Technical Guide No. 6

BASIC CHECKLIST FOR "U.S.D.A. SOIL TAXONOMY" CLASSIFICATION

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SUMMARY

This Guide highlights several important aspects of soil classification which may facilitate the classification of the soils of Jamaica according to U.S.D.A. Soil Taxonomy.
A checklist is given for the analytical data and its derived values; diagnostic horizons, epipedons and soil characteristics are briefly discussed. Guidelines for classification at family level are presented.
For final classification, this checklist can not replace the use of the Keys to Soil Taxonomy.

This is the sixth Technical Guide issued by the Jamaica Soil Survey Project (JM/89/001), a bi-lateral undertaking of the Governments of Jamaica and the Netherlands. The report has been prepared by P.A.M. van Gent.
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INTRODUCTION

This Technical Guide, which has been prepared for Survey Staff and in particular for Assistant Soil Surveyors, presents a checklist for soil classification according to the U.S.D.A. Soil Taxonomy. The paper does not pretend to be complete, because the Keys to Soil Taxonomy (1987) is the most comprehensive reference book on classifcation available today.
The checklist highlights the most important steps which are to be followed for a consistent soil classification. For classification up to subgroup level the Keys to Soil Taxonomy (1987) should always be used.
Part of this paper can be used in the Soil Survey Guidelines for Jamaica, to be written for specific Jamaican conditions.

SIMPLE CHECKLIST FOR SOIL TAXONOMY CLASSIFICATION

1. Compile the final profile description according to the standard format

2. Work out the analytical data

2.1. Check the following calculations (on fine earth fraction):

- *% sand* is (100 - % silt - % clay), written in whole numbers

- *texture* (using the texture triangle)

- *C/N* (rounded figure, % C is given in one decimal, % N_2 is given in two)

- *sum of exchangeable bases:* (Ca + Mg + Na + K) in NH_4OAc at pH 7.

  Exchangeable Ca is given with one decimal; the other exchangeable bases are written with two decimals. Sum as well as exchangeable cations are expressed in meq/100 g soil, which is equal to cmol(+)/kg soil as used in the Keys to Soil Taxonomy (1987)

- *exchangeable Ca:* CEC (NH_4OAc at pH 7) - exchangeable (Mg + Na + K).

  This only is the case in $CaCO_3$ rich soils. Assume the BSP to be 100 %. CEC is given with one decimal

- *base saturation percentage (BSP):* $\frac{\text{sum of exchangeable bases} \times 100\%}{\text{CEC}}$

Exchangeable bases and CEC are in meq/100 g soil and are determined in NH_4OAc at pH 7. BSP is expressed as a whole number

- *Al-saturation percentage:*

$$\frac{\text{exchangeable Al} \times 100\%}{(\text{exchangeable bases} + \text{exchangeable acidity})}$$

Al-saturation percentage is written as a whole number. Exchangeable bases (in NH_4OAc at pH 7) and acidity (in1 M KCl) are expressed in meq/100 g soil. Exchangeable acidity is exchangeable (Al + H).

- *exchangeable sodium percentage (ESP):* $\frac{\text{exchangeable Na} \times 100\%}{\text{CEC}}$

ESP is expressed as a whole number; exchangeable Na and CEC (NH_4OAc at pH 7) are given in meq/100 g soil

- *sodium adsorption ratio (SAR):*

$$\frac{\text{exchangeable Na}}{\text{sq. root }((\text{exchangeable Ca} + \text{exchangeable Mg})/2)}$$

SAR is written with one decimal; exchangeable Na, Ca and Mg are expressed in meq/100 g soil

- $CaCO_3$ is written with one decimal; in case the value is smaller than 0.5 then < 0.5 is indicated

- pH values are given with one decimal

- K_2O and P_2O_5 are expressed in whole numbers

- $EC_{2.5}$ in mmho/cm (equals mS/cm) is written with two decimals

2.2. Check the following results:

<u>If: pH-H_2O (1:2.5) < 7.0,</u> then:
- BSP is lower than 100%
- there might be some exchangeable acidity (H and Al); usually only determined when pH < 5.5
- usually no $CaCO_3$ is present (there may be some at pH 6.7 - 7.0)
- if some $CaCO_3$ is present, the calculated BSP will be >100%. It must be

realized that the actual BSP can never be more than 100%, but that the data from the current laboratory determinations sometimes indicate a calculated BSP figure > 100%

<u>If: pH-H_2O (1:2.5) > 7.0,</u> then:
- without $CaCO_3$ and with a low EC, BSP is normally 100%
- with $CaCO_3$ and/or a high EC, the calculated BSP > 100%
- fertilizer application and burning can cause a high pH as well as high exchangeable K and/or high exchangeable Na
- although impossible in theory, a calculated BSP > 100% and exchangeable acidity may be found at the same time; if this occurs, then check if the soil has been limed.

2.3. **Calculate**

- *clay in family control section* (usually 25-100 cm):

$$\text{clay \%} = \{(x_a/y_{25-a}) + (x_b/y_{a-b}) + (x_c/y_{b-c}) \ldots\ldots\ldots + (x_{100}/y_{..-100})\}/75$$

in which x_a: clay % in horizon with lower boundary at the depth of a cm and y_{25-a}: the width [cm] of the soil horizon starting at 25 cm and having its lower boundary at the depth of a cm (see figure1)

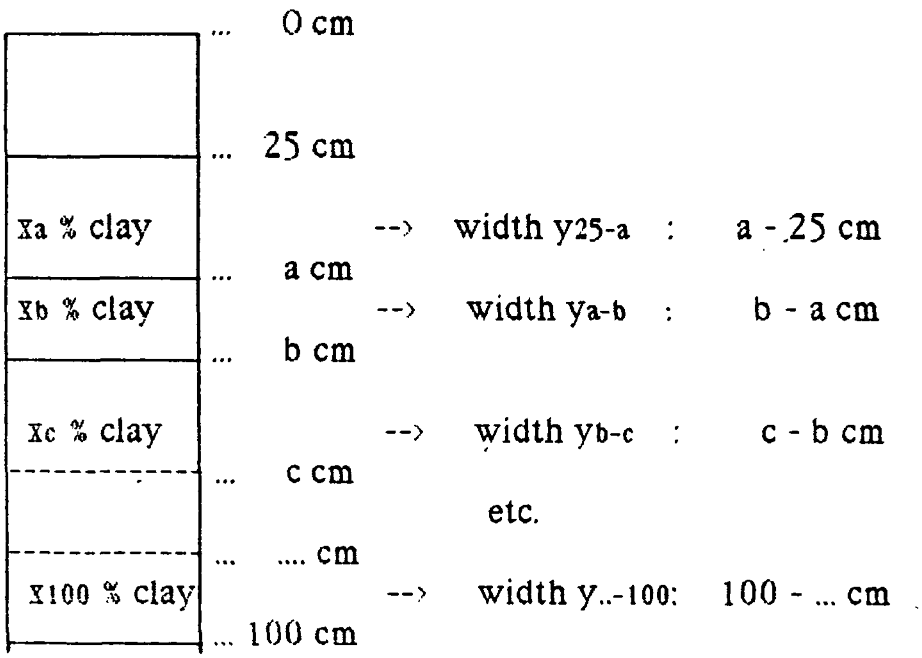

Figure 1. Calculation of the clay % in the family control section (usually 25-100 cm) from horizon width and clay%.

- *organic carbon content in the upper part* (0-100 cm): O.C. in kg/m^2 =

$$\{(p_a \times q_a \times r_a)_{0-a} + (p_b \times q_b \times r_b)_{a-b} + \ldots\ldots\ldots + (p_{100} \times q_{100} \times r_{100})_{..-100}\} / 10$$

in which p: O.C. content in % of the specific horizon and
q: width of the specific horizon [cm]
r: (estimated) bulk density [g/cm^3] of the specific horizon
0-a: upper boundary (0) and lower boundary (a) of the specific horizon [cm] (see figure 2)

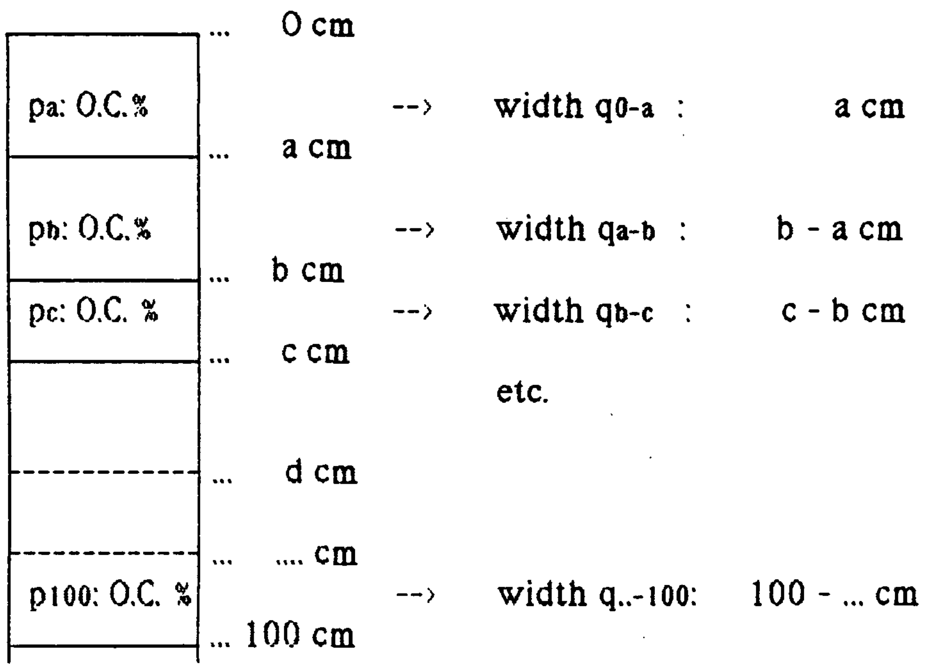

Figure 2. Calculation of the O.C.% in the upper part (0-100 cm) of the profile from the O.C. % and the horizon width.

- *CEC-clay*: $\frac{\text{CEC} \times 100\%}{\text{clay } \%}$

CEC is determined in NH_4OAc at pH 7; CEC-clay is expressed as a rounded figure

- *ECEC* = (exchangeable (Ca + Mg + Na + K) in NH_4OAc at pH 7) + (exchangeable (Al + H) in 1 M KCl)

ECEC is written with one decimal, in meq/100 g soil

- *ECEC-clay* = $\frac{\text{ECEC x100\%}}{\text{clay \%}}$

ECEC is expressed as round figure, in meq/100 g clay

- *moisture content in vol.%* = $\frac{\text{moisture content in weight \%}}{\text{dry bulk density in g/cubic cm}}$

- *available moisture in vol.%* = moisture content at pF 2.0 - moisture content at pF 4.2

3. Check for most important diagnostic epipedons and subsurface horizons

Mollic epipedon:

- has a soil structure that is strong enough that the epipedon is not both hard and massive or very hard when dry
- if there is < 40% finely divided lime, has a colour value darker than 3.5 (moist) and 5.5 (dry) and a chroma less than 3.5 throughout the major part of the matrix and an O.C. content > 0.6%
- if there is >= 40% finely divided lime, has a colour value of <= 5 (moist) and an O.C. content > 2.5% in the upper 18 cm (calculate when necessary)
- has a BSP >= 50%
- has a thickness of 10 cm when underlain by a (para-)lithic contact, but generally > 25 cm (if the texture is finer than loamy fine sand) or > 18 cm in a loamy or clayey epipedon
- has < 250 mg P_2O_5/kg soil (soluble in 1% citric acid)
- if not irrigated, part of the epipedon is moist for 3 or more months (cumulative) in 7 out of 10 years
- has a n-value (index for ripening stage) < 0.7

Umbric epipedon:

- has all characteristics of the mollic epipedon except for the BSP
- a BSP < 50%

Oxic horizon:

- starts below 18 cm depth
- >= 30 cm thick
- has a sandy loam or finer texture
- has ECEC clay <= 12 meq/100 g clay and CEC-clay <= 16 meq/100 g clay
- has <10% weatherable minerals

- has a diffuse upper horizon boundary i.e. when the eluvial horizon has:
  <= 20 % clay : there is less than 4% absolute clay content increase
  20-40% clay: there is less than 1.2 times clay content increase within 15 cm
  >= 40% clay: there is less than 8% absolute clay content increase
- has < 5% (vol.) rock structure

Kandic horizon:

- has the following clay content increase requirements, within a vertical distance of 15 cm; when the eluvial horizon has:
  <= 20 % clay : there is more than 4% absolute clay content increase
  20-40% clay: there is more than 1.2 times clay content increase within 15 cm
  >= 40% clay: there is more than 8% absolute clay content increase
- has ECEC-clay <= 12 meq/100 g clay and CEC-clay <= 16 meq/100 g clay
- >= 30 cm thick, or when there is a (para-)lithic contact witin 50 cm, the thickness is at least 15 cm
- has a loamy very fine sand texture or finer
- underlies a coarser textured surface horizon of >= 18 cm

Argillic horizon:

- has an obvious clay increase within a vertical distance of 30 cm; when the eluvial horizon has:
  <= 15 % clay : there is more than 3% absolute clay content increase
  15-40% clay: there is more than 1.2 times clay content increase
  40-60% clay: there is more than 8% absolute clay content increase
  > 60% clay: there is more than 8% absolute <u>fine clay</u> content increase
- has a thickness of the horizon, where the clay increase occurs, of at least 1/10 of the overlying horizons; the minimum is 7.5 cm in loamy and clayey soils; in sand and loamy sand the minimum is 15
- if peds are present, has clay skins (not necessary when there are 2:1-clays and when there is evidence of pressure faces)

Albic horizon:

- has colours determined by primary (uncoated) sand and silt grains
- has a colour value of 4 or more (moist) and/or 5 or more (dry)
- if the colour value is 6 or more (moist) and/or 7 or more (dry), the chroma must be 3 or less (dry and moist)

Natric horizon:

- has all characteristics of argillic horizon

- has prisms/columns that may or may not break into blocks; or has blocky structure and tongues (> 2.5 cm deep) of an eluvial horizon
- has a SAR>= 13 within 40 cm; or {exchangeable (Mg + Na) >= exchangeable (Ca + acidity) all expressed in meq/100 g soil} at pH 8.2 within 40 cm, when SAR >= 13 within 2 m of the surface

Cambic horizon:
- does not have the dark colours, organic matter content and structure that are definitive for a histic, mollic or umbric epipedon
- has a very fine sand, loamy very fine sand or finer texture
- has a soil structure or absence of rock structure at least in 50% (vol)
- has a CEC > 16 meq/100 g soil; or > 10 % weatherable minerals
- shows some alteration in:
  * grey colours and regular decrease in O.C. content to 0.2% at 1.25 m and/or cracks that open and close and/or a histic epipedon consisting of mineral soil material, a mollic or umbric epipedon
  * stronger chroma, redder hue or higher clay content than the underlying horizon
  * removal of carbonates
  * if no carbonates, mottles have a chroma of <= 2; if not mottled and a value < 4, then the chroma <1; if the value >= 4 then the chroma must be <= 1
- has properties that do not meet the requirements of an argillic, kandic or spodic horizon
- has no cementation
- has the lower boundary >= 25 cm

4. Check for most important diagnostic soil characteristics

- *gilgai:* micro relief of a few cm to 1 m, as result of seasonal changes in moisture content
- *slickensides:* polished, grooved surfaces, common in swelling clays with marked changes in moisture content; to be diagnostic, the slickensides should be close enough to intersect
- *lithic contact:* boundary between the soil and the underlying hard material (not possible to dig). In Oxisols this boundary should be within 125 cm, in other soils within 50 cm
- *ruptic-lithic contact:* as lithic, but with a few infilled cracks in the underlying hard material
- *paralithic contact:* boundary between soil and underlying coherent soft material (soft, but still very hard to dig)
- *abrupt textural change:* when there is a transition from an ochric epipedon or albic horizon into an argillic horizon, the clay increase is as follows: when < 20% clay in the upper horizon, the clay content

should double within max. 7.5 cm; when > 20% clay, the increase should be more than 20% (absolute) within 7.5 cm

- *mottles that have a chroma of 2 or less:* refers to soils that are saturated with water during part of the year, these are mottles (either a minor or major part of the soil) which have a chroma <= 2 (moist) and value >= 4 (moist) surrounded by other parts of the soil having a higher chroma
- *soil moisture regime of the soil moisture control section:* roughly the soil moisture control section is 10-30 cm for fine loamy, coarse silty, fine silty or clayey soils, 20-60 cm in coarse-loamy soils and 30-90 cm in sandy soils.

  Classes are only given for temperature conditions of > 22 oC mean annual soil temperature and < 5 oC difference in mean summmer and winter soil temperature at 50 cm depth:

  * perudic: precipitation exceeds evapotranspiration in all months.
  * udic: in most years the soil moisture control section is not dry in any part for as long as 90 cumulative days; the soil must be a 3-phase system, i.e. solid-liquid-gas
  * ustic: in most years, the soil moisture control section is dry in part or all parts for 90 cumulative days or more, but moist for more than 180 (cumulative) days or it is continuously moist in some part for at least 90 consecutive days
  * aridic: in most of the years the soil moisture control section is never moist in some or all parts for as long as 90 consecutive days and dry in all parts for more than 6 months (cumulative)

5. Classify soils up to suborder level using the Keys to Soil Taxonomy (1987)

6. Classify soils at family level

6.1. Determine particle size class of control section.

The particle size control section refers not only to the fine earth fraction, but to the whole soil. Control section: upper 50 cm of Bt; or bottom Ap/25 cm - 100 cm.

1. *fragmental:* stones, cobbles, gravels and very coarse sand particles
2. *sandy-skeletal:* > 35% (by volume) rock fragments (> 2mm), interstices filled with sand or loamy sand
3. *loamy-skeletal:* > 35% (vol.) rock fragments, interstices filled with loamy very fine sand, very fine sand or finer
4. *clayey-skeletal:* > 35% (vol.) rock fragments, interstices filled with clay
5. *sandy:* < 35% (vol.) rock fragments, texture is sand or loamy sand (but

not loamy very fine sand or very fine sand)

6. *loamy:* < 35% (vol.) rock fragments; texture is loamy very fine sand, very fine sand or finer
   - 6a. coarse loamy: < 18% clay and >= 15% fine sand (0.25-0.1 mm) or coarser, including fragments up to 7.5 cm diameter
   - 6b. fine loamy: 18-34% clay (Vertisols 18-30% clay) and >= 15% fine sand 0.25-0.1 mm) or coarser, including fragments up to 7.5 cm diameter
   - 6c. coarse silty: < 18% clay and < 15% fine sand (0.25-0.1 mm) or coarser, including fragments up to 7.5 cm diameter
   - 6d. fine silty: 18-34% clay (Vertisols 18-30% clay) and < 15% fine sand (0.25-0.1 mm) or coarser, including fragments up to 7.5 cm diameter
7. *clayey:* < 35% (vol.) rock fragments and >= 35% clay.
   - 7a. fine: 35-59% clay (Vertisols 30-59% clay)
   - 7b. very fine: >= 60% clay

The 11 above mentioned classes, i.e. the first five classes and the subdivisions of the loamy and clayey classes are used for all families except for the lithic, arenic and grossarenic subgroups and shallow families. In Ultisols and Oxisols the subclasses of the loamy particle-size classes are used, but not the subclasses of the clayey class.

When andic or andeptic subgroups are found, usually in cases of strongly contrasting families, only 7 particle-size classes (i.e. the 7 main classes) are used.

For Vertisols, only fine and very fine particle-size classes are recognized.

When there are strongly contrasting particle size classes within a profile, a more specific indication should be given, as listed in the Key to Soil Taxonomy (1987, p. 46-47)

6.2. Check for soil mineralogy class:

See tables 2 and 3 of Keys to Soil Taxonomy (1987, p. 56 and 57)

6.3. Determine the soil temperature regime

Two soil temperature regimes occur on Jamaica:

iso-hyperthermic: mean soil temperature > 22 oC and the difference between mean summer and winter soil temperature at 50 cm depth < 5 oC.

iso-thermic: mean soil temperature 15-22 oC and the difference between mean summer and winter soil temperature at 50 cm depth < 5 oC.

LITERATURE

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TG- 5 Guidelines for Soil Description. Soil Survey Staff. Oldeman, P.H. (April 1989, x p.p.)

TG- 6 Basic checklist for "U.S.D.A. Soil Taxonomy" Classification. Gent, P.A.M. van. (April 1989, 11 p.p.)

TG- 7 Guidelines for writing the chapter on land evaluation in Soil Survey Reports. N.H. Batjes. (April 1989, 13 p.p.)