

Mineralogical study of some soil units in siwa oasis,egypt

Nabil Mohmed Abd El-Latef Ahmed Bahanasawy

5. SUMMARY Nineteen profiles were studied in different locations in Siwa oasis, Egypt (with 54 soil samples); the study area is bounded by longitudes 25° 24' and 26° 00' East, and latitudes 29° 00' and 29° 19' North, at about 300 km south west of the Marsa Matruh city Mcapital of Marsa Matruh Governorate. The area consisted of eight regions, (from west to east): (1) El-Maraqui, (2) Khamisa, (3) Siwa, (4) Aghormi, (5) Qureishet, (6) Abu-Shrouf, (7) El-Zeitun and (8) Timeira. 1-Soil morphological characteristics, calcareousness, gypseverusness and organic matter content. Soils ranged from sand to heavy clay (mainly clayey) slightly to strongly calcareous. (0.75 to 17.75 % active carbonate) and low gypsum (0.05 to 2.94 % gypsum), and organic matter content not exceeding 2.63 %. 2-Soil chemical properties: A-Soils are neutral to alkaline (pH of 7.07 to 8.17) non-saline to extremely saline (EC saturation extract 1.52 to 160.80 dSm⁻¹), with a tendency to increase in salinity with depth. B-Soluble cations: Na⁺ > Ca⁺² > Mg⁺² > K. anions: Cl⁻ > SO₄⁻² > HCO₃⁻ with no presence of CO₃⁼. C-Cation exchange capacity ranges between 17.50 and 40.25 cmolc/kg. D-Exchangeable cations: Ca⁺² > Mg⁺² > Na⁺ > K⁺ Exchangeable sodium percent (ESP) ranges from 0.14 to 21.99; exchangeable potassium percent (EPP) ranges between 0.63 and 10.21 Sodium adsorption ratio (SAR), ranges between 1.05 and 105.1, potassium adsorption ratio (PAR), ranges between 0.16 and 7.61. 3-Mineralogy of the sand fraction: A-Light minerals: Light minerals (Sp. g < 2.85) are dominated by quartz which constitutes over 93 % of light minerals. Others are orthoclase, plagioclase and microcline, occurred in little amounts ranging from 3.0 to 7.0 % of light minerals, the order being: microcline > plagioclase > orthoclase. B-Heavy minerals: Non-opaque minerals are the most common and opaque minerals are mainly dominated by pyroxenes, amphiboles followed by epidotes and biotite, then the ultra-stable minerals (zircon, rutile and tourmaline). Para metamorphic minerals are garnet, kyanite, staurolite, silimanite and andalusite. Soils seem to have derived from granitic igneous and metamorphic rocks. 4- Mineral frequency distribution; mineral ratio and weathering ratio and implications on uniformity of soil parent materials: Frequency distribution of resistant minerals and their ratios indicate that the soils are of heterogeneous origin being of multi-origin or multi-depositional regimes. The index figure is low in most soils; with the sandy soils having the highest value (2.29), and the clayey ones having the lowest value (0.20). SUMMARY 1565-Total surface area: Total surface area ranges between 32.17 and 41.39 m²/g soil low in the sandy soils and high in the clayey soils. 6-Amorphous inorganic materials: A-Ranges of amorphous inorganic materials of silica and sesquioxides: 0.20 to 26.21 % SiO₂, 0.15 to 4.40 % Al₂O₃, 5.09 to 42.70 % Fe₂O₃ and 0.08 to 2.30 % MnO. The order of silica, sesquioxides and other oxides: Fe₂O₃ > SiO₂ > Al₂O₃ > MnO. Amorphous iron oxide increased with the soil fineness. B- SiO₂/Al₂O₃ molar ratio exceed the value of 3 in the great majority of the soil samples thus indicating presence of the 2:1 and / or 2:2 layer silicate minerals in soils. 7-Mineralogy of the clay fraction: The Kandite group (kaolinite), the smectite group (montmorellonite), attapulgite and illite were the main minerals, with some accessory minerals (which are mainly feldspars). They were followed by quartz, dolomite, palygorskite and calcite. 8-Mineralogy of the silt fraction: Mixed-layer minerals (chlorite/ vermiculite or chlorite/ smectite), along with smectite, kaolinite, illite and qartz are present in traces to dominant amount; other minerals include meta-halloysite, calcite, amphiboles, K-feldspars and olivine are in traces to moderate amounts.

9-Mineralogy of the fine sand: Minerals were many quartz in dominant; other were mainly in traces they include with calcite being mostly in few to moderate amount, dolomite, olivine, gypsum, hematite, goethite and K-feldspars.

10- Cations exchange capacity (CEC), surface area of soil separates clay, silt, and sand :

a-Clay fraction ($< 0.002 \text{ mm}$): i-Cation exchange capacity (CEC) ranged from 19.5 and 83.0 cmolc/kg clay. The lowest value was in an Aghormi soils. The highest was in a Timeira El-Maaser soil. ii-Surface area of the clay ranges between 838 and 922 m^2/g clay. The lowest value was in an Khamisa soils, while the highest was in an El-Maraqui soil.

B- Silt fraction ($0.02 - 0.002 \text{ mm}$): 1-CEC ranged from 14.0 to 51.0 cmolc/kg silt. The lowest was in a Timeira El-Maaser soil, while the highest was in an Aghormi soil. 2-Surface area ranged between 777 and 861 m^2/g silt. The lowest value was in an Aghormi soil, while the highest was in a Siwa soils.

C-Fine sand fraction ($0.2 - 0.02 \text{ mm}$): i-CEC ranged from 3.4 to 8.1 cmolc/kg fine sand. The lowest value was in a Timeira El-Maaser soil, while the highest was in a Qureishet region soil. ii-Surface area ranged between 58 and 68 m^2/g fine sand. The lowest value was in a Qureishet soil, while the highest value was in a Qureishet soil.

SUMMARY 15

11-Macronutrients soil:

A-Nitrogen (N): Total N varied between 140 to 3360 mg kg^{-1} with an average of 1234 mg kg^{-1} . Available N varied between 21 to 84 mg kg^{-1} with an average of 50 mg kg^{-1} .

B-Phosphorus (P): Total phosphorus varied between 5.0 to 649.8 mg kg^{-1} with an average of 189.8 mg kg^{-1} . Available phosphorus (NH_4 - bicarbonate-DTPA extract) varied between 0.5 to 18.6 mg kg^{-1} with an average of 9.17 mg kg^{-1} .

C-Potassium (K): Total potassium varied between 99 to 4325 mg kg^{-1} with an average of 1512 mg kg^{-1} . Available potassium varied between 36 to 1850 mg kg^{-1} with an average of 353 mg kg^{-1} .

12-Micronutrients status in the studied soils:

A-Iron (Fe): i-Total iron: 1024 to 23550 mg kg^{-1} . Variation in total Fe is associated with soil texture, CaCO_3 content and soil mineralogy. ii-Available (DTPA-extractable) Fe: 1.2 to 277.7 mg kg^{-1} , reflecting sufficient contents for most crops.

B-Manganese (Mn): i-Total manganese: 47.1 to 836.0 mg kg^{-1} . ii-Available (DTPA-extractable) Mn: 6.0 to 305.5 mg kg^{-1} , reflecting sufficiency for most crops.

SUMMARY 15

iii-Zinc (Zn): Total zinc content: 7.45 to 178.80 mg kg^{-1} , while available (DTPA-extractable) Zn: 0.35 to 5.44 mg kg^{-1} , being deficient to sufficient for most crops.

iv-Copper (Cu): Total copper: 0.98 to 13.59 mg kg^{-1} , available (DTPA-extractable) Cu: 0.17 to 4.55 mg kg^{-1} ; and being deficient to sufficient for most crops.

13-Distribution trends of total Fe, Mn, Zn, and Cu:

A-iron: Weighted mean through the soil profile (W): varies widely: 1695 to 22734 mg/kg with a tendency of increase towards the fine texture. The computed trend (T) indicates a more symmetrical distribution. The specific range (R) of total Fe indicates heterogeneous soil parent material, except in one case in Timeira which indicates homogeneous soil materials.

B-Manganese: W: 60.0 to 4199 mg/kg with a tendency of increase toward the fine texture. T indicates symmetrical distribution in six profiles. R: indicates homogeneous soil materials in five profiles, while the other profiles seem of heterogeneous soil materials.

C-Zinc: W: 11.0 to 87.1 mg/kg with a tendency of increase towards the fine texture. T: indicates that seven profiles show more symmetrical distribution. R: indicates that four profiles are of homogeneous soil materials, while the other profiles are of heterogeneous soil materials.

SUMMARY 16

D-Copper: W: 2.45 to 8.84 mg/kg with a tendency of increase toward the fine texture. T: indicates that eight profiles had symmetrical distribution. R: indicates that three profiles are of homogeneous soil materials, while other profiles are of heterogeneous materials.

14-Distribution trends of available Fe, Mn, Zn, and Cu:

A-iron: W: 1.4 to 135.0 mg/kg with a tendency of increase toward the fine texture. T: indicates that of one profile in El-Maraqui region soils is in more symmetrical distribution. R: indicates that two profiles of homogeneous soil materials, while others are of heterogeneous materials.

B-Manganese: W: 7.3 to 193.7 mg/kg with a tendency of increase toward the fine texture. T: indicates that four profiles of more symmetrical distribution than the others. R: indicates that three profiles are of homogeneous soil materials, while the others are of heterogeneous materials.

C-Zinc: W: 55 to 4.33 mg/kg with a tendency of increase toward the fine texture. T: indicates that six profiles had more symmetrical distribution than the others. R: indicates that two profiles are of homogeneous soil materials, while the others are of heterogeneous materials.

D-Copper: W: 0.17 to 4.52 mg/kg with a tendency of increase toward the fine texture. T: indicates that seven profiles had more symmetrical distribution than the others. R: indicates that two profiles are of homogeneous soil materials, while the others are of

heterogeneous materials. 15-Land capability classification: Application of the capability index for the studied soil profiles reveals that the studied soil profiles are placed between (II) and (VI) grades as follows: 1- Grade (II). Good soils represented by profiles 4 and 5. 2- Grade (III). Fair soils, represented by profiles 1, 2, 7, 13, 14, 15 and 16. 3- Grade (IV). Poor soils, represented by profiles 6, 8, 9, 10 and 11. 4- Grade (V). Very poor soils represented by profiles 3, 12 and 17. 5- Grade (VI). Non agricultural soils represented by profiles 18 and 19. 16- Correlation: Simple, multiple, and stepwise correlations were conducted involving total as well as available nutrients P, K, Fe, Mn, Zn, and Cu. Regarding simple correlations, there were positive correlations relating available P^{**}, K^{*}, Mn^{**} and Cu^{**} with clay (*, and ** referring to 5 % and 1 % levels of significance). Correlations with silt showed positive significance with K^{**} and Mn^{*}. Those of total CaCO₃ showed positive significance with P^{*}, Mn^{**} and Cu^{**}. Those of active CaCO₃ showed significance with Mn^{**} and Zn^{*}. SUMMARY 162 Regarding multiple correlations equations for both were determined. As for the stepwise correlations, equations were determined and the most correlated parameters were as follows available nutrients: CaCO₃ (particularly active CaCO₃) was mostly involved; minerals most involved were illite and kaolinite. Results for total nutrients were in line with those of available forms. SUMMARY 163