

Memorandum on

ANALYSES OF SOIL SAMPLES

ISN-2304939

Dost, June 1970.

The preliminary conclusions of the reconnaissance soil survey, in the context of the Cat Clay investigations, are mainly based on morphologically determined properties of soil material and soils. In order to check these morphological observations with more quantitative intrinsic properties, soil samples were collected. Laboratory analysis should now provide the parameters for those intrinsic properties, considered most important for the present project i.e. the properties conditioning the initial ripening of the various immature sediments. The properties are:

- a) Initial content of moisture, clay and organic matter (conditioning shrinkage).
- b) Initial content in sulfides and minerals capable of neutralizing acids e.g. lime, bicarbonates etc. (conditioning degree of thioxidation and acidification).
- c) Ultimate base-status of ripened soil (conditioning stability of physical properties and availability of plant nutrients).

ad a) Initial content of moisture, clay and organic matter.

Best parameters are humidity of wet samples and percentage of clay and carbon of dry soil material. Humidity is easily determined in the Tucupita laboratory. Clay and carbon determinations are complicated by high organic matter contents.

Organic matter should be determined first and by a method based on measurement of the quantity of CO₂ developed after oxidation. Accuracy should be of the order of 0.1% for carbon percentages below 5%, of 1% for percentages of 5-20 and 10% for higher percentages.

Determinations of clay contents require destruction of organic matter. This will be more cumbersome for samples with higher organic matter contents. For these latter samples, however, the accuracy of clay contents can be less as the influence of organic matter is dominating that of clay anyhow. For samples with higher organic matter contents therefore smaller subsamples for clay determination are justified, as long as accuracies of clay percentages remain within the following criteria: Accuracy of clay percentage of the order of 0,1% for samples with carbon percentages lower than 5%; of the order of 1% for samples with 5-20% carbon, and of the order of 10% for more

ad b) Initial content of sulfides and acid neutralizing components cannot be determined easily, owing to fast changes in the samples, even when kept moist in plastic bags. First estimates are made in the field by judging the reaction of the fresh soil material on Sodium azide (for sulfides) and hydro-chloric acid (for carbonates). The field estimate is sustained by a microscopic estimate of pyrites in the moist sample. The Calcium/Sulphur balance has been proposed as a parameter, but its value for the purpose of predicting potential acidification is doubtful as apart from calcium also iron, bicarbonates and mineral and organic buffering substances are involved. For the moment no specific laboratory method can be recommended. Comparison of the field methods and the microscopic observations with actual acidification of samples in various stages of oxidation is presently most convenient. The parameter for actual acidification is the actual base status of the sample.

ad c) The ultimate base status of the soil has also to be deducted from the actual base status of samples representative for sequential stages of soil development. Actual base status implies the base status of the soil in situ at the moment of sampling. In the laboratory it has to be determined in the dried sample, but drying of samples implies for immature soil materials oxidation and stronger acidification. In order to minimize the deviation between wet soil and dried sample, the soil samples have to be dried quickly e.g. in the oven at ~~205~~ 105° C. This is presently being done in Tucupita.

The base status of the samples is calculated as the difference between total exchangeable cations and water soluble cations. Most important cations are those of Sodium, Potassium, Calcium, Magnesium and Hydrogen, and, for samples with a pH lower than 4.0, also Aluminium and Iron. For the cation exchange a neutral salt should be used. Herefore normally potassium chloride is chosen. This method is well established but has the inconvenience that it provides no information on the amount of potassium cations exchanged. Exchangeable Potassium might be calculated on the base of the proportion of Sodium and Potassium cations in the aqueous extract or else by separate determination with Ammonium Acetate as exchanger. This latter mentioned method is widely used and well established.

Extracts should preferably be made by shaking fine earth with respectively water and exchange solutions and by centrifugal separation of the suspension. The determination of the cations in the extracts should preferably be done by atom adsorption spectrography.

Part of the aqueous extract can be used for determination of Electrical Conductivity and pH. The E.C. being a welcome check on total amount of soluble salts. Valuable information on presence of acid sulphates or gypsum may be derived from an additional determination of sulphur in the aqueous extract. A determination of phosphorus content of the aqueous extract might be used as a primitive indicator of the relative availability of this plant nutrient.

As the presence of gypsum is a common feature of the soils under consideration, the preparation and separation of the suspensions should be adapted to prevent discrepancies between soluble and exchangeable Ca kations due to unequal dissolving of gypsum e.g. by applying small suspension ratios, relatively long shaking etc.

The interpretation of the base status as an indicator of fertility may gain if additional information is available on total nitrogen. Nitrogen figures combined with the carbon figures give moreover additional information on the degree of decomposition of peaty materials.

The total set of laboratory determinations recommended on the basis of the foregoing, reads as follows:

1. Carbon % of total dry soil material
2. Clay % of mineral soil material
3. Nitrogen % of total dry soil material
4. Aqueous extract
 - 4a pH
 - 4b EC in mmhos.
 - 4c Na in me/100 g dry soil material
 - 4d K " " " " "
 - 4e Ca " " " " "
 - 4f Mg " " " " "
 - 4g H " " " " "
 - 4h P " " " " " (P₂O₅)
 - 4i S " " " " " (SO₄)

~~for pH lower than 4.00~~

for pH lower than 4.0:

- 4j Al in me/100 g dry soil material
- 4k Fe " " " " "

5. N - KCl extract

- 5a Na in me/100 g dry soil material
- 5b Ca " " " " "
- 5c Mg " " " " "
- 5d H " " " " "

for samples with pH(water) lower than 4.0:

- 5e Al in me/100 g dry soil material
- 5f Fe " " " " "

6. NH₄Ac. extract

- 6a Na in me/100 g dry soil material
- 6b K " " " " "
- 6c Ca " " " " "
- 6d Mg " " " " "
- 6e H " " " " "

The following list represents a selection of soil samples submitted for analysis at this moment. These samples cover the whole scale of soil materials and soil situations encountered during the reconnaissance soil survey. About twice as much samples have been collected. The reserve of samples can eventually be used for eventual additional investigations.

The list shows the status of the samples at the present date June 1, 1970. Humidity determinations, quick drying and joining of samples, still to be performed in Tucupita, prior to shipment to specialised laboratories have been indicated.

LIST OF SOIL SAMPLES (total 217)

Figures represent first and last sample numbers for a profile or for a set of samples.

Figures linked by + are composite samples.

For a more detailed list see Appendix.

2-3			
4-8	114	263	792-799
9	115+116+117	264+265	846-854
11	118	266-269	863-873
13-19	119+120	282+283	883-891
20-24	123	284-285	892-899
	124*)		
25+26	126-127*)	286+287	900-903
27-28	173	288+289	907-914
30-35	175-176	290	
36-38*)			
39-42	178-179 **)	634-637	
43	201	651-654	
78+79	202+203	663-670	
80+81	204+205	693-696	
82+83	206+207+208	699	
84+85	209+210	701	
	211+212	703-704	
86+87	213	706-711	
88	214+215	712-720	
89+90	216	727-738	
91-92		747-754	
93+94		765-772	
95+96		783-791	
97+98			
99+100			

*) only Aquous Extract.

***) contain CaCO_3

REMARK

The analyses proposed in the foregoing deviate in some details from earlier specifications. The main difference is that presently more emphasis is laid on the application of centrifugal separation of soil material and extract and of atom adsorption spectrography for elemental analysis of extracts. These two methods are quicker and more precise than classic methods of percolation and titrimetric determination of extract constituents, and should therefore also be less expensive. The classical methods have been maintained for determinations of clay, carbon, and nitrogen. It seems logical that all of these determinations are performed by a laboratory that is equipped with centrifuge and atom adsorption spectrograph.