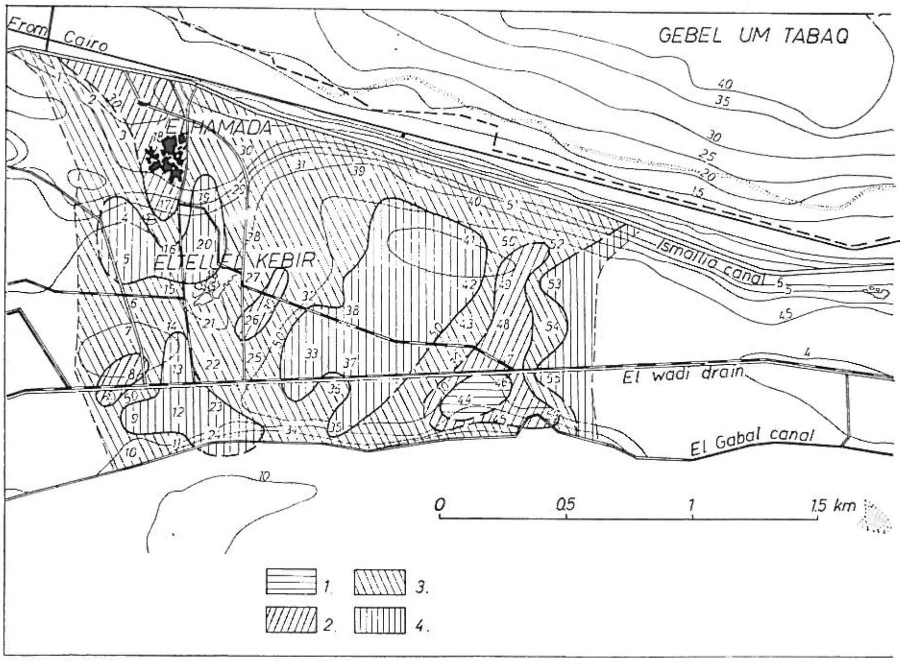
I.
More than 160 m.e./l;5. Approximate observed and inferred boundaries;6. Contours; U.A.R. railway



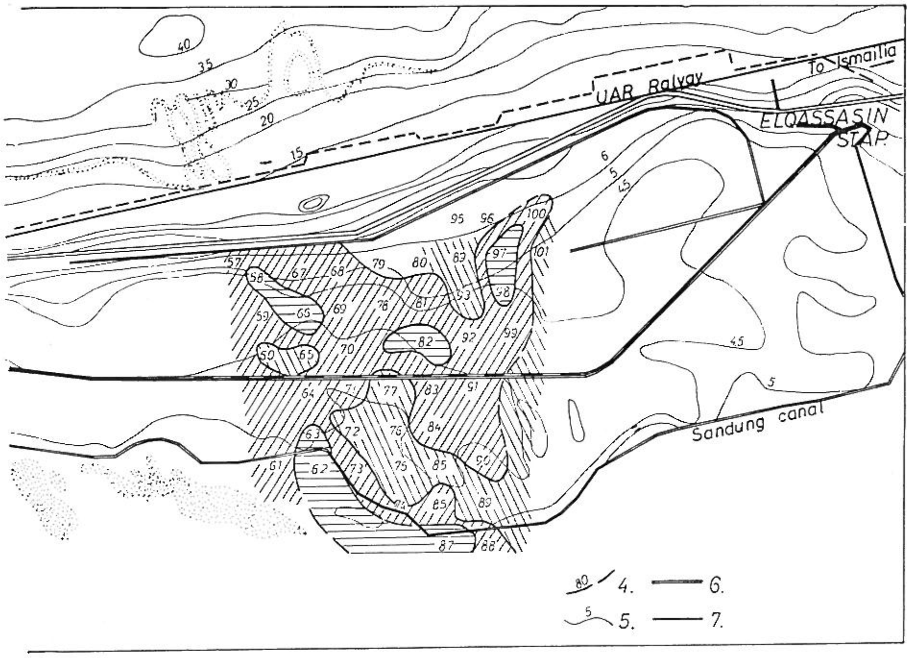
II.
40%;5. Approximate observed and inferred boundaries;6. Contours;7. Canal and drain railway



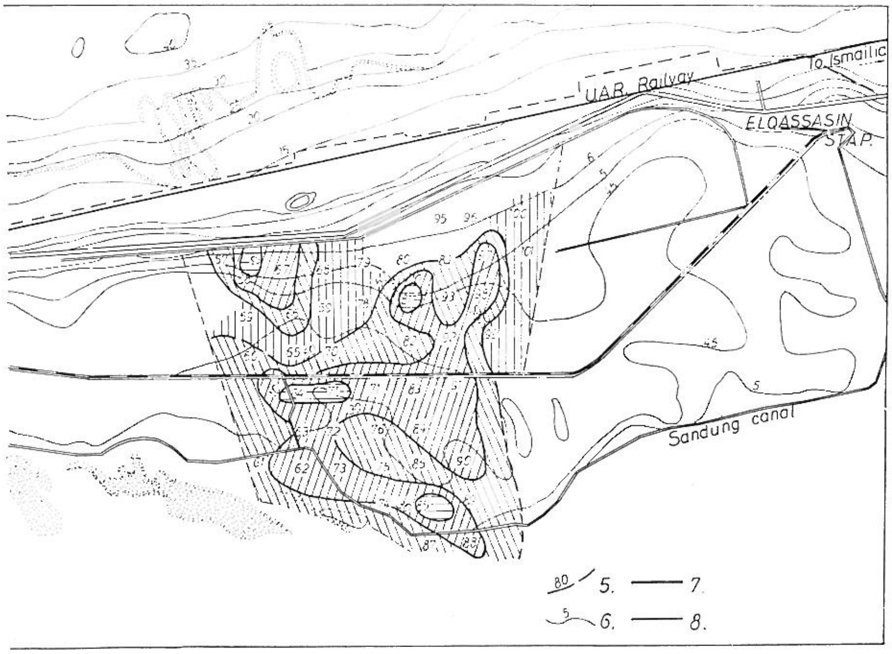
Map.
Soluble sodium percent in ground water. 1. <50;2. 50—75;3. >75;4. Approximate



Map.
Soluble bicarbonate in ground water. 1. <10%; 2. 10—30%; 3. 30—50%; 4. >50%
8. U.A.R.



III.
observed and inferred boundaries.; 5. Contours; 6. Canal and drain ;7. U.A.R. railway



IV.
5. Approximate observed and inferred boundaries.;6. Contours;7. Canal and drain; railway

The second type I am reporting on is found in the Ferhash area in the north-west part of the Delta. It is located in a transitional zone between the Nile alluvium and desert fringes. Here the source of alkalinization is the composition of ground water which is rich in salts, especialy Na_2CO_3 and

Table 1

The soils of Wadi Tumilat. Chemical composition of saturation extracts

Depth, cm	E.C. mmhos/cm	Ca^{2+} (m.e./liter)	Mg^{2+} (m.e./liter)	Na^+ (m.e./liter)	Na%	SAR	Cl^- (m.e./liter)	CO_4^{2-} (m.e./liter)	HCO_3^- (m.e./liter)
Normal soil									
0— 15	1.15	6.0	2.10	1.02	11.2	0.51	5.6	Tr	3.5
15— 30	0.98	4.0	1.70	2.20	27.8	1.30	4.9	Tr	3.1
30— 60	0.75	3.5	1.73	2.27	30.3	1.40	3.5	Tr	4.2
60— 85	0.80	3.0	0.80	5.80	56.1	4.19	5.6	Tr	4.1
85—110	0.93	2.5	1.30	6.50	63.1	4.71	6.3	Tr	4.0
110—140	0.95	2.1	0.85	6.65	70.0	5.58	7.0	Tr	2.5

Depth, cm	E.C. mmhos/cm	Ca^{2+} (m.e./liter)	Mg^{2+} (m.e./liter)	Na^+ (m.e./liter)	Na%	Cl^- (m.e./liter)	SO_4^{2-} (m.e./liter)	CO_3^{2-} (m.e./liter)	HCO_3^- (m.e./liter)
Saline alkaline soil with water table									
0—15	24.0	4.4	7.7	176.6	93.5	128.8	50.9	Tr	9.0
15—30	7.0	1.6	1.5	73.7	96.0	53.7	14.7	Tr	8.5
30—60	3.6	2.3	0.9	31.3	91.0	21.2	5.9	Tr	7.5
G.w. (40 cm)	4.3	1.1	3.7	44.7	90.3	26.3	3.2	Tr	20.0

$NaHCO_3$. It is believed that a fault passes through this area and that the alkaline ground water continuously contributes to salinization and alkalinization of the soil. Here also the ground water level plays a dominant role.

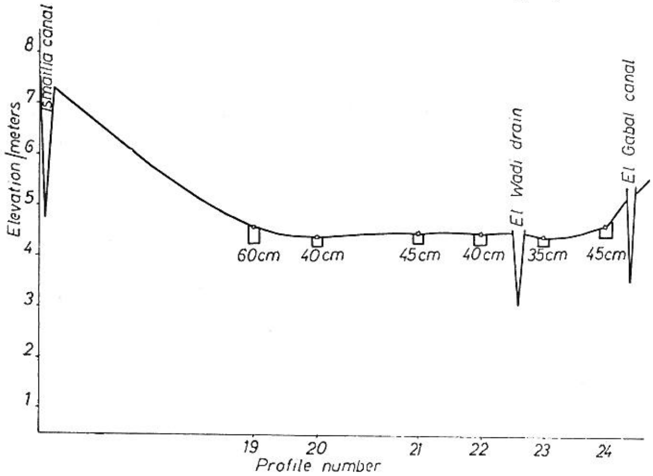


Fig. 1

Transect at point (A) showing the effect of relief on ground water depth

Stratification has greatly modified the pattern of alkalinity. Where clay dominates in the surface or throughout the profile, the soil is highly alkaline. This soil differs from the previous type by containing up to 35% $CaCO_3$.

The analytical data presented in Table 2 show the effect of the composition and level of the ground water table on salinization and alkalinization processes.

Table 2

The soils of Ferhash
The chemical composition of saturation extracts of normal and saline alkaline soils

Depth, cm	E.C. mmhos/cm	Ca^{2+}	Mg^{2+}	Na^{+}	CO_3^{2-}	HCO_3^{-}	Cl^{-}	SO_4^{2-}
		mol./liter						
A. Saline-alkaline soil with high water table								
0—15	103,0	1.9	2.1	1026.0	278.0	45.0	1393.0	238.0
15—30	28.2	1.0	1.0	280.0	24.0	9.6	240.0	85.0
G.w. (30 cm)	2.6	0.6	1.0	24.4	1.6	6.9	11.3	6.0
B. Normal soil with low water table								
0—15	1.4	3.0	2.0	9.0	—	3.2	11.5	8.1
15—30	1.7	1.9	1.1	14.0	—	8.7	7.4	17.4
30—60	3.4	3.0	6.0	25.1	—	4.8	30.1	10.2
60—85	3.6	2.9	7.1	26.3	1.2	4.8	15.0	23.5
G.w. (85 cm)	1.9	0.41	0.4	18.2	1.4	3.4	13.7	3.2

Figure 2 shows the effect of relief on the distribution of soluble salts in the different soil layers along a given transect. It is clear that salt accumulation takes place where ground water is at or close to the surface. Figure 3 shows similar effects of relief and ground water composition on alkalinity

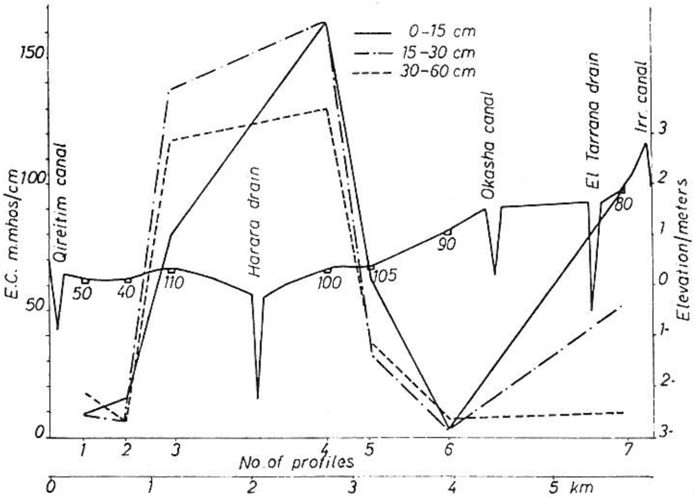


Fig. 2
Effect of relief on the distribution of T.S.S. in the different layers along the transect (A)

distribution along a given transect. Figure 4 shows that the variation in texture along the same transect greatly affects the pattern of salinization and alkalinization.

Map V shows the textural stratification of the main soil types within the area as well as the contour lines.

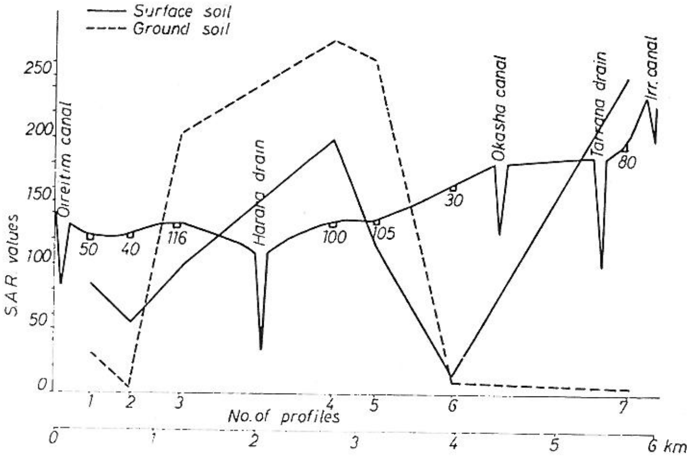


Fig. 3

Effect of relief and ground water composition on alkalinity distribution pattern for soil surface along the transect (A—A)

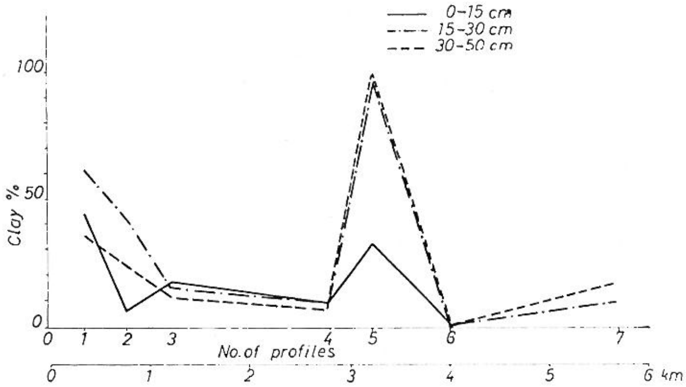


Fig. 4

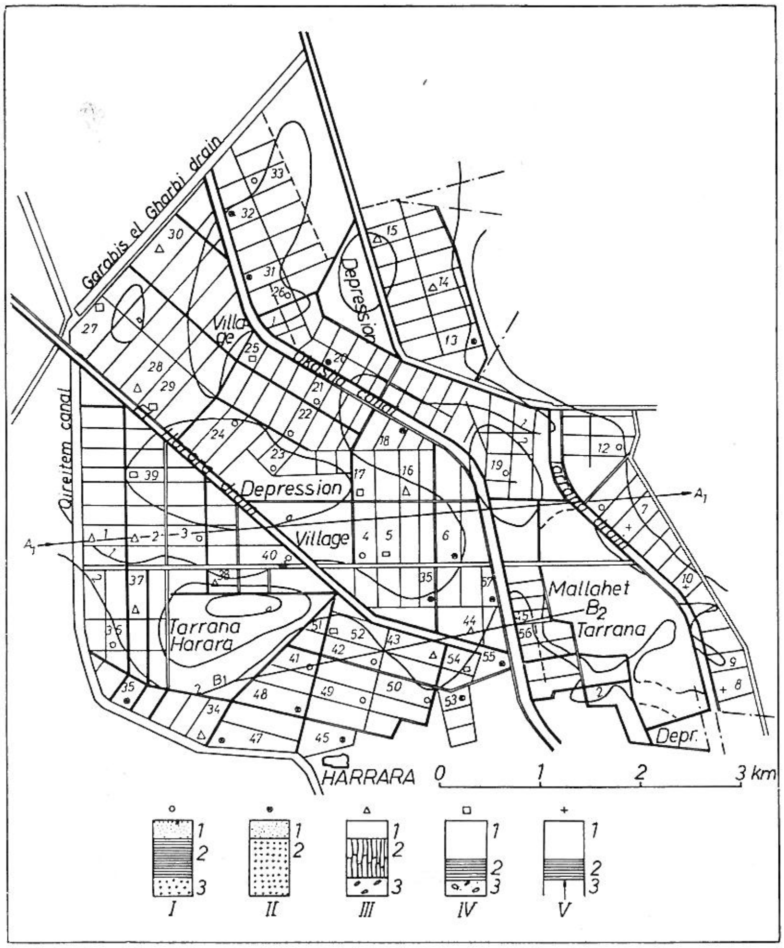
Distribution of clay along the transect (A—A)

The third type is that found in the Natroun depression some 40 kilometres west of the Rosetta branch, nearly midway between Cairo and Alexandria. This depression is 25 meters below sea level with a total difference in elevation of 60 meters. The total area is about 120,000 acres intersected by saline-alkaline lakes.

The depression is surrounded on the east by an old terrace composed of sand and gravel deposited during the miocene. It is derived from tectonics, erosion and denudation. It was first carved by the Nile branches draining into it and finally into the Mediterranean. It was finally closed by tectonics.

The depression is underlain by relatively permeable sedimentary rocks. These are underlain by a sequence of relatively impermeable beds of clay and limestone. Folding, faulting and local sedimentary conditions may modify this picture. There is a major fault transversing the area in a north-east to south-west direction with a vertical displacement of about 400 meters in the direction of the Delta.

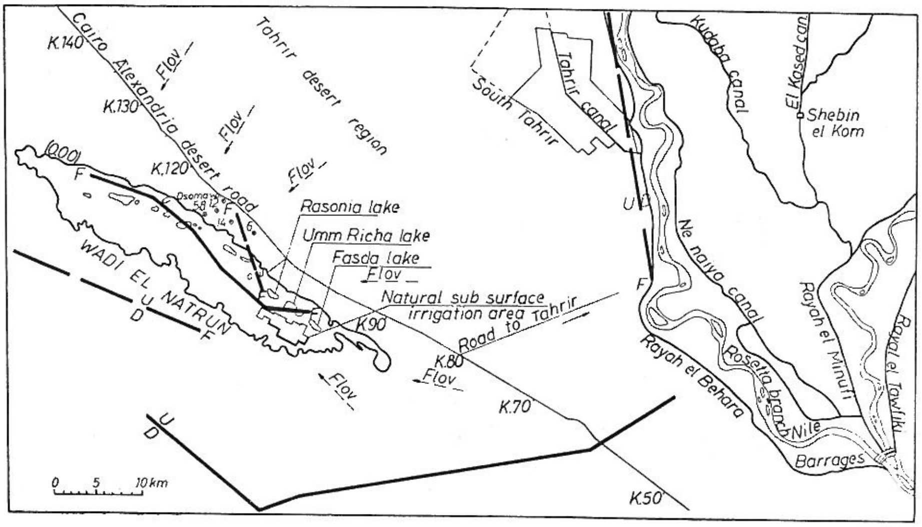
The underlying ground water is contained in the fluvial and deep sand. It flows to the depression from the north-east and south-east. It thus acts as a drainage outlet for surrounding areas.



Map. V

Ferhash project. Morphological characteristic profiles and location of sampling sites. I/1. Fine sand; I/2. Loam; I/3. Coarse sand; II/1. Fine sand; II/2. Coarse sand; III/1. Clay loam; III/2. Clay; III/3. Loamy sand; IV/1. Clay loam; IV/2. Heavy clay; IV/3. Sandy loam; V/1. Sandy loam; V/2. Sticky clay; V/3. Coarse sand

The hydrological conditions are complicated. In the north-eastern part the ground water is associated with old alluvium with no artesian pressure and is of medium quality. Beneath the old Nile channel the aquifer is of two layers separated by impervious strata and thus under pressure and the water is of medium quality. Owing to complex faulting along the margins of the depression, water from cretaceous formations may move into the surface ground water.



Map. VI

Showing the locations of: *a)* Expected faults (after Regwa Co. 1962); *b)* Expected directions of flow; *c)* Natural sub-surface irrigation project; *d)* Wells where pumping tests were carried out forestimation of recharge across the desert road

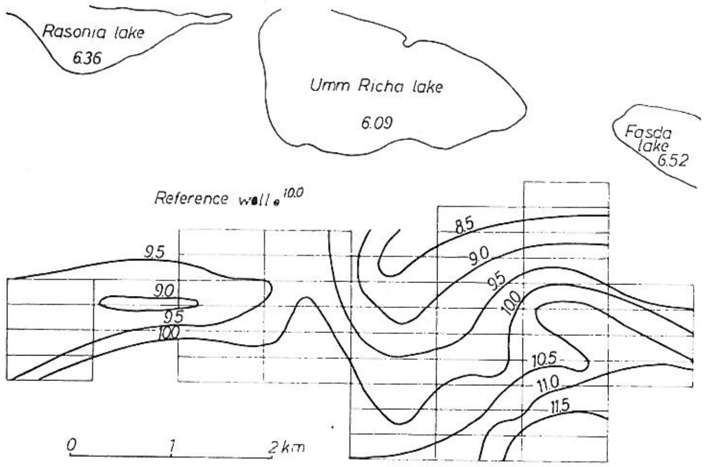


Fig. 5

Water table map. All levels related to reference well in meters

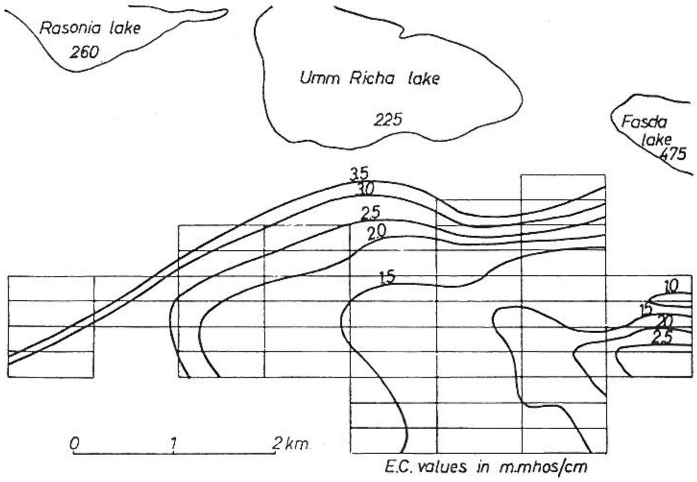


Fig. 6
Ground water salinity map

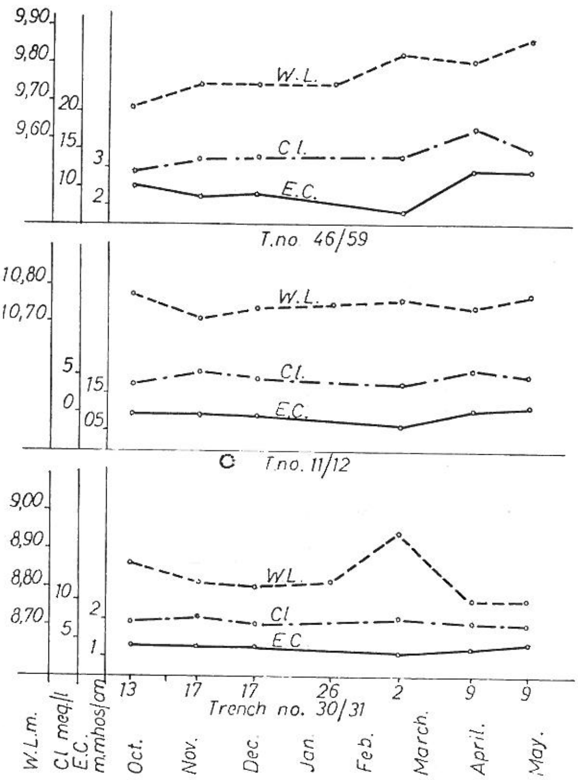


Fig. 7
Changes in water quality and levels in trenches during the period Oct. 63—May 64

Monthly measurements of the level and concentration of the ground water on the west side of the depression were made and an example is shown in Figures 5 and 6. It is clear that ground water level, relief and composition are related. Figure 7 shows the seasonal variation in the level and composition of ground water in the trenches. There is a more pronounced variation in the level than in composition of the water.

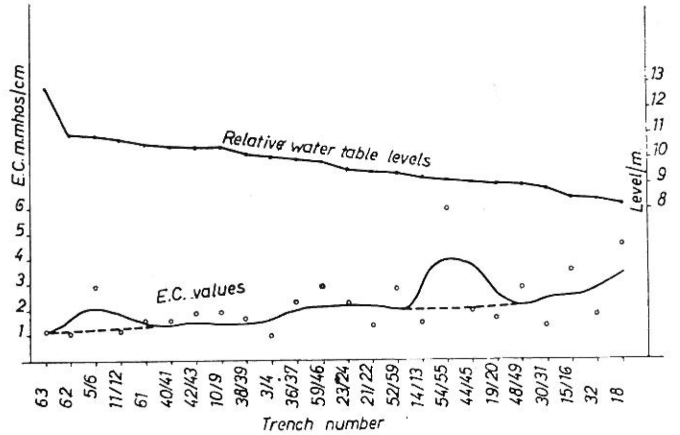


Fig. 8

Relationship between relative water table levels and quality of water in trenches on 9—5—64

Figure 8 shows the relationship between relative water table level and salt content.

Figure 9 shows the effect of salt water lakes on the quality of ground water.

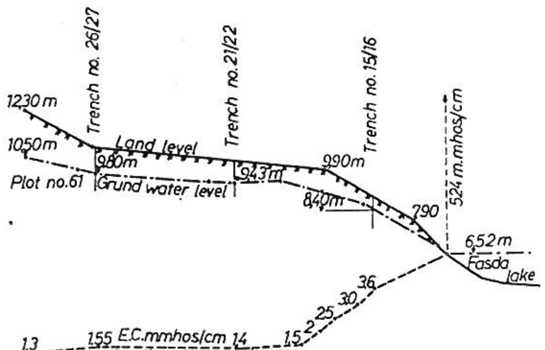


Fig. 9

Longitudinal sectional view from Fasda lake to plat N°61 to study the effect of salt water lakes on the quality of ground water

With these soils the source of salinization and alkalinization is the ground water which is rich in carbonate and bicarbonate ions (Table 3).

Table 3

Water in lakes and trenches in the natrium depression. The chemical composition of Lake and Trench waters

Sample	E.C. mmhos/cm	Ca^{2+}	Mg^{2+}	Na^{+}	CO_3^{2-}	HCO_3^{-}	Cl^{-}	SO_4^{2-}
		me./liter						
Lake	150	1.32	3.96	1494.0	183.0	228.7	1250.0	3.3
Trench	3.35	1.31	0.8	21.4	4.88	7.32	17.5	tr

References

[1] ALY, S. H.: A study on the origin of sodic soils in Tal Al Kabir region. Diploma thesis, University of Alexandria, Institute of Land Reclamation. 1964.

[2] MOHAMMED, A. G. H.: Movement and source of ground water at Wadi Al Natroun depression with special reference to salinity. Diploma thesis, University of Alexandria. Institute of Land Reclamation. 1964.

[3] SHATA, W.: Study on the origin of sodic soils in Ferhash project. Diploma thesis, University of Alexandria. Institute of Land Reclamation. 1965.