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SOIL SURVEY OF THE ICRISAT SAHELIAN CENTER

Niger, West Africa

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PREFACE

Texas A&M University/Texas Agricultural Experiment Station are the lead institutions for the Semi-Arid Tropics agroecological zone under the AID-sponsored Soil Management Collaborative Research Support Program (TropSoils).

Niger was chosen during the planning phase as the primary research site for the Semi-Arid Tropics under TropSoils. Texas A&M scientists first visited Niger in February, 1982 to initiate discussions with USAID and Government of Niger officials. Discussions were also held with ICRISAT administrators and scientists concerning TropSoils plans for research at the Sahelian Center.

Growing out of these talks was an informal agreement by TropSoils to conduct a detailed soil survey of the Center. This accomplished two useful objectives: (1) provide basic information on the soil resources of the Center of use to ICRISAT researchers and (2) furnish an early opportunity for Texas A&M pedologists to gain information on the soils of the Sahel. The completed report will serve both objectives well.

The reader should be aware that the conditions and data provided in this report reflect those that existed in August, 1982. These soils are poorly buffered against chemical change. Such changes are, to a degree, predictable and explainable as long as an accurate history of management is kept on experimental plots at the Center. Both annual and seasonal monitoring of essential plant nutrients and exchangeable aluminum status in the soil is very important.

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INTRODUCTION

Agricultural research results and technology generated at the ICRISAT Sahelian Center must play a major role during the coming years in reversing crop yield declines throughout the Sahel. The potential success of the Sahelian Center rests, to a great degree, on the transferability of this technology to regions of the Sahel far from southern Niger. Is an improved millet—cowpea production practice developed on a few hectares of land south of Niamey, Niger going to function as well near Segou, Mali? Both sites are similar in terms of latitude, temperature and rainfall. They are both located on the Niger River and they may or may not suffer from the same socioeconomic constraints.

Crop modelers deal quite well with yield predictions based on the above-ground environment. Unfortunately, conditions in the rooting zone of crops all too often dictate yield potential to as great a degree as either socioeconomic or external biophysical factors. This is both the essence and bane of technology transfer in the tropics: the principles are generally well understood but their application is very site specific.

A well designed, intensive soil survey is a major step forward in neutralizing some of the site-specific constraints to technology transfer. This report provides a detailed inventory of the spatial distribution of the soils at the Sahelian Center. It also provides information on the range of chemical, physical and mineralogical properties of these soils thereby facilitating predictions of crop response under different management practices. It provides a fundamental data set of soil properties which are of primary importance to crop production on the Sahelian Center. Superimposed on this data set, over the coming years, will be additional data sets encompassing research on cropping systems, plant breeding, pest management, forage production, tillage practices, erosion control and soil-water-plant relations. These data sets will be gleaned, consolidated and analyzed in an effort to derive specific crop production recommendations for testing under local conditions throughout the Sahel. Performance of these recommended practices will vary considerably. These technological packages will need both gross and fine tuning in order to reflect variations in socioeconomic and biologic factors which will differ from those at the Sahelian Center. A thorough understanding of the edaphic basis upon which these recommendations were developed will better enable research scientists and extension agents to evaluate successes and failures in the agrotechnology transfer process.

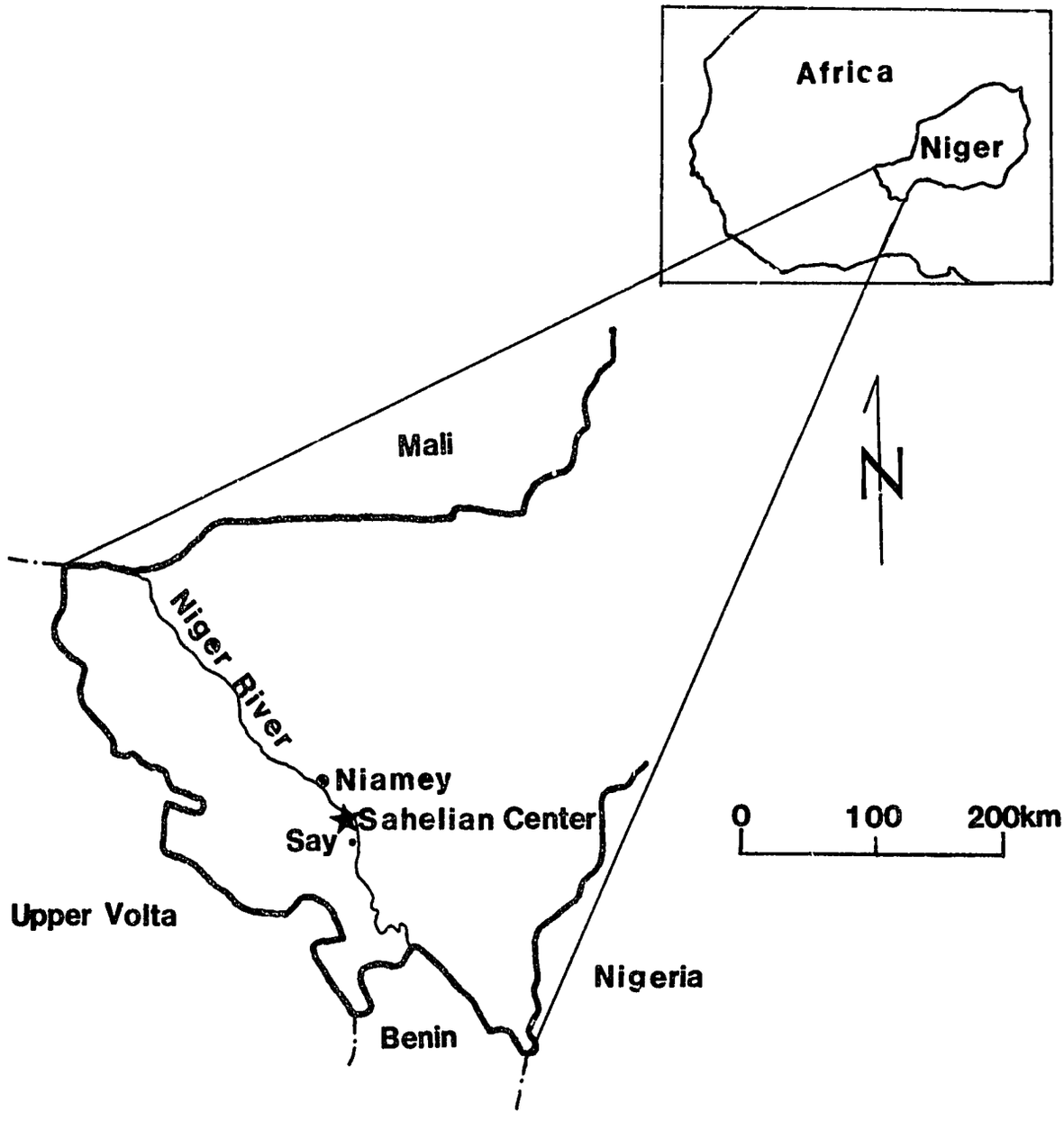


Figure 1. Location of the ICRISAT Center

GENERAL NATURE OF THE AREA

The ICRISAT Sahelian Center is located in the southwestern part of Niger at 13° 15′ N latitude and 2° 18′ E longitude (Fig. 1). The 500 ha Center lies 40 km southeast of Niamey, the capital of Niger; 22 km northwest of Say and 7 km west of the Niger River (UNPD and ICRISAT, undated) (Fig. 1). The Center lies within the Sahel bioclimatic zone· an extensive semi-arid belt immediately south of the Sahara Desert in North Africa.

The population density of this part of Niger is 20 to 25 persons per square kilometer. More than 90% of these people are involved in subsistence agriculture.

The primary food crop is pearl millet (*Pennisetum spp.*) which is often intercropped with cowpeas. Peanuts are also commonly grown in the area and are a major cash crop. Other crops include sorghum, maize, rice, and manioc. Pastoral grazing of sheep, goats, and cattle is another major agricultural enterprise.

The growing of crops in the area is almost entirely done by hand labor. The sandy soils are easily tilled, and animal or mechanical traction for agriculture is rare.

Climate

Atmospheric Climate

The climate of the area is characterized by a June to September rainy season and a dry season throughout the remainder of the year. The seasons are regulated by the intertropical convergence (ITC), a zone of merger between an equatorial low-pressure belt and a high-pressure mass situated over the Sahara Desert. The ITC travels north and south in response to the apparent movement of the sun (Sivakumar, et al., undated). Rainfall follows the passage of the ITC by 200-300 km and most falls within a 75 to 90 day period. The ITC also promotes periods of dry, "harmattan" winds bearing dust from the north and east during the dry season.

Rainfall is irregular and normally comes in the form of convective storms. As much as 100 mm of rain may fall during a single event. Periodic drought is not uncommon. Potential evapotranspiration is approximately 2000 mm annually. Annual rainfall at Kolo (13° 18′ N; 2° 21′ E) averages 574 mm with 90% probability of receiving more than 380 mm (Sivakumar, et al., undated). Farther south at Say (13° 6′ N; 2° 21′ E) mean annual rainfall is 658 mm with a 90% chance of receiving more than 295 mm and 75% probability of annual rainfall being greater than 414 mm (Sivakumar, et al., undated).

Temperatures are warm year round and average 29°C. In Niamey, average monthly daytime maxima of 40 to 42°C occur during March, April, and May. Two periods of cooler daytime temperatures occur; one of 32°C in August, during the rainy season, and one of 34°C during December and January. These two months are also the period of the coolest night time temperatures with an average of 14 to 15°C (Sivakumar, undated).

Soil Climate

Placement of a soil into a moisture regime depends on the length of time and season during the year that the moisture control section (approximately 30 to 90 cm for sandy soils) is moist or dry. The ustic moisture regime is defined on the basis of the moisture control section being dry for more than 90 cumulative days and being moist for at least 90 consecutive days during the year (Soil Survey Staff, 1975). Soils that are dry more than half the time and moist less than 90 consecutive days are placed into the aridic moisture regime.

Using atmospheric climatic data and the Newhall computer model to estimate soil moisture conditions, the moisture control section for soils in the Niamey area has been estimated to be dry for 251 cumulative days and moist for 98 consecutive days during the year (Van Wambeke, 1982). Thus, the soils on the Sahelian Center classify in an ustic moisure regime. However, they closely border the aridic moisture regime with the number of consecutive moist days just over the 90 day limit.

Mean annual soil temperature in the Niamey area is estimated to be 31.5°C (Van Wambeke, 1982). Mean summer soil temperature is estimated to average 31.1°C while the estimate of winter soil temperature is 28.5°C. Soils with mean annual soil temperature above 22°C classify as hyperthermic (Soil Survey Staff, 1975), and because summer and winter soil temperatures differ by less than 5°C, the soils on the Sahelian Center are placed in the isohyperthermic temperature regime.

The iso prefix is defined on the basis of summer and winter soil temperatures. These seasons normally exhibit the maximum and minimum yearly temperatures in temperate climates, and small yearly temperature variation is important to interpretation of soils. However, in the Niamey area, summer and winter are both cool seasons with similar temperatures while the spring months at the end of the dry season have the highest temperatures. Because the summer and winter seasons do not exhibit the maximum variation in temperature, it might be more appropriate to base the iso criterion (5°C yearly temperature variation) on the seasons which do exhibit the maximum temperature difference; winter and spring for the region in question. The mean winter (December, January, and February) temperature for Niamey is 25.3°C and mean spring (March, April and May) temperature is 32.7°C. Thus, the seasonal temperature variation is 7.4°C, and if maximum seasonal differences were used, the soils would be placed as hyperthermic rather than isohyperthermic.

Vegetation

The rainfall and temperature pattern is typical of the Sahel and supports a vegetation of grasses and thorny bushes with scattered trees. Native vegetation on the Sahelian Center consists primarily of *Combretum glutinosum, Balanites aegyptica, Acacia albida, Pitistigma reticulata*, and *Parinari macrophylla* (ICRISAT, undated). The area included by the Center is currently under cultivation or is under fallow.

Geology

Stratigraphy

The stratigraphy, or sequence of sediments in the surface few meters, strongly influences the properties of soils, geomorphology, and hydrology of the ICRISAT Sahelian Center and surrounding area (Daniels and Wilding, 1983; Gavaud, 1966; Greigert, 1966).

Continental Terminal

The oldest near-surface sediment is a complex formation(s) called the Continental Terminal (Gavaud, 1966). Greigert (1966) suggests the Continental Terminal is younger than Paleocene, probably Eocene or younger. Gavand (1966) interprets the age of this formation(s) as Oligocene to Miocene. For this report, the Continental Terminal will be considered Miocene in age. These units are exposed only in road cuts and river escarpements; seldom at the surface. They were not observed on the Center but are exposed at the Niger River bluffs east of the Center. The Miocene sediments are deeply weath

ered and those exposed in the vicinity of the Center are largely a sandy loam texture. Ironstone or laterite caps the Miocene in most parts of the landscape. The sediments immediately underlying the ironstone cap are weathered and have many characteristics of a soil. These sediments may be equivalent to the Gwandu (II + III) Continental Terminal deposits of Sombroek and Zonneveld (1971). According to their report these deposits belong to the *gres argileux du Moyen Niger* and are of upper Eocene in age.

The ironstone cap is a prominent landscape feature. The ironstone (laterite sesquioxide sheets, blocks, or cemented ironstone gravels) is the resistant ledge-former for plateaus in the area. It may occur as a thin sheet only a few 10's of cm thick or as a massive ironstone layer that may be as much as 1 meter or more thick. The upper contact of the cap may have a laminar layer a few cm thick. The ironstone cap occurs on all plateaus but is not confined to surface exposures alone. Below thick sands, a cemented and indurated laterite gravel contact is encountered. It is believed that this layer is a constructional surface of fluvitile gravels that were cemented after emplacement.

Sand Mantle

Overlying the Miocene sediments and its almost universal ironstone cap is a sandy mantle with fine sand, loamy fine sand, or rarely fine sandy loam texture. The sand grains are subangular to rounded, coated with iron oxides and clay, and most of the larger grains are frosted. The sand fraction is largely quartz.

Geomorphology

Geomorphically the area of the ICRISAT Center can be divided into two elements: (i) gently sloping plateaus with discontinuous sand cover and (ii) broad sand plains (terrace-like stepped surfaces).

Plateaus

Major plateaus several kilometers across occur in the near vicinity of the Center at elevations of 220, 240, and 260 m. The plateau element that occurs at the western margin of the Center is at about 240 m. Most plateaus have sandy or loamy mantles over laterite or cemented laterite gravels that form an aquitard (water restrictive layer). Soils of the plateau are commonly armored with a thin (2-4 mm thick) mantle of ironstone pebbles (desert pavement) over thin, massive or weakly platy surface horizons that effectively serve as a crust. Both wind and water are effective in truncating the shallow cover materials as evidenced by deflation basins 10 to 25 cm lower than surrounding areas, desert pavement, exposed laterite, and fluvial-cut rills and channels into the surface. Depending on the slope gradient (which generally is <0.5%), plateaus pond water or are major sources of runoff to adjacent lower topographic reaches.

The age of the laterite associated with plateau areas is indefinite, but has been reported to be Tertiary by Sombroek and Zonneveld (1971) in a study along the Rima-Sokoto River Basin in Nigeria.

Sand Plains (Terraces)

The sand plains unit along the Niger River consists of thick (2-8 m) eolian sands mantling a series of "stepped" surfaces or levels of cemented laterite gravels. Speculatively, the laterite gravel contact probably represents a series of constructional fluvial surfaces graded to previous base levels of the Niger River. Only the upper terrace level at elevations of 225 to 235 m is represented on the Center. It gently slopes towards the Niger River (Fig. 2). The sands are well sorted and there is no evidence of bedding or textural stratification. Most of the sand grains are subrounded and coated with iron oxides and clay. Those which are uncoated appear frosted. The surface has a well expressed dune relief with a local relief differential of 0.25 to 1 m between deflationary basins and dune crests. This lends strong support to the credence that the sands are of eolian origin. It is possible that the sands were fluvially deposited and then later the surface reworked by wind. However, if this were the case, one would expect more evidence of poorly sorted sands and stratification at depth in the sands. The sand cover on all "stepped" levels is similar except for small differences in color, texture, and pH.

The sand plains unit described on the Center may be correlative with the Tureta sandy wash-plain deposits of Sombroek and Zonneveld (1971) in the Rima-Sokoto River Basin, N. W. Nigeria. They describe these sands as older fluvial deposits (terraces) occurring as bands along permanent rivers and minor ephemeral streams. The macro-relief of these deposits is flat but the plain has a very gentle slope towards rivers and locally expresses a "meso-relief" of a few meters over 100 m in the form of low dunes. Texturally the Tureta sandy wash-plain deposits and the sand plains at the Center are comparable. Sombroek and Zonneveld (1971) believe that originally all the sands of their area came from locally exposed sandy Tertiary bedrocks (i.e. Gwandu II + III). This may well be the case for the sands at the ICRISAT Center too. The age of the Tureta sandy deposits is placed at late Pleistocene about 20 to 40,000 years B.P. The description of the Tureta sands is closely similar to those observed at the ICRISAT Center. Further, the soils and cultural practices fit well. The major difference is the interpretation of depositional history.

At the southwest corner of the Center a valley wall slopes to a northwest-southeast trending ephemeral stream. Here, the valley has abruptly incised the laterite-capped plateau and cut into the underlying Miocene sediments. Subsequent to cutting, the valley has been partially filled with eolian sands of at least two different episodes. Evidence for this is a paleosol in the lower sand unit that parallels the modern surface and is of equivalent or stronger pedogenic development than the modern soil. The upper sand unit is 4.8 m thick. It overlies the paleosol that is 3.5 m thick which abruptly mantles very gravelly

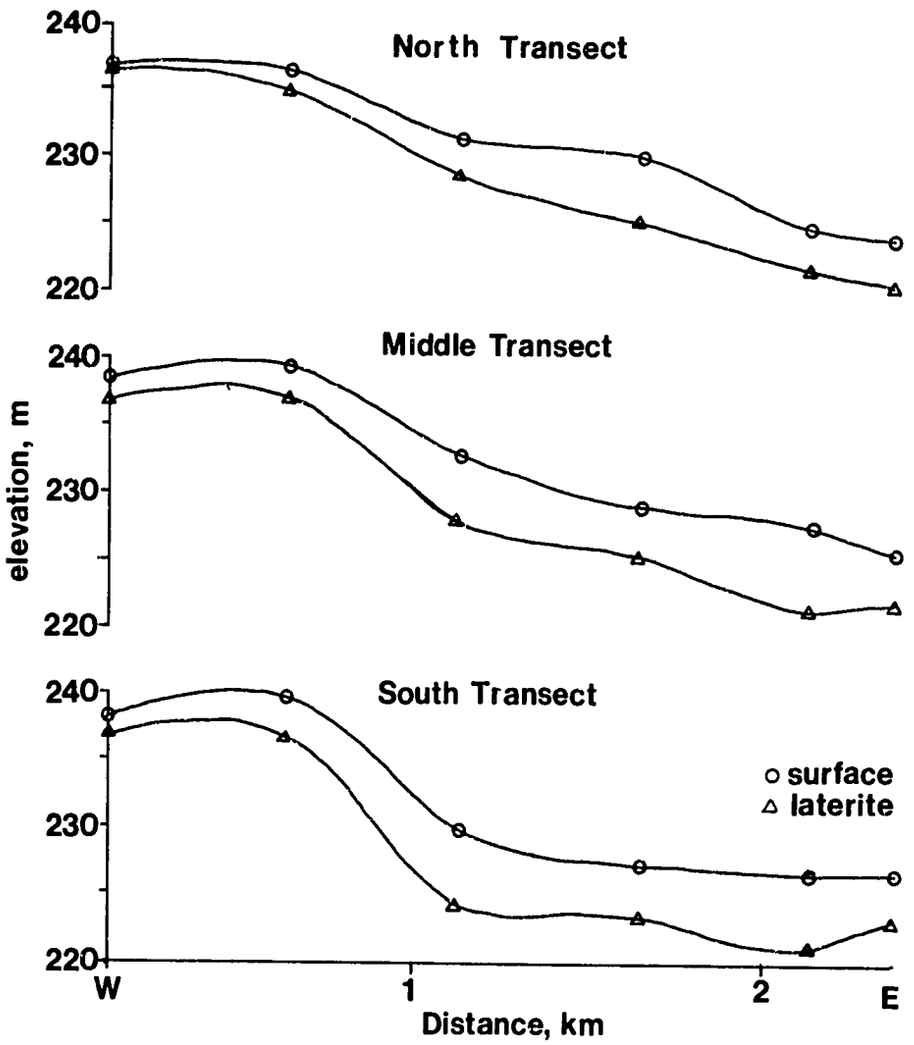


Figure 2. Elevation of soil surface and underlying laterite along the three deep transects; transects are in a west to east direction

loamy sand materials 0.5 m thick (ironstone gravels rich in Miocene sediments). At the base are cemented ironstone gravels. The paleosol in the lower sand unit was not observed over the rest of the Center. These observations confirm that the upper sand unit which mantles the plateau and sand plains is of eolian origin and of the same age across the area. It also indicates paleo conditions of sand stability-instability corresponding to oscillations in climate and vegetation similar to those described by Sombroek and Zonneveld (1971). The more pluvial periods are interpreted as intervals of maximum pedogenic development.

Topography

The most evident topographic feature on the Center is a north-south trending escarpment from a nearly level plateau along the western margin of the Center to the sand plain across the rest of the Center. The plateau is at about 240 m elevation and the sand plain ranges from 225 to 235 m. This escarpment is most evident in the southern part of the Center where a 10 to 15 m drop in elevation occurs over a lateral distance of 500 m (Fig. 2). Northward the relief change from the plateau to the sand plain is less abrupt; along the northern border, the escarpment has only 2 to 3 m of relief (Fig. 2).

Across the sand plain the topography is gently undulating in the form of low dunes. No dune orientation is evident. Local slopes associated with dune features are generally less than 3% and the sand plain grades imperceptibly to the east-southeast towards the Niger River. The local relief differential of dunes is commonly from 0.25 to 1 m but may be up to 2 m; distances between crests and depressions are 50 to 100 m or more. Superposed on these elongated but irregular dunes are coppice mounds which form around standing vegetation. These microrelief features are commonly 25 to 50 cm above the adjacent surrounding dune surface. Small elevated areas on a larger scale than the elongated dunes occur over the eastern three-fourths of the Center. These areas are 1 to 3 m higher than surrounding areas but they still express the subdued dune relief pattern. Perhaps these areas are a complex network of dunes of different scale, shape, and time.

HOW THIS SURVEY WAS MADE

Field Methods

The initial step in this survey as in any soil survey, was designing and establishing a map unit legend. Because soils as a natural body vary with landscape element, the dominant soil occurring on each element must be determined, and decisions must be made as to which soils differ sufficiently to warrant separation during mapping. Taxonomic class and interpretive groupings for the expected use of the survey are important factors in this decision making process, but map scale and landscape complexity must also be considered. For example, if two soils cannot be consistently and accurately separated in the mapping process, it is more appropriate to map a unit containing both soils and accurately describe the proportion and occurrence of the soils than to attempt to separate the two soils.

On the Sahelian Center five soil series were identified. They were differentiated primarily on morphological properties although interpretations for soil water properties, erosion, and soil management were also considered. Map units were designed and tested by mapping limited areas in different parts of the center and verifying composition. Single map units were established for the Dayobu, Gagani, Tondi, and Zogoti series, and for interpretive considerations, the Labucheri series was divided into four map units phased by slope or landscape position.

Because the soil cannot be observed at every point in the landscape, placement of soil boundaries was made on the basis of landform conditions that covary with soils including: landscape position, slope, appearance of the surface, and vegetation. Initially, boundaries were drawn onto photo base maps with aid of a stereoscope. Confirmation of soils and boundary adjustments were then made in the field after obtaining ground truth.

These mapping techniques are normally successful in delineating the systematic soil changes. However, soils normally have a random variation component which causes most map units to have inclusions of soils other than those identified in the map unit name (See discussion of Map Units). The inclusions are of two types: (i) soils that can be expected to behave similarly to the named soil, even though classified differently, and (ii) soils that are classified differently and are expected to behave in a much different manner than the named soil. The second type of inclusion is often recognized by the soil scientist in the mapping process but occurs in areas too small to be delineated at the scale of mapping. Inclusions do not necessarily impair the usefulness of a map unit if their occurrence is documented and the user is aware of their presence.

Map Unit Transects

To document the composition of the map units on the Sahelian Center, transects were made across selected delineations of each map unit. Delineations to be transected were selected to be representative of the map unit in different parts of the Center. The transects were composed of 6 to 14 observations of the soil along a line selected to be parallel to the dominant slope in the delineation. Length of the transects ranged from 50 to 900 m, and distance between observations varied from 15 to 90 m depending on transect length.

Table 1. Map unit transect data

Transect	Number of Observations	Number Correct[1]	Transect Length m
	Dayobu sand 0 to 2 percent slopes (Da)		
1	8	8	105
2	5	5	75
3	3	2	60
	Gagani loamy sand, 0 to 1 percent slopes (Ga)		
1	13	13	300
	Labucheri sand, 0 to 2 percent slopes, concave (La)		
1	6	6	75
2	9	9	120
	Labucheri sand, 0 to 1 percent slopes (LaA)		
1	9	9	200
2	6	6	290
3	9	9	120
	Labucheri sand, 1 to 3 percent slopes (LaB)		
1	11	11	900
2	11	9	300
3	11	10	300
4	9	9	320
	Tondi sand, 0 to 3 percent slopes (To)		
1	3	3	50
	Zogoti sand, 0 to 3 percent slopes (Zo)		
1	12	12	275

[1]Number correct is the number of observations that fit within the map unit concept.

At each observation along the transect, sufficient properties to classify the soil were recorded along with slope and microtopographic position. Additionally, the A horizon, upper B horizon, and lower B horizon of selected observations were sampled for laboratory analyses to document property variability on the Center. The number of transects per map unit ranged from one to four and depended on area covered by the unit and evidence of variability during mapping. Results of the transects are given in Table 1. Locations are shown on Figure 3. Property variability results are given in Table 2.

Three transects were also made across the Center to determine depth to laterite or lateritic gravels (Fig. 2). The transects were in an east-west direction and spaced about 550 m apart dividing the center roughly into quarters. Observations along each transect were made at about 550 m intervals with the first and last observation occuring at the eastern and western boundaries of the Center. Only depth to laterite or lateritic gravels was recorded at each observation, and these depths ranged from 41 cm to more than 6 m. Results are given in Table 3.

Field Sampling

To document physical, chemical, and mineralogical properties of each soil series, six pedons were sampled for laboratory analyses (The Labucheri Series was sampled in both LaA and LaB map units because of its large areal extent). Additionally, a termite mound was sampled to document properties of these disturbed soils in contrast to associated soils. Sampling sites are shown on Figure 3. The pedons were described from a pit wall using standard terminology (Soil Survey Staff, 1982), and bulk samples were collected from each horizon or sub-horizon. Oriented clods for thin section preparation and clods for bulk density measurement were also collected from each non-gravelly horizon.

Table 2. Mean and standard error of the mean for selected soil properties

Property	A horizon n	A horizon $\bar{Y}$	A horizon $S\bar{x}$	B horizon n	B horizon $\bar{Y}$	B horizon $S\bar{x}$
Dayobu Series						
Total Sand, %	3	92.0	0.3	9	92.6	0.5
Total Silt, %	3	3.4	0.3	9	2.8	0.2
Total Clay, %	3	4.6	0.3	9	4.5	0.4
0.1 bar H_2O, %	2	8.4	0.0	4	9.7	2.4
15 bar H_2O, %	2	1.3	0.0	7	1.2	0.1
pH	3	4.9	0.1	9	4.7	0.0
Al Saturation, %	3	36.9	7.1	9	51.3	4.9
CEC, meq/100 g	3	1.5	0.0	9	1.1	0.1
Base Saturation, %	3	19.7	5.0	9	21.9	4.2
Labucheri Series						
Total Sand, %	13	91.2	0.5	35	87.8	0.5
Total Silt, %	13	4.7	0.3	35	4.7	0.2
Total Clay, %	13	4.2	0.4	35	7.6	0.3
0.1 Bar H_2O, %	4	11.4	1.9	6	14.6	2.5
15 Bar H_2O, %	4	1.8	0.4	15	2.5	0.1
pH	13	4.9	0.1	35	4.9	0.1
Al Saturation, %	13	23.5	4.0	35	21.1	2.4
CEC, meq/100 g	13	1.3	0.1	35	1.3	0.1
Base Saturation, %	13	41.9	6.5	35	45.8	3.0
Tondi Series						
Total Sand, %	3	88.3	0.6	4	85.9	1.4
Total Silt, %	3	5.6	0.7	4	4.9	1.1
Total Clay, %	3	6.2	1.2	4	7.2	0.4
0.1 Bar H_2O, %	2	14.0	3.6	2	8.3	0.1
15 Bar H_2O, %	2	1.7	0.3	3	2.9	0.2
pH	3	4.8	0.2	4	4.5	0.1
Al Saturation, %	3	31.3	9.3	4	41.3	3.3
CEC, meq/100 g	3	2.1	0.1	4	1.9	0.2
Base Saturation, %	3	18.7	6.2	4	13.8	1.7
Zogoti Series						
Total Sand, %	3	90.4	1.2	8	82.8	0.6
Total Silt, %	3	4.1	0.5	8	5.8	0.5
Total Clay, %	3	5.6	1.0	8	12.0	0.3
0.1 Bar H_2O, %	2	11.9	4.6	3	9.2	0.6
15 Bar H_2O, %	2	2.0	0.5	6	3.7	0.1
pH	3	4.7	0.1	8	4.9	0.1
Al Saturation, %	3	38.7	9.0	8	22.6	6.1
CEC, meq/100 g	3	1.4	0.1	8	1.8	0.1
Base Saturation, %	3	21.3	0.3	8	53.5	9.2

Table 3. Transects of depth to laterite

Observation[1]	Depth to laterite m
North Transect	
1	0.4
2	1.6
3	2.9
4	3.9
5	3.1
6	3.4
Middle Transect	
1	1.6
2	2.2
3	5.1
4	3.8
5	6.0
6	4.2
South Transect	
1	1.2
2	2.9
3	5.5
4	3.8
5	5.4
6	3.8

[1]Observations are numbered in order from the west side of the station to the east with about 550 m between observations

Laboratory Methods

Sample Preparation

Bulk samples were dried at 35°C and crushed with a wooden rolling pin to pass a 2 mm sieve. Samples with coarse fragments were weighed and the coarse fragments separated and weighed at the Sahelian Center.

Physical Methods

Particle size distribution: Particle size was determined by the pipette method after a modification of the method described by Kilmer and Alexander (1949). Ten grams of soil were dispersed with sodium hexametaphosphate (calgon) in 400 ml of water and placed in a constant temperature bath. Five ml aliquots collected at a 5 cm depth were removed for weighing after appropriate settling times.

Bulk Density: Bulk density was measured at 0.1 bar tension and at oven dryness on Saran-coated clods as described by Brasher, et al. (1966).

Coefficient of linear extensibility (COLE): COLE, as a measure of shrink-swell potential, was calculated from 0.1 bar and oven dry bulk densities by the following equation (4D1; Soil Survey Staff, 1972).

$$COLE = (Db_d/Db_m)^{1/3} - 1$$

where Db_d is oven dry bulk density and Db_m is bulk density at 0.1 bar.

Water retention: Samples for water retention measurements were equilibrated on ceramic plates in a pressure extraction apparatus. Water retained at 0.1 bar was measured on saran-coated clods and 15-bar water was

measured on crushed soil material (methods 4A1 and 4B2; Soil Survey Staff, 1972).

Chemical Methods

Methods used to measure ion exchange and other chemical properties closely follow those outlined by the Soil Survey Staff (1972). Notations in parenthesis refer to the particular method outlined in that publication.

Soil reaction: Soil pH was measured on a 1:1 soil-water suspension with a glass electrode (8C1a).

Organic carbon: Total carbon was determined by dry combustion and gravimetric measurement of CO_2 evolved (6A2b). Because the samples were noncalcareous, total carbon is equivalent to organic carbon.

Extractable bases: Extractable Ca, Mg, Na, and K were leached from soil samples with 1 *N* ammonium acetate at pH 7.0 (5A6) with a mechanical extractor described by Holmgren, et al. (1977). Concentrations of Ca and Mg were determined by atomic absorption, and Na and K were measured by flame emission.

Cation exchange capacity: Cation exchange capacity was determined by Na saturation at pH 8.2 and subsequent displacement by NH_4^+ using a method similar to 5A2 as adapted for use with a mechanical extractor.

KCl extractable Al: Aluminum was extracted from soil samples with 1 *N* KCl (6G2). Al concentration was measured by atomic absorption spectrometry.

Free iron oxides: Free iron oxides were extracted with a sodium citrate-sodium dithionite solution (6C2), and iron in solution was measured using atomic absorption spectrometry.

Mineralogical and Micromorphological Methods

Sand and silt mineralogy: Mineral components of sand and silt fractions were identified from X-ray diffraction (XRD) patterns from randomly oriented powder samples.

Clay mineralogy: Clay fractions of selected horizons were separated and fractionated into coarse (0.2-2 μm) and fine (<0.2 μm) separates. Mineral identification and estimates of abundance were made from XRD patterns obtained from samples oriented on ceramic plates. The clays were magnesium saturated and analyzed air-dry, ethylene glycolated, and heated at 300 and 550°C.

Micromorphology: Thin-sections were prepared from oriented clod samples from selected horizons that had been impregnated with thermalplastic resin. Observations of fabric and special features were made by examination with a petrographic microscope.

SOIL MAP UNITS

It is important that the users of this soil survey understand the distinction between soil map units (landscape units) and soil series (taxonomic units). The scientific basis of a soil survey is that soils and their location on the landscape are predictable to an experienced soil scientist who has a knowledge of the geology, climate, and [illegible] patterns of the area. The soil scientist is not able to observe or sample the soil at every point on the landscape. Only enough observations are made during mapping to determine soil landscape relations and confirm predictions of soil models established from these relationships. Thus, map unit delineations are derived, to a great extent, from inferences gained from a small sampling of the landscape. This is possible because soil properties change systematically with landscape position, and visible changes in slope, vegetation, surface color, and drainage pattern enable a soil scientist to locally extrapolate soil-landscape relationships previously established. Thus, a soil map unit is a landscape (cartographic) unit that reflects the dominant soil conditions of a landscape element or segment.

On the other hand, soil series are conceptual taxonomic (classification) units. They are defined as having a particular combination and range of physical, chemical, and mineralogical properties. This definition is based on the properties observed in several exposures of limited area (pedons); but the series, in contrast to a map unit, has absolute ranges for any property. Thus, any observation of a pedon can be compared to a series definition and can be categorized as either being a member of that series or a member of another series.

Most map units are named for the dominant soil series occurring in the delineated landscape body. Unfortunately, one of the common properties of soils as natural landscape bodies is variability. In addition to the systematic variation observed above, some variability occurs in an undefined (random) manner. Soil scientists are aware of this random variability and make every attempt to design map units and to map soils that restrict property variability to limits that permit meaningful interpretations of soil use, management, and behavior. However, soil properties are not homogenous within mapped areas. They often have ranges that exceed the limits imposed by the definition of the soil series naming the map unit. Thus, map units may consist of a number of soils either similar or dissimilar to the named series.

The goal of the soil scientist is to design the map units and delineate them in a manner that limits the number of inclusions. However, inclusions are almost always present both as similar soils with properties just outside the series range and as areas of dissimilar soils too small to delineate at the scale of mapping. Serious errors, from a user's stand point, may occur when a soil map is used to greater detail than the accuracy of mapping warrants. Detailed inspection is needed if minor soil variation is important to the intended use. The map unit descriptions should alert the user to expected variations.

Overview of Soil Properties

The soils mapped on the ICRISAT Sahelian Center have similar properties in many respects. They are sandy, reddish colored, and exhibit weak structural development. All have evidence of translocated clay, and all but the Dayobu soil have argillic horizons. The surface of the soils is friable and easily tilled. The subsoil is also friable when moist, but is slightly brittle and difficult to dig when dry.

Hydraulic conductivity of the surface horizon (infiltration rate) of these soils is generally rapid unless the A horizon has been removed by erosion. The very deep soils have rapid hydraulic conductivity through the subsoil (permeability), but water movement will be restricted in those soils with laterite at depths less than 2 m. Surface runoff is minimal over the Center. However, during high intensity, short duration storm events, some water may run from microtopographic highs to microtopographic lows and may move on to concave landscape positions. Capacity for these soils to store water for plant growth (Cummulative Water Retention Difference, CWRD) is very low to low depending on soil thickness over laterite.

The soils on the center have low native fertility, and their low organic matter and CEC limits their nutrient storage capacity. These soils are generally very strongly acid to strongly acid, and [illegible] comprises a high percentage of the exchangeable cations.

The soils are highly susceptible to wind erosion without proper protection. Danger of water erosion is low. However, severe gullies were noted in areas away from the Center where runoff is concentrated. Areal and proportionate extent of each map unit is given in Table 4.

Table 4. Areal and proportionate extent of the soils

Map Symbol	Map unit name	Hectares	Percent
Da	Dayobu sand, 0 to 2 percent slopes	12	2.4
Ga	Gagani loamy sand, 0 to 1 percent slopes	15	3.0
La	Labucheri sand, 0 to 2 percent slopes, concave	15	3.0
LaA	Labucheri sand 0 to 1 percent slopes	86	17.2
LaB	Labucheri sand, 1 to 3 percent slopes	305	61.0
LaC	Labucheri sand, 3 to 5 percent slopes	12	2.4
To	Tondi sand, 0 to 3 percent slopes	12	2.4
Zo	Zogoti sand, 0 to 3 percent slopes	43	8.6

Map Unit descriptions

Da—Dayobu sand, 0 to 2 percent slopes.

This very deep, gently sloping soil occurs in concave positions limited to the northern one-half of the Center.

Typically, these soils are yellowish red sands throughout the profile and have weak structural development. The surface horizon is normally about 29 cm thick with 7 to 10 cm of more recently deposited overburden present in most pedons. The Bt horizon extends to about 175 cm in most areas with a C horizon extending to depths greater than 2 m. Depth to laterite gravel is about 2 to 4 m. These soils are very strongly acid throughout the profile.

Hydraulic conductivity of the surface and the most limiting horizon is rapid. Surface runoff is slow. These soils occur in concave landscape positions that may receive extra water as runon. Cummulative water retention difference (CWRD) is low.

This map unit is composed of 88% Dayobu soils. The remaining soils were identified as Labucheri soils occurring mostly near the margins of the Dayobu units.

Pedon S82TX-004-01 was sampled to represent this map unit. Pedon S82TX-006-02 was sampled to document variability in this map unit.

Ga—Gagani loamy sand, 0 to 1 percent slopes.

This shallow, nearly level soil occurs on upland positions along the west side of the Center where laterite is within 50 cm of the soil surface.

The A horizon is reddish brown loamy sand about 9 cm thick. The Bt horizon is yellowish red sandy loam to about 34 cm. The lower part of this horizon may contain up to 50 percent ironstone gravels from 2 mm to 5 cm in diameter. Underlying the B horizon is indurated laterite. These soils are very strongly to extremely acid.

Over about 40% of the area of this map unit, the surface horizon has been removed by wind and water erosion. Where the B horizon is at the surface, the soils have a thin compact crust and are normally barren of vegetation.

These soils have rapid surface hydraulic conductivity if the A horizon has not been removed by erosion. However, where truncated, the crusting character of the exposed Bt horizon limits hydraulic conductivity and increases runoff. Because the laterite underlying these soils at shallow depths forms a root and water restrictive layer, limiting layer hydraulic conductivity is very slow, and water ponds in shallow depressons in the map unit during the rainy season. The soil has a very low CWRD.

Only Gagani soils were identified in this map unit, but small areas may contain sufficient gravel in the B horizon to cause placement in loamy-skeletal particle size families. Additionally, because the surface of the laterite is known to be wavy, small areas of this map unit may be greater than 50 cm to laterite and belong to the Tondi series. The average depth to laterite is 35 cm with an observed range of 27 to 48 cm. Indications of wetness were observed in depressional areas that pond water. Pedon S82TX-004-06 was sampled to represent this map unit.

La—Labucheri sand, 0 to 2 percent slopes, concave.

This very deep gently sloping soil occurs in concave positions that may receive extra water as runon during intense rains. Local relief differential below surrounding highs ranges from 0.5 to 1 m.

The surface horizon is yellowish red sand about 26 cm thick with 6 to 10 cm of overburden present in most pedons. This horizon is underlain by a red loamy sand or sand Bt horizon to a depth of more than 2 m. Structural development is weak throughout the profile. Laterite gravels occur at 2 to 4 m.

These soils have rapid hydraulic conductivity of the surface as well as most limiting horizons. CWRD is low for this soil. Surface runoff is very slow.

This map unit is dominantly Labucheri. However, small inclusions of Dayobu soils are present. Also, small areas were noted that have low base saturation and classify as Psammentic Paleustults.

Pedons S82TX-006-07 and S82TX-006-11 were sampled to represent this map unit.

LaA—Labucheri sand, 0 to 1 percent slopes.

This very deep nearly level soil occurs in irregular areas over much of the Center. Most areas of this soil have gentle undulations with relief between highs and lows less than 0.5 m.

The surface horizon of these soils is yellowish red sand about 27 cm thick with 6 to 10 cm of overburden present in most pedons. The Bt horizon is red loamy sand or sand that extends to more than 2 m. Laterite gravels occur at 2 to 4 m.

These soils have rapid surface and subsoil hydraulic conductivity. Surface runoff is slow. Water storage capacity (CWRD) is low for this soil.

Labucheri was the dominant soil identified in this map unit. A few small areas of Dayobu soils were identified in this unit.

Pedons S82TX-004-02 and S82TX-004-08 were sampled to represent this map unit, and pedons S82TX-006-05, S82TX-006-08, and S82TX-006-10 were sampled for variability documentation.

LaB—Labucheri sand, 1 to 3 percent slopes.

This very deep, gently sloping soil is the dominant soil found on the Center. Slopes are plane to convex. Most areas of this soil are gently undulating with less than 0.5 m of relief between highs and lows.

Typically, these soils have yellowish red, sand surface horizons about 27 cm thick with overburden thickness ranging from 0 to 7 cm. The Bt horizon is red loamy

sand or sand that continues to depths greater than 2 m. Laterite gravel is encountered at depths of 3 to more than 6 m.

These soils have rapid hydraulic conductivity throughout the profile. Surface runoff is slow and CWRD is low. They are easily eroded by wind, and more sloping areas may be subject to erosion by water during intense rains.

The composition of this map unit derived from line transect data is 93% soils which fit the map unit name and 7% inclusions of other soils. The inclusions were small areas of Labucheri soils with short slopes greater than 3%, small areas of Dayobu soils, and small areas with low base saturation which place as Psammentic Paleustults.

Pedon S82TX-004-04 was sampled to represent this map unit. Pedons S82TX-006-09 and S82TX-006-12 were sampled to do document variability.

LaC—Labucheri sand, 3 to 5 percent slopes.

This very deep, moderately sloping soil was mapped as one unit in the southwest corner of the Center. Slopes are plane to convex and gentle undulations are found over much of this soil.

The surface horizon of this soil is typically yellowish red sand that extends to about 27 cm. The Bt horizon underlying this layer is red sand with weak structural development to more than 2 m. Overburden present in other Labucheri map units is mostly absent from these soils. The hydraulic conductivity of the surface and subsurface is rapid. The CWRD is low and surface runoff is moderate to slow. Wind erosion hazard is high, and because of the steeper slopes of these soils, erosion by water may be a problem during intense rains.

A buried paleosol in eolion sands was identified under two pedons in the upper and midslope position of this map unit. The paleosol began at about 4.8 m and extended to 8.3 m over lateritic gravels. The paleosol parallels the present surface and supports the interpretation of multiple deposits of eolian sand and prior periods of more pluvial climates. Labucheri was the only soil observed in this map unit.

To—Tondi sand, 0 to 3 percent slopes.

These moderately deep soils occur on plane to concave slopes on the west side of the Center. These soils were mapped as a thin unit circling the Gagani soils and were also mapped in concave positions where the soils were moderately deep over laterite or lateritic gravels.

Typically, the surface horizon of these soils is yellowish red sand about 15 cm thick. The Bt horizon is red loamy sand and is typically about 65 cm thick. The lower 5 to 10 cm of the Bt may contain up to 50 percent ironstone gravels. The Bt horizon is underlain by indurated laterite at depths ranging from 50 to 100 cm.

These soils have rapid surface hydraulic conductivity. Hydraulic conductivity of the subsoil is limited by underlying laterite. Surface runoff is slow. Areas of this soil mapped in concave positions may receive runoff from adjacent higher areas during intense storms, and perched water was observed above the laterite in some of these areas. These soils have very low CWRD.

Tondi was the dominant soil observed in this map unit during transecting. The only inclusions observed were soils without the necessary clay increase for an argillic horizon which belong to Ustoxic Quartzipsamment subgroups.

Pedons S82TX-004-05 and S82TX-006-04 were sampled to represent this map unit.

Zo—Zogoti sand, 0 to 3 percent slopes.

This very deep, gently sloping soil occurs primarily on the west side of the Center. Slopes are plane to convex, and most areas of this soil are gently undulating with less than 0.5 m of relief between highs and lows. These soils are underlain by lateritic gravels at depths of 1 to 2 m.

The surface horizon of these soils is yellowish red sand about 21 cm thick. The underlying Bt horizon is red loamy sand with weak structural development to about 144 cm. Below this horizon is a red, very gravelly loamy sand Bt horizon that extends to depths greater than 2 m. The gravelly Bt horizon may have up to 50% ironstone gravels and stones.

These soils have rapid hydraulic conductivity throughout the profile. Surface runoff is slow and CWRD is very low. Depth to ironstone gravels ranges from 100 to 200 cm, and some perching of water may occur at the contact with the gravels as inferred by the increase in base saturation.

Zogoti was the only soil observed in transects of this unit.

Pedons S82TX-004-03 and S82TX-006-03 were sampled as representative of this map unit.

SOIL PROPERTIES AND MANAGEMENT

Physical Properties

Textures of the soils on the Sahelian Center are dominated by sands and loamy sands. Sand contents are generally greater than 85%. Most horizons have less than 10% clay, with many having only five to eight percent (Fig. 5). Coarse fragments were present in horizons developed in lateritic gravels, and gravel contents of these horizons ranged up to 80% by weight. The gravelly horizons had slightly higher clay contents than those developed in the sandy materials.

Bulk density of surface horizons at 0.1-bar water content ranged from 1.55 to 1.76 g/cm^3. Subsoil bulk densities were slightly lower ranging from 1.44 to 1.65 g/cm^3. Oven dry bulk densities were only slightly higher than those at 0.1 bar which yielded low shrink-swell potential (COLE) values as would be expected in sandy soils with kaolinitic mineralogy. The Dayobu pedon (S82TX-004-01) had the highest bulk densities possibly because of the extremely weak structural development in this soil.

Water content at 15-bar tension was relatively low and highly correlated to clay content (Table 5). It ranged from 1.4 to 4.0% by weight. Water content at 0.1 bar was much more variable ranging from 6 to 21%. Poor correlation was found between particle size and water retention difference (WRD = (0.1 bar water − 15 bar water) × (bulk density at 0.1 bar), = g H_2O/cm^3 soil). Other measured parameters were also poorly correlated with WRD and 0.1 bar water.

Cummulative water retention difference (CWRD) data is given in Table 6 and in Figure 4.

Table 5. Regression relationships among soil properties[1]

Relationship	N	R^2
Chemical Properties		
CEC = 0.17 + 4.00 (organic carbon) + 0.11 (clay)	84	0.72**[4]
CEC = 0.71 + 0.11 (clay)	84	0.38**
CEC = 0.92 + 4.01 (organic carbon)	64	0.34**
Base Saturation = −190.8 + 46.9 (pH)	84	0.55**
Base Saturation = 51.2 − 12.9 (ΔpH)[2]	47	0.01NS
Base Saturation = −181.2 + 53.2 (KpH)[3]	47	0.67**
Al Saturation = 191.5 − 33.6 (pH)	84	0.42**
Al Saturation = 27.4 + 0.5 (ΔpH)	47	0.00NS
Al Saturation = 188.3 − 38.6 (KpH)	47	0.50**
Mean Base Saturation of B horizon = −0.1 + 0.2 (Soil thickness)	6	0.61NS
Water Retention		
15 Bar Water = 0.17 + 0.31 (clay)	47	0.87**
0.1 Bar Water = −3408 + 34 (clay) + 34 (silt) + 34 (sand)	28	0.14NS
WRD = −3514 + 35 (silt) + 35 (sand) + 35 (clay)	28	0.20NS

[1]Samples from the termite mound were excluded from the data set
[2]ΔpH = pH − pH in 1*N* KCl
[3]KpH = pH in 1 *N* KCl
[4]R^2 significant at P = 0.01; NS = R^2 nonsignificant at P = 0.05

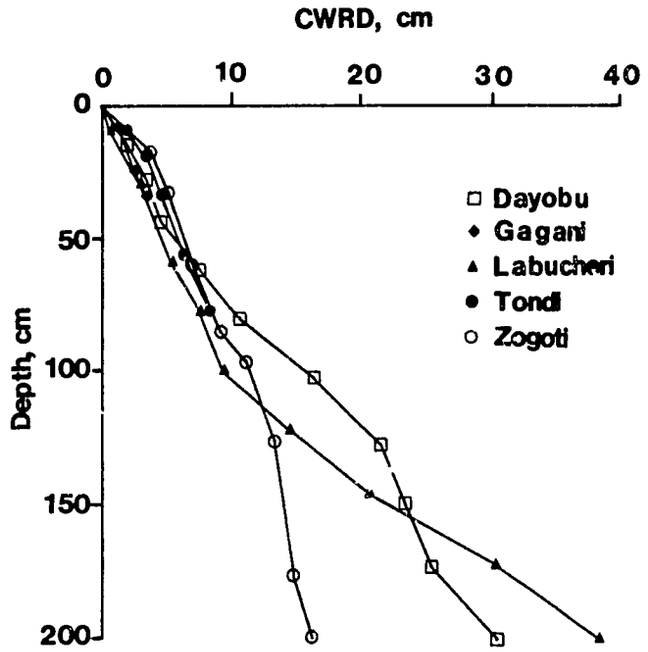


Figure 4. CWRD versus depth for soils mapped on the ICRISAT Center

Chemical Properties

Cation exchange capacity (CEC) of the soils is quite low (0.6 to 3.2 meq/100g soil) and is highly correlated with clay and organic carbon contents (Table 5). No consistent depth trends were observed for CEC because carbon generally decreased as clay content increased with depth. The CEC expressed per 100 g organic carbon is about 400 meq, and that for total clay is 11 meq/100 g (equation Table 5). Observed CEC's for clay ranged from 11 to 30 meq/100 g clay in subsoils without correction for organic carbon content. This reflects the kaolinitic and Fe-oxide dominated clay in the soils.

Table 6. Cummulative Water Retention Difference (CWRD) for pedons sampled

Soil	Pedon	(Cm H_2O/CWRD[1])/2 m	Rating
Dayobu	S82TX-004-01	30.1	low
Gagani	S82TX-004-06	3.4	very low
Labucheri	S82TX-004-02	38.4	low
Labucheri	S82TX-004-04	32.5	low
Tondi	S82TX-004-05	8.2	very low
Zogoti	S82TX-004-03	16.3	very low

[1]CWRD = (0.1 bar water − 15 bar water for horizon) × (0.1 bar bulk [illegible] × (horizon thickness) for 2 m soil section

The pH's are extremely acid to strongly acid and base saturations are generally less than 35% in the upper 50 cm. One pedon of Labucheri (S82TX-004-04) which is located on a footslope, has apparently been base recharged from upslope discharge and has high base saturation in the surface. Base saturations increase with depth in the Labucheri (S82TX-004-02) and Zogoti (S82TX-004-03) pedons and are more than 50% in lower horizons of these soils. Base saturations remain low (13 to 39%) in the other soils. Al saturation is relatively high

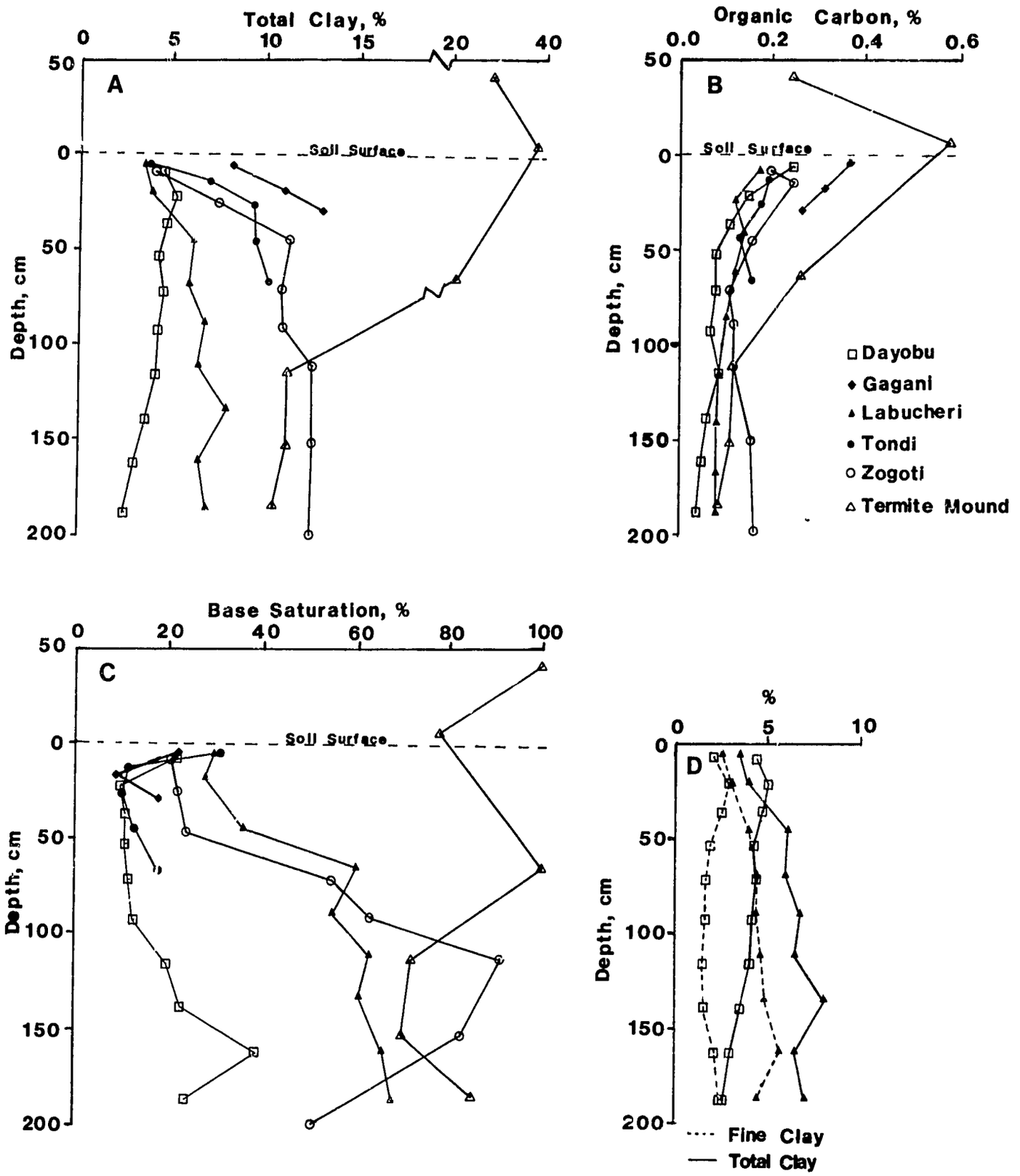


Figure 5. Depth distributions of clay, organic carbon and base saturation for soils mapped on the ICRISAT Center including a termite mound. A—Total clay; B—Organic carbon; C—Base saturation; D—Fine and total clay for Labucheri and Dayobu soils

(33 to 67%) in the surface horizons of all soils except for the Labucheri pedon (S82TX-004-04) located on a footslope. It is above 50% in lower subsoils of soils exhibiting low base saturation. Both Al saturation and base saturation show moderate correlation (R^2 = 0.42 – 0.55) with pH (Table 5), but pH in 1 *N* KCl (KpH) is better correlated with these parameters (R^2 = 0.50 – 0.67).

Citrate-dithionite (CD) extractable Fe ranged from 0.4 to 1.4%. Higher values were from horizons containing ironstone gravels as coarse fragments. Samples of the indurated laterite underlying the Gagani and Tondi pedons contained 18.5 to 22.0% CD Fe. While absolute percentage of CD Fe in the soils is low, the ratio of Fe to clay is high (0.04-0.17) and may be a more important measure.

The termite mound has striking differences from associated soils demonstrating the remarkable effects of biocycling by these organisms. In short, termites have been instrumental in concentrating clay by 4 to 8 times, organic carbon by 2 to 3 times, and bases by 2 to 4 times the levels in associated soils. The major effect is found in the zone from the top of the mound to a depth of 1 m or more below the natural soil surface. The presence of active and abandoned termite mounds augment lateral spacial variability of soil properties in these landscapes. Differences between the properties of termite mounds and associated soils observed herein are similar to those reported in other tropical areas (Watson, 1974).

Mineralogical Properties

The mineral components of these soils reflect their highly weathered nature. Quartz was the only mineral identified in the sand fraction by X-ray diffraction (XRD). The silt fraction was similar with quartz being the dominant mineral component, but trace amounts of more weatherable feldspar minerals were detected.

Both the coarse (0.2-2 μm) and fine (<0.2 μm) clay fractions were dominated by kaolinite. Kaolinite was estimated from XRD patterns to comprise more than 60% of these fractions. Quartz was the next most abundant component and was present in both fine and coarse clay fractions of all the samples analyzed. Quartz contents tended to decrease with depth. Trace quantities of Anatase (TiO_2) were identified in both clay fractions. Also present were trace amounts of a 2:1 layer clay which could not be positively identified by techniques used. No iron minerals were identified in these samples.

The lack of weatherable minerals and 2:1 layered clays limits the native fertility of these soils. Few basic cations for plant nutrition can be expected to be supplied by weathering or cation exchange processes. Additionally, the lack of cation exchange capacity severely limits these soils ability to retain applied plant nutrients against losses by leaching.

Fertility Capability

The classification of the soils according to the Fertility Capability Classification System (Sanchez, et. al., 1982) is given in Table 7. All the soils classify in the *S*, sandy topsoil type and carry the modifiers *d*, dry; *e*, low CEC; and *k*, low potassium reserves. Additionally, the Gagani soils classify in the *R*, rock, substrata type. All the soils except Labucheri have the *a*, aluminum-toxicity, modifier, while Labucheri carriers the *h*, acid modifier.

With these placements, general statements can be made concerning soil fertility considerations. Moisture will be limiting in these soils, and germination will be a problem if the first rains during the rainy season are sporadic. These soils have a very low capacity to retain nutrients against leaching and K reserves are low by the definition of Sanchez, et al., (1982). Elemental K in the silt fractions is high (~1%), but silts comprise only 2 to 6% of the total soil.[1] Application of fertilizers is probably necessary for maximum yields, and heavy fertilizer and lime applications should be split. Plants sensitive to Al-toxicity may be affected unless lime is applied. However, because of the low CEC and coarse soil textures, excess exchangeable Al can be easily neutralized with moderate lime applications; in fact, these soils can potentially be overlimed. The low pH would generally favor dissolution of rock phosphate amendments.

Ongoing research at the Sahelian Center is yielding further information concerning fertility relationships in these soils. Even with low pH's, local varieties of millet do not seem to respond to liming (personal communication, Dr. Les Fussell, ICRISAT, Niamey). Additionally, sulfur may be a limiting micronutrient for millet. Positive yield responses in millet have been observed with sulfur application on the Center (personal communication, Dr. Andre Batiano, ICRISAT, Niamey).

Table 7. Fertility capability classification of the soils (Sanchez, et al., 1982).

Soil	FCC*
Dayobu	Sdeak
Gagani	SRdeak
Labucheri	Sdehk
Tondi	Sdeak
Zogoti	Sdeak

*Class [illegible] code is as follows
S = loamy sand or sand (USDA [illegible]), texture of plow layer.
R = rock or other root restricting layer
e = low CEC, ECEC <4 meq/100 g soil in plow layer
a = aluminum toxicity, >60% Al [illegible] of the ECEC within 50 cm of the surface
h = acid, 10-60% Al saturation of the ECEC within 50 cm of the surface
k = low K reserves, <10% weatherable minerals in silt and sand fractions within 50 cm of the surface

[1]Unpublished data from Soil and Crop Sciences Department, Texas A&M University.

These soils do not carry the modifier designating them as having a high P-fixation capacity because clay contents are too low. However, the ratio of free iron oxide to clay is quite high, and much of the native phosphorous may be fixed in iron and aluminum forms in these soils. This fact may cause maintenance of plant available phosphorus to be important in maximizing yields. Responses to phosphate fertilier or rock phosphate on millet research plots have been very strong with and without nitrogen (Batiano, 1982). Nitrogen response has been variable and its critical level for millet is unclear. These soils will have low native N levels because of low organic matter contents, and because of rapid hydraulic conductivities, nitrogen will be strongly subject to seasonal flushing from surface horizons.

Soil Management[1]

The high sand content of the soils makes them very subject to wind erosion. Such erosion can be initiated at 1.4 to 2.4 m s^{-1} which is well below the windspeeds of 2.9 to 10.5 m s^{-1} measured at the Center. Wind erosion is a major problem in crop establishment in such soils. The young seedlings may be killed from abrasion or covered with blowing sand. Mechanical tillage with chisels or sweeps to roughen the surface immediately (1-3 days) following a rain can minimize these problems.

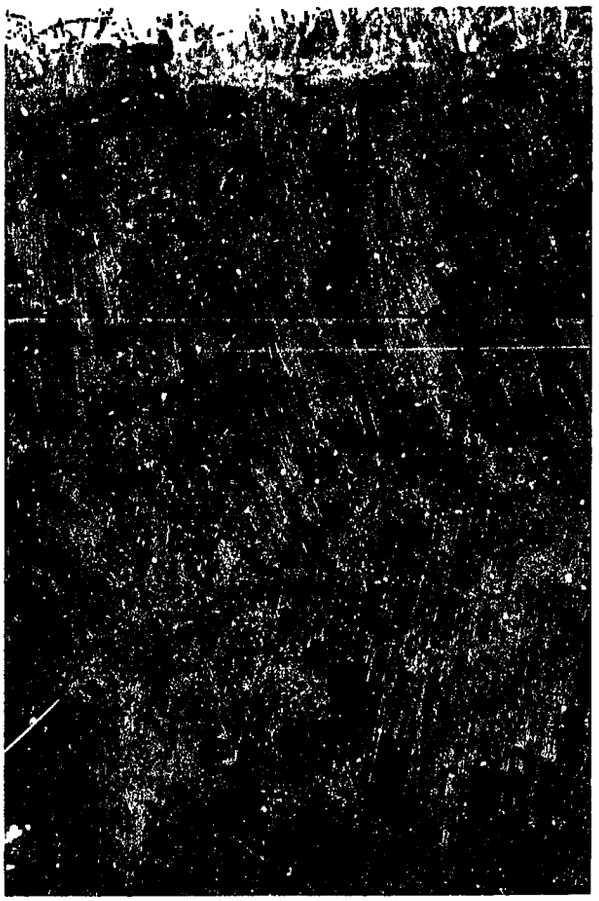
Mechanical tillage is considered to be emergency tillage and is normally used when there are no other options. Ideally, some form of stubble mulching should be practiced. In this system, stubble residue from the previous crop is left standing in the field and the crops are planted in the stubble. In the manpower culture of the Sahel, this may have more immediate application than the emergency tillage techniques. Currently, much of the crop residue is used as fuel and as construction material for huts and granaries.

For long term, permanent windbreaks such as trees should be considered, especially if the trees can be used for wood. One species, *Acadia albida* appears to be especially promising since it does not compete for water during the growing season, is a legume, can be used for livestock feed, and is a souce of wood.

The importance of wind erosion cannot be overemphasized. In addition to the seasonal crop losses, fertility is reduced and the fine fractions (organic matter, silt, and clay) are removed; leaving the sand skeleton which is even more difficult to manage. It is often difficult to increase the productivity of such soils.

Although water erosion on the Center is observed to be minimal, it is a hazard in much of the Sahel area. In those areas where it is a problem, such practices as terracing, bed tieing (furrow-diking), and ground cover techniques should be evaluated. To minimize power requirements and decrease hazards from wind and water erosion, care should be taken to till the soils only when they are moist.

[1]By Charles Wendt, Soil Physicist, TAES, Lubbock, TX.



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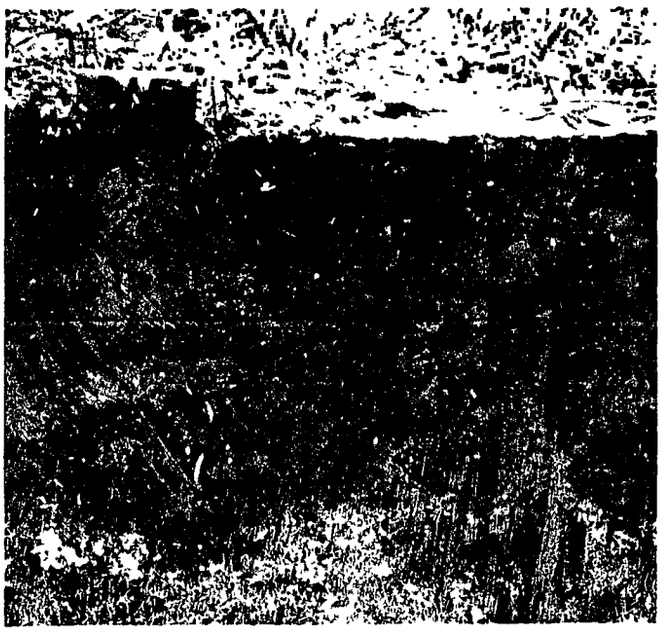

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PLATE CAPTIONS

PLATE 1 1—Profile of Labucheri soil 2—Profile of Gagani soil. 3—Termite mound on LaA landscape. 4—Micrograph of thin-sections from A, Bt, and C horizons of Labucheri soil. Granular s-matrix with free grain ferriargillans Cutans have undulic plasmic fabric. Q = quartz, f = ferriargillans, bar length = 1 mm; partially crossed nichols

SOIL GENESIS

Soils of the ICRISAT Center are polygenetic and reflect more pluvial paleoclimatic conditions. It is improbable that the thick sola of these coarse-textured soils, their low pH, low base status, high exchangeable aluminum and underlying laterite could have formed during the current semi-arid climate (See Pedon Descriptions and Data). If these soils had slightly higher clay contents, their subsoils would meet the requirements of oxic horizons because the clay fraction is dominated by low-charge minerals including kaolinite, iron oxides, and quartz. In comparison with most of the Ustalfs of the United States, these soils are unique and do not follow conventional concepts of soils occurring in ustic bordering on aridic moisture regimes.

Formation of Argillic Horizons

All of the soils mapped on the Center have evidence of an argillic horizon except for Dayobu (Fig. 5). The latter has textural evidence for translocated clay but the magnitude of this expression is insufficient to meet requirements for an argillic horizon. The thickness of the argillic is variable depending on thickness of sand over lateritic materials but is commonly 2 to 3 m in soils with thick sandy parent materials (Labucheri and Zogoti). Laterally, the argillic horizons conform topographically to the eolian dune relief features. That is, the Bt is encountered at about the same depth and is of the same thickness below the surface on dune crests as in depressional troughs with local relief differential of 0.5 to 1 m. This suggests that the genesis of argillic horizons occurred concommitantly on both topographic elements once the sand was emplaced and stabilized. The Dayobu mentioned above occurs in depressional basins and represents an exception to this relationship. Field evidence suggests that its argillic horizon has been truncated by eolian deflationary processes. A transect from an adjacent crest to the basin of this soil demonstrates that the argillic horizon and corresponding thickness of sand superposed over the petroferric contact have been decreased proportional to the difference in topographic relief.

Argillic horizons of the thickness encountered in these soils do not likely reflect current climatic conditions of the area. Even during the most intense storm events of the rainy season, a free water front capable of translocating suspended colloids and iron oxide-clay flocs would infrequently reach a depth equal to the maximum expression of the argillic horizon (1-2 m). Thus, to form argillic horizons >2 m thick most probably would require more pluvial paleoclimatic periods. This is consistent with oscillatory wetter and drier climatic periods during the Pleistocene as postulated by Sombroek and Zonneveld (1971) for a border region in northern Nigeria.

Field evidence for an argillic horizon consists of (i) higher clay contents in the position of the Bt than in either A or subjacent C horizons, (ii) redder colors of the Bt (2.5YR 4/6-4/8) versus yellower (5YR 5/8) colors in BC and C horizons—redder colors are closely correlated with higher clay contents; and (iii) lateral continuity of the argillic horizon across both macro and micro topographic elements. Further, it is apparent that at least a portion of the total clay is water dispersible based on evident movement of colloids during raindrop impact, and degree of hand pigmentation during field texturing.

Laboratory evidence of argillic horizons include: (i) systematic depth increases in both fine and total clay from the surface to a maximum in the argillic horizon and then decreases in lower Bt and C horizons (Fig. 5); (ii) 2 to 3 fold increase in fine clay in argillic horizon maxima compared to A or C horizons; and (iii) iron-oxide-clay grain cutans in argillic horizons that are at least twice as thick as in A or C horizons (Plate 1). There are no striking differences in the ratios of fine/total clay between argillic and A or C horizons, but most of the total clay fraction is fine clay (50-75%). While grain cutan bridges were observed in microfabric analyses, no well expressed iluviation ferriargillans with strong continuous band extinction were observed. Much of the plasma coating sand grains appear flocculated rather than dispersed. This granular fabric, with pore interstices much larger than the plasma aggregates (iron-oxide rich floculated colloids), would favor translocation of clay not only in the dispersed state but also as flocs or aggregates of clay. This may explain the lack of strong illuviation bridges between skeleton grains. Such a translocation mechanism would be favored by a high frequency of wetting and drying cycles, high intensity-short duration storm events, and more wet season rainfall than under the current climate.

Alternatively, textural differentiation in these soils might be interpreted as eolian deflation of silt and clay separates relative to coarser separates from surface horizons. While this may be a plausible mechanism and in fact partially functional, it is not the primary cause for textural differentiation. Particle size data do not support this differential transport hypothesis in that (i) ratios of total sand/total silt, fine silt/coarse silt, and very fine sand/fine sand do not systematically vary between surface and subsurface horizons; (ii) clay-free total sand and silt and subseparates of these fractions are relatively constant with depth; and (iii) total and fine clay would not be expected to systematically increase to a maximum and then decrease with depth if textural differentiation was due primarily to deflationary processes (Pedon Descriptions and Data). Changes in sand and silt particle size ratios and clay-free separates are attributed primarily to parent stratification in the sand deposit during eolian transport.

Mineralogy

Soils of the ICRISAT Center have dominantly kaolinitic, iron oxide, and quartzitic mineralogical systems. They have low charge characteristics, commonly less

than 15 meq/100 g clay (Pedon Descriptions and Data), reflecting the low-activity kaolinitic clays. The mineralogical suite in these soils represent stable residual systems. This is attributed to an inherited mineralogical suite from parent sediments that have previously been through weathering, erosion and sedimentation polycycles rather than intensive, contemporaneous, *in situ* pedogenesis. This is supported by the presence of quartz in fine clay fractions throughout the solum. Hence, these soils have undergone little desilication in the present environment. Alternatively, eolian additions of quartz to the surface with subsequent translocation to subsoils could explain the occurrence of fine clay-sized quartz. Under there conditions it may be very difficult to establish pedogenic-age relationships among soils on different geomorphic surfaces even if chronologic differences occur.

In hand specimens inspected with a 14X hand lens, most of the fine and very fine sand grains are quartz, appear frosted, are subrounded and are likely of eolian origin. Few mafics are evident; however, some opaques that are likely sesquioxide nodules are observed.

Mineral suites observed in these soils are not typical for many soils formed under semi-arid conditions of temperate regions (Allen and Fanning, 1983). Generally, a larger component of the phyllosilicates would be 2:1 layer structures, free iron oxide to clay ratios would be lower, weatherable sand and silt minerals would be more abundant.

Base Cycling

The nutrient and base balance in these low-charged, slightly buffered, permeable soil systems is a dynamic equilibrium between base renewal by dust additions and biocycling (plants and termites), and removal by leaching and lateral interflow. Termites are effective in bringing bases and clay to the surface (Watson, 1974). Soils with thinner sola over the petroferric restrictive layers exhibit lower base status throughout (i.e. Tondi and Gagani vs Labucheri and Zogoti, Fig. 5). This is attributed to more complete flushing of bases through the shallow sola during the wet season, which effectively removes the bases from the root zone and subsequent biocycling. Some caution must be exercised in interpreting these data because bases are dynamic and the sampling represents a single-time frame. None-the-less, there is strong evidence that in most of these soils that the bases have been leached from 50 to 100 cm below the surface during rainy periods (Fig. 5). Base trends in upper sola probably represent the net flux of soluble constituents below the surface under present climatic regimes. Base saturation minima of 10 to 30% commonly occur within the upper meter. In soils developed in thicker sands, base saturations increase to 40 to 90% at a depth of 1.5 to 2 m (commonly 50 to 60%). Two exceptions to this generality are the termite mound soil (S82TX-004-07) and Labucheri (S82TX-004-04) (Pedon Descriptions and Data). The termite mound has base saturations ranging from 70 to 100% to a depth of 2 m. The Labucheri pedon is located at the lower end of a valley toeslope or backslope, and surface horizons of this soil may be base recharged from run-on waters or interflow received from adjacent upslope soils. The base saturation of this soil surface decreases from a maximum at the surface (91%) to values of 50 to 60% below 70 cm.

Soil Acidity

Exchangeable Al is the major source of exchange acidity in these soils. It commonly comprises from 50 to 75% or more of the effective CEC (sum of bases plus exchangeable Al) in the upper 50 to 75 cm of the sola (Pedon Descriptions and Data). While it commonly exhibits a decreasing depth function from the surface, higher exchangeable Al values do not consistently covary with organic carbon contents. One plausible explanation for this is that exchangeable Al is a function of both organic matter content and clay content, and the latter two variables are reciprocally related with depth in these soils. Exchangeable Al is believed to be related to pedogenic weathering intensities in these acid soils (past and present) but small quantities of exchangeable Al are found throughout lower Bt and C horizons suggesting at least a small inherited component with clay minerals.

The Dayobu soils have relatively high exchangeable Al throughout the pedon even though clay contents are

Table 8. Classification of the soils by the U.S. and French systems[1]

Series	Classification	
	French System	U.S. System
Dayobu	Sol Peu E volué, non climatique, d'apport eólien	Ustoxic Quartzipsamment; isohyperthermic, coated
Gagani	Sol a'Sesquioxydes de Fer, ferrugineux (tropical), indure	Petroferric Haplustult; loamy, siliceous, isohyperthermic, shallow
Labucheri	Sol a'Sesquioxydes de Fer, ferrugineaux (tropical), modal	Psammentic Paleustalf; sandy, siliceous, isohyperthermic
Tondi	Sol a'Sesquioxydes de Fer, ferrugineaux (tropical), indure	Petroferric Haplustult; sandy, siliceous, isohyperthermic
Zogoti	Sol a'Sesquioxydes de Fer, ferrugineaux (tropical), modal	Psammentic Paleustalf; sandy, siliceous, isohyperthermic

[1]French system classifications were provided by Claude Charreau, IRAT, Paris, France.

low and approximately constant. This pedon appears more strongly leached even though it is over 200 cm to the petroferric contact. In contrast, the termite mound has low exchange Al values throughout; these contents are likely inherited with the parent clays.

Soil Classification

Placement of the soils on the Sahelian Center according to the U.S. system of soil classification, *Soil Taxonomy* (Soil Survey Staff, 1975), and the French classification system is given in Table 8.

Classification of these soils in *Soil Taxonomy* does not accomodate some of their important properties at higher categorical levels. For example, it would have been desirable to recognize these soils as intergrading to an aridic moisture regime. Additionally, Dayobu was the only soil that had a connotation of low activity clays (oxic) in its placement. The classification presented are as provided for in *Soil Taxonomy*. No attempt was made to develop provisional placements that accommodated properties not recognized in a soils classification.

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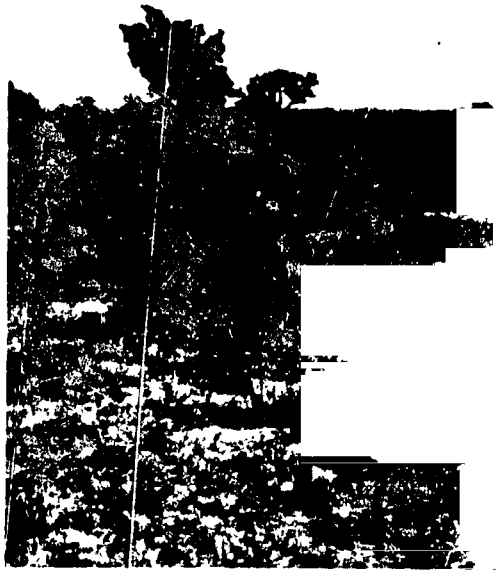

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PLATE 2. 1—Landscape in Gagani (Ga) map unit. Lighter areas have lost their A horizon by erosion. 2—Fallow area in Labucheri (L
Research plots on the Sahelian Center. 4—Gully in Labucheri soil near the Sahelian Center.

PEDON DESCRIPTIONS AND DATA

Map Unit Symbol	Series		Page
Da	Dayobu	Description	22
		Pedon data	24
		Transect pedon data	26
Ga	Gagani	Description	27
		Pedon data	29
La	Labucheri	Transect pedon data	40
LaA	Labucheri	Description	30
		Pedon data	32
		Transect pedon data	42
LaB	Labucheri	Description	34
		Pedon data	36
		Transect pedon data	45
To	Tondi	Description	48
		Pedon data	50
		Transect pedon data	52
Zo	Zogoti	Description	53
		Pedon data	55
		Transect pedon data	57
	Termite Mound	Description	58
		Pedon data	60

SOIL SERIES: DAYOBU PEDON: S82TX-004-001

PEDON CLASSIFICATION: USTOXIC QUARTZIPSAMMENT; ISOHYPERTHERMIC, COATED

COUNTY: DATE: 8/18/82

LOCATION: ICRISAT SAHELIAN CENTER; APPROXIMATELY 40 KM SOUTH OF NIAMEY, NIGER. THIS PEDON IS LOCATED 75 M NORTHWEST OF TEMPORARY HUTS NEAR CENTER OF THE STATION.

LANDFORM: DEPRESSION ELEVATION (M): 242

SLOPE: 1.5% SLOPE ASPECT: E

TOPOGRAPHY: GENTLY SLOPING LAND USE: FALLOW

PARENT MATERIAL: EOLIAN SAND

FORMATION:

DRAINAGE: WELL DRAINED

COLLECTORS: L. T. WEST AND J. K. LANDECK

HORIZON	DEPTH (CM)	SOIL DESCRIPTION (COLORS FOR MOIST SOIL UNLESS OTHERWISE STATED)
A1	1-15	YELLOWISH RED (5YR 4/6) SAND; COMMON MEDIUM DISTINCT YELLOWISH RED (5YR 5/6) MOTTLES; WEAK COARSE SUBANGULAR BLOCKY STRUCTURE; SOFT; VERY FRIABLE; MANY FINE ROOTS; FEW VERY FINE PORES; SAND GRAINS MOSTLY UNCOATED; MANY PEDOTUBULES; HORIZON HAS 3 CM OF OVERBURDEN WITH WEAK THIN PLATY STRUCTURE; STRONGLY ACID; CLEAR SMOOTH BOUNDARY.
A2	15-27	YELLOWISH RED (5YR 4/6) SAND; COMMON MEDIUM DISTINCT YELLOWISH RED (5YR 5/6) MOTTLES; WEAK VERY COARSE SUBANGULAR BLOCKY STRUCTURE; SOFT; VERY FRIABLE; MANY VERY FINE ROOTS; FEW VERY FINE PORES; SAND GRAINS MOSTLY UNCOATED; COMMON PEDOTUBULES; VERY STRONGLY ACID; CLEAR SMOOTH BOUNDARY.
BT1	27-44	YELLOWISH RED (5YR 4/8) SAND; MASSIVE AND WEAK COARSE SUBANGULAR BLOCKY STRUCTURE; SOFT; VERY FRIABLE; COMMON VERY FINE ROOTS; FEW VERY FINE PORES; FEW THIN VERY PATCHY CLAY BRIDGES BETWEEN SAND GRAINS; SAND GRAINS MOSTLY COATED; FEW PEDOTUBULES THE SAME COLOR AS THE MATRIX; VERY STRONGLY ACID; GRADUAL SMOOTH BOUNDARY.
BT2	44-80	YELLOWISH RED (5YR 5/8) SAND; MASSIVE AND WEAK COARSE SUBANGULAR BLOCKY STRUCTURE; SOFT; VERY FRIABLE; FEW VERY FINE ROOTS; FEW VERY FINE PORES; FEW THIN VERY PATCHY CLAY BRIDGES BETWEEN SAND GRAINS; SAND GRAINS MOSTLY COATED; FEW YELLOWINSH RED (5YR 4/8) PEDOTUBULES; VERY STRONGLY ACID; GRADUAL SMOOTH BOUNDARY.

BW	80-126	YELLOWISH RED (5YR 5/8) SAND; WEAK VERY COARSE SUBANGULAR BLOCKY STRUCTURE; SOFT; VERY FRIABLE; FEW VERY FINE ROOTS; FEW VERY FINE PORES; 80 % OF SAND GRAINS COATED; FEW PEDOTUBULES APPROXIMATELY 4 CM IN DIAMETER; VERY STRONGLY ACID; GRADUAL SMOOTH BOUNDARY.
BC	126-173	YELLOWISH RED (5YR 5/8) SAND; MASSIVE; SOFT; VERY FRIABLE; FEW VERY FINE ROOTS; FEW VERY FINE PORES; 80 % OF SAND GRAINS COATED; FEW 1 CM DIAMETER PEDOTUBULES; VERY STRONGLY ACID; GRADUAL SMOOTH BOUNDARY.
C	173-200	REDDISH YELLOW (5YR 6/6) SAND; MASSIVE; SOFT; VERY FRIABLE; FEW VERY FINE ROOTS; FEW VERY FINE PORES; 50 % OF SAND GRAINS COATED; NO PEDOTUBULES OBSERVED; VERY STRONGLY ACID.

REMARKS: A FEW PIECES OF CHARCOAL WERE OBSERVED THROUGHOUT THE PEDON. THIS PEDON IS LOCATED ON THE SIDE OF A NARROW (¬50 M WIDE), SHALLOW (¬0.5 M DEEP) DEPRESSION.

SOIL CHARACTERIZATION LABORATORY
SOIL AND CROP SCIENCES DEPT., THE TEXAS AGRICULTURAL EXPERIMENT STATION

SOIL SERIES: DAYOBU
SOIL FAMILY: USTOXIC QUARTZIPSAMMENT; ISOHYPERTHERMIC, COATED
LOCATION: ICRISAT SAHELIAN CENTER

PEDON NUMBER: S82TX-004-01

LAB NO	DEPTH (CM)	HORIZON	PARTICLE SIZE DISTRIBUTION (MM) SAND VC (2.0-1.0)	C (1.0-0.5)	M (0.5-0.25)	F (0.25-0.10)	VF (0.10-0.05)	TOTAL (2.0-0.05)	SILT FINE (0.02-0.002)	SILT TOTAL (0.05-0.002)	CLAY FINE (< 0.0002)	CLAY TOTAL (< 0.002)	TEXTURE CLASS	COARSE FRAGMENTS %
			%											
1469	0- 15	A1	0.1	7.0	26.8	40.7	17.9	92.5	0.9	3.0	2.1	4.5	S	0
1470	15- 27	A2	0.1	8.4	28.2	38.0	17.0	91.7	0.7	3.2	2.9	5.1	S	0
1471	27- 44	BT1	0.0	9.1	28.2	36.5	18.3	92.1	1.0	3.2	2.6	4.7	S	0
1472	44- 62	BT2	0.1	9.5	28.8	36.6	17.7	92.7	0.4	3.0	1.9	4.3	S	0
1473	62- 80	BT3	0.0	9.0	27.7	36.7	19.6	93.0	0.3	2.5	1.7	4.5	S	0
1474	80-103	BW	0.0	10.2	29.8	36.0	16.5	92.5	0.1	3.2	1.7	4.3	S	0
1475	103-126	BW	0.1	8.9	27.6	35.6	21.2	93.4	0.1	2.5	1.6	4.1	S	0
1476	126-150	BC	0.1	9.6	28.5	34.7	21.6	94.5	0.3	1.9	1.6	3.6	S	0
1477	150-173	BC	0.1	7.4	31.1	36.1	20.3	95.0	0.7	2.0	2.3	3.0	S	0
1478	173-200	C	0.0	4.8	27.2	39.4	23.2	94.6	0.6	2.9	2.5	2.5	S	0

LAB NO	ORGN C %	PH (H2O) 1:1	PH (0.1N KCL)	NH4OAC EXTR BASES CA	MG	NA	K	TOTAL	KCL EXTR AL	NAOAC CEC	ECEC	BASE SAT %	ESP %	EXTR FE
				MEQ/100G										
1469	0.25	5.1	4.0	0.2	0.1	0.0	0.1	0.3	0.6	1.5	0.9	22	1	0.3
1470	0.15	4.9	3.9	0.1	0.0	0.0	0.1	0.2	0.7	1.5	0.9	10	1	0.3
1471	0.11	4.8	3.9	0.1	0.0	0.0	0.0	0.1	0.7	1.3	0.9	11	2	0.2
1472	0.08	4.8	3.9	0.0	0.0	0.0	0.0	0.1	0.6	1.1	0.7	11	2	0.3
1473	0.08	4.8	4.0	0.1	0.0	0.0	0.0	0.1	0.6	1.0	0.7	12	2	0.3
1474	0.07	4.8	4.0	0.1	0.0	0.0	0.0	0.1	0.6	1.0	0.7	13	1	0.3
1475	0.09	4.9	4.0	0.1	0.0	0.0	0.0	0.2	0.5	0.9	0.7	20	3	0.3
1476	0.06	4.8	4.0	0.1	0.0	0.0	0.0	0.2	0.5	0.8	0.7	23	3	0.3
1477	0.05	4.5	4.0	0.1	0.1	0.0	0.1	0.3	0.4	0.7	0.7	39	4	0.3
1478	0.04	4.9	4.1	0.1	0.0	0.0	0.0	0.2	0.4	0.7	0.6	24	1	0.3

SOIL CHARACTERIZATION LABORATORY
SOIL AND CROP SCIENCES DEPT., THE TEXAS AGRICULTURAL EXPERIMENT STATION

SOIL SERIES: DAYOBU
SOIL FAMILY: USTOXIC QUARTZIPSAMMENT; ISOHYPERTHERMIC, COATED
LOCATION: ICRISAT SAHELIAN CENTER

PEDON NUMBER: S82TX-004-01

LAB NO	BULK DEN 0.10 BAR ---G/CC--	BULK DEN AIR DRY ---G/CC--	COLE CM/CM	WATER CONTENT 0.10 BAR ---WT%---	WATER CONTENT 15 BAR ---WT%---	WRD G/CC	CLAY MINERALOGY SM	VR	MI	IN	KK	GI	QZ	FD	CA	SKELETAL MINERALOGY QZ	FD	CA
1469	1.76	1.80	0.008	8.4	1.3	0.12					***		**			***		
1470	1.65	1.72	0.014	8.4	1.3	0.11												
1471	1.62	1.67	0.010	5.9	1.4	0.07					***		**			***		
1472	1.63	1.66	0.006	11.9	1.2	0.17												
1473					1.2													
1474	1.65	1.66	0.002	15.5	1.2	0.23												
1475					0.9													
1476	1.67	1.69	0.004	5.6	1.1	0.07												
1477					1.2													
1478	1.66	1.70	0.008	11.8	0.9	0.18					***		*			***		

SM=SMECTITE VR=VERMICULITE MI=MICA IN=INTERSTRATIFIED
KK=KAOLINITE GI=GIBBSITE QZ=QUARTZ FD=FELDSPAR CA=CALCITE
T=TRACE *=0-10% **=10-50% ***=GREATER THAN 50%

LAB NO	PARTICLE SIZE DISTRIBUTION (CLAY-FREE BASIS) SAND VCS	SAND C	SAND M	SAND F	SAND VF	SAND TOTAL	SILT C	SILT F	SILT TOTAL	RATIOS S/SI	RATIOS FSI/CSI	RATIOS VFS/FS	CEC/C
	---%---												
1469	0.1	7.3	28.1	42.6	18.7	96.9	2.2	0.9	3.1	31.3	0.4	0.4	0.34
1470	0.1	8.9	29.7	40.0	17.9	96.6	2.7	0.7	3.4	28.4	0.3	0.4	0.29
1471	0.0	9.5	29.6	38.3	19.2	96.6	2.3	1.1	3.4	28.4	0.5	0.5	0.28
1472	0.1	9.9	30.1	38.2	18.5	96.9	2.7	0.4	3.1	31.3	0.1	0.5	0.26
1473	0.0	9.4	29.0	38.4	20.5	97.4	2.3	0.3	2.6	37.5	0.1	0.5	0.22
1474	0.0	10.7	31.1	37.6	17.2	96.7	3.2	0.1	3.3	29.3	0.0	0.5	0.23
1475	0.1	9.3	28.8	37.1	22.1	97.4	2.5	0.1	2.6	37.5	0.0	0.6	0.21
1476	0.1	10.0	29.6	36.0	22.4	98.0	1.7	0.3	2.0	49.0	0.2	0.6	0.22
1477	0.1	7.6	32.1	37.2	20.9	97.9	1.4	0.7	2.1	46.6	0.5	0.6	0.23
1478	0.0	4.9	27.9	40.4	23.8	97.0	2.4	0.6	3.0	32.3	0.3	0.6	0.30

SOIL CHARACTERIZATION LABORATORY
SOIL AND CROP SCIENCES DEPT., THE TEXAS AGRICULTURAL EXPERIMENT STATION

SOIL SERIES: DAYOBU (DA-2)
SOIL FAMILY: USTOXIC QUARTZIPSAMMENT; ISOHYPERTHERMIC, COATED
LOCATION: ICRISAT SAHELIAN CENTER

PEDON NUMBER. S82TX-006-02

LAB NO	DEPTH (CM)	HORIZON	PARTICLE SIZE DISTRIBUTION (MM) SAND VC (2.0-1.0)	C (1.0-0.5)	M (0.5-0.25)	F (0.25-0.10)	VF (0.10-0.05)	TOTAL (2.0-0.05)	SILT FINE (0.02-0.002)	TOTAL (0.05-0.002)	CLAY FINE (< 0.0002)	TOTAL (< 0.002)	TEXTURE CLASS	COARSE FRAGMENTS %
			%											
578	0- 22	A	0.1	7.8	24.8	40.5	18.6	91.8	1.5	4.0	3.4	4.2	S	0
579	22- 34	BT	0.1	8.4	26.3	39.1	16.8	90.7	0.6	3.3	4.4	6.0	S	0
580	190-200	BT	0.1	4.4	20.7	42.7	22.0	89.9	0.6	3.7	4.1	6.4	S	0

LAB NO	ORGN C %	PH (H2O) 1:1	PH (0.1N KCL)	NH4OAC EXTR BASES CA	MG	NA	K	TOTAL	KCL EXTR AL	NAOAC CEC	ECEC	BASE SAT	ESP	EXTR FE
				MEQ/100G								%		
578	0.19	4.7		0.2	0.1	0.0	0.0	0.4	0.3	1.4	0.7	27	0	
579	0.16	4.6		0.2	0.1	0.0	0.0	0.4	0.5	1.6	0.9	23	1	
580	0.07	4.7		0.3	0.2	0.0	0.0	0.6	0.3	1.2	0.8	45	2	

LAB NO	BULK DEN 0.10 BAR	AIR DRY	COLE	WATER CONTENT 0.10 BAR	15 BAR	WRD	CLAY MINERALOGY SM	VR	MI	IN	KK	GI	QZ	FD	CA	SKELETAL MINERALOGY QZ	FD	CA
	G/CC		CM/CM	WT%		G/CC												
578																		
579																		
580																		

SM=SMECTITE VR=VERMICULITE MI=MICA IN=INTERSTRATIFIED
KK=KAOLINITE GI=GIBBSITE QZ=QUARTZ FD=FELDSPAR CA=CALCITE
T=TRACE *=0-10% **=10-50% ***=GREATER THAN 50%

LAB NO	PARTICLE SIZE DISTRIBUTION (CLAY-FREE BASIS) SAND VCS	C	M	F	VF	TOTAL	SILT C	F	TOTAL	RATIOS S/SI	FSI/CSI	VFS/FS	CEC/C
	%												
578	0.1	8.1	25.9	42.3	19.4	95.8	2.6	1.6	4.2	22.8	0.6	0.5	0.34
579	0.1	8.9	28.0	41.6	17.9	96.5	2.9	0.6	3.5	27.6	0.2	0.4	0.27
580	0.1	4.7	22.1	45.6	23.5	96.0	3.4	0.6	4.0	24.0	0.2	0.5	0.19

SOIL SERIES: GAGANI PEDON: S82TX-004-006

PEDON CLASSIFICATION: PETROFERRIC HAPLUSTULT; SANDY, SILICEOUS, ISOHYPERTHERMIC, SHALLOW

COUNTY: DATE: 8/20/82

LOCATION: ICRISAT SAHELIAN CENTER; APPROXIMATELY 40 KM SOUTH OF NIAMEY, NIGER. THIS PEDON IS LOCATED 750 M SOUTH OF THE NORTH FENCE AND 100 M EAST OF THE WEST FENCE.

LANDFORM: UPLAND ELEVATION (M): 246

SLOPE: 0.5% SLOPE ASPECT: N

TOPOGRAPHY: NEARLY LEVEL LAND USE: RANGE

PARENT MATERIAL: EOLIAN SAND OVER LATERITE

FORMATION:

DRAINAGE: WELL DRAINED

COLLECTORS: L. T. WEST AND J. K. LANDECK

HORIZON	DEPTH (CM)	SOIL DESCRIPTION (COLORS FOR MOIST SOIL UNLESS OTHERWISE STATED)
A	0-9	REDDISH BROWN (5YR 4/4) LOAMY SAND; WEAK THIN PLATY AND WEAK MEDIUM SUBANGULAR BLOCKY STRUCTURE; SLIGHTLY HARD; FRIABLE; MANY VERY FINE ROOTS; COMMON VERY FINE PORES; FEW FINE BLACK CONCRETIONS; 50% OF SAND GRAINS COATED; PEDS ARE SLIGHTLY BRITTLE WHEN DRY; VERY STRONGLY ACID; CLEAR SMOOTH BOUNDARY.
BT	9-24	YELLOWISH RED (5YR 4/6) SANDY LOAM; COMMON MEDIUM FAINT YELLOWISH RED (5YR 5/6) MOTTLES; WEAK MEDIUM SUBANGULAR BLOCKY STRUCTURE; SLIGHTLY HARD; FRIABLE; COMMON VERY FINE ROOTS; FEW FINE PORES; FEW THIN PATCHY CLAY BRIDGES BETWEEN SAND GRAINS; SAND GRAINS MOSTLY COATED; FEW PEDOTUBULES IN LOWER PART OF HORIZON; EXTREMELY ACID; CLEAR SMOOTH BOUNDARY
2BT	24-34	YELLOWISH RED (5YR 5/6) VERY GRAVELLY SANDY LOAM; WEAK MEDIUM SUBANGULAR BLOCKY STRUCTURE; SLIGHTLY HARD; FRIABLE; COMMON VERY FINE ROOTS; FEW FINE PORES; THIN PATCHY CLAY BRIDGES BETWEEN SAND GRAINS; FEW THIN CLAY FILMS ON ROCK FRAGMENTS; 50% BY VOLUME IRONSTONE GRAVELS UP TO 5 CM ON LONG AXIS; VERY STRONGLY ACID; ABRUPT WAVY BOUNDARY.
2BSM	34-	REDDISH BROWN (2.5YR 4/4) LATERITE; MANY COARSE RED (2.5YR 5/6) AND MANY COARSE STRONG BROWN (7.5YR 5/6) MOTTLES; MATERIAL IS LAMINAR IN THE UPPER PART; MANY FE-MN STAINS ON FRACTURE PLANES.

REMARKS: THIS PEDON WAS SAMPLED IN A VEGETATED AREA WITH SOME OF THE SURFACE HORIZON REMAINING. APPROXIMATELY 40% OF THESE SOILS HAVE APPARENTLY HAD THE SURFACE REMOVED BY WIND DEFLATION. THE WIND DEFLATED AREAS ARE MOSTLY BARREN. THE DEPTH TO THE PETROFERRIC HORIZON RANGES FROM 32 TO 42 CM IN THIS PEDON. B HORIZON COLORS IN THE AREA RANGE FROM DARK RED (2.5YR 3/6) TO LIGHT BROWNISH GRAY (10YR 6/2).

SOIL CHARACTERIZATION LABORATORY
SOIL AND CROP SCIENCES DEPT., THE TEXAS AGRICULTURAL EXPERIMENT STATION

SOIL SERIES: GAGANI
SOIL FAMILY: PETROFERRIC HAPLUSTULT; LOAMY, SILICEOUS, ISOHYPERTHERMIC, SHALLOW
LOCATION: ICRISAT SAHELIAN CENTER

PEDON NUMBER: S82TX-004-06

LAB NO	DEPTH (CM)	HORIZON	PARTICLE SIZE DISTRIBUTION (MM) SAND VC (2.0-1.0)	C (1.0-0.5)	M (0.5-0.25)	F (0.25-0.10)	VF (0.10-0.05)	TOTAL (2.0-0.05)	SILT FINE (0.02-0.002)	TOTAL (0.05-0.002)	CLAY FINE (<0.0002)	TOTAL (<0.002)	TEXTURE CLASS	COARSE FRAGMENTS %
			%											
1514	0- 9	A1	0.5	11.6	23.0	27.1	18.9	81.1	3.6	10.9	3.6	8.0	LS	0
1515	9- 24	BT	1.2	11.8	23.4	27.1	16.1	79.6	3.8	9.5	6.0	10.9	SL	0
1516	24- 34	2BT	1.1	13.2	27.6	25.4	11.3	78.6	2.6	8.4	6.5	13.0	SL	57
1517	34- 35	2BSM												0

LAB NO	ORGN C %	PH (H2O) 1:1	PH (0.1N KCL)	NH4OAC EXTR BASES CA	MG	NA	K	TOTAL	KCL EXTR AL	NAOAC CEC	ECEC	BASE SAT	ESP	EXTR FE
				MEQ/100G								%		
1514	0.37	4.9	3.8	0.3	0.2	0.0	0.1	0.6	0.8	2.6	1.4	22	0	1.0
1515	0.31	4.4	3.8	0.2	0.1	0.0	0.0	0.3	1.3	3.2	1.6	9	1	1.0
1516	0.26	4.6	3.9	0.3	0.2	0.0	0.0	0.5	1.0	2.9	1.5	18	1	1.1
1517														

LAB NO	BULK DEN 0.10 BAR	AIR DRY	COLE	WATER CONTENT 0.10 BAR	15 BAR	WRD	CLAY MINERALOGY SM	VR	MI	IN	KK	GI	QZ	FD	CA	SKELETAL MINERALOGY QZ	FD	CA
	G/CC		CM/CM	WT%		G/CC												
1514	1.65	1.69	0.008	11.6	3.2	0.13												
1515	1.56	1.61	0.011	10.6	3.9	0.10												
1516					4.4													
1517																		

SM=SMECTITE VR=VERMICULITE MI=MICA IN=INTERSTRATIFIED
KK=KAOLINITE GI=GIBBSITE QZ=QUARTZ FD=FELDSPAR CA=CALCITE
T=TRACE *=0-10% **=10-50% ***=GREATER THAN 50%

LAB NO	PARTICLE SIZE DISTRIBUTION (CLAY-FREE BASIS) SAND VCS	C	M	F	VF	TOTAL	SILT C	F	TOTAL	RATIOS S/SI	FSI/CSI	VFS/FS	CEC/C
	%												
1514	0.5	12.6	25.0	29.5	20.5	88.2	7.9	3.9	11.8	7.5	0.5	0.7	0.32
1515	1.3	13.2	26.3	30.4	18.1	89.3	6.4	4.3	10.7	8.3	0.7	0.6	0.29
1516	1.3	15.2	31.7	29.2	13.0	90.3	6.7	3.0	9.7	9.3	0.4	0.4	0.23

SOIL SERIES: LABUCHERI PEDON: S82TX-004-002

PEDON CLASSIFICATION: PSAMMENTIC PALEUSTALF; SANDY, SILICEOUS, ISOHYPERTHERMIC

COUNTY: DATE: 8/18/82

LOCATION: ICRISAT SAHELIAN CENTER; APPROXIMATELY 40 KM SOUTH OF NIAMEY, NIGER. THIS PEDON IS LOCATED 950 M SOUTH OF THE NORTH FENCE AND 300 M WEST OF THE EAST FENCE.

LANDFORM: BACKSLOPE ELEVATION (M): 236

SLOPE: 1.0% SLOPE ASPECT: E

TOPOGRAPHY: NEARLY LEVEL LAND USE: FALLOW

PARENT MATERIAL: EOLIAN SAND

FORMATION:

DRAINAGE: WELL DRAINED

COLLECTORS: L. T. WEST AND J. K. LANDECK

HORIZON	DEPTH (CM)	SOIL DESCRIPTION (COLORS FOR MOIST SOIL UNLESS OTHERWISE STATED)
A1	0-9	YELLOWISH RED (5YR 4/8) SAND; FEW FINE RED (2.5YR 4/8) MOTTLES; WEAK COARSE SUBANGULAR BLOCKY STRUCTURE; SOFT; VERY FRIABLE; MANY VERY FINE ROOTS; FEW FINE PORES; SAND GRAINS MOSTLY UNCOATED; FEW PEDOTUBULES COMPRISING MOTTLES; UPPER 2-3 CM APPEARS TO BE OVERBURDEN WITH WEAK PLATY STRUCTURE; VERY STRONGLY ACID; CLEAR SMOOTH BOUNDARY.
A2	9-30	YELLOWISH RED (5YR 4/8) SAND; WEAK MEDIUM AND COARSE SUBANGULAR BLOCKY STRUCTURE; SOFT; VERY FRIABLE; COMMON VERY FINE ROOTS; COMMON VERY FINE PORES; SAND GRAINS MOSTLY UNCOATED; COMMON MEDIUM TO COARSE RED (2.5YR 4/8) PEDOTUBULES; VERY STRONGLY ACID; CLEAR SMOOTH BOUNDARY.
BT1	30-58	RED (2.5YR 4/6) SAND; FEW COARSE RED (2.5YR 4/8) MOTTLES; WEAK MEDIUM AND COARSE SUBANGULAR BLOCKY STRUCTURE; SLIGHTLY HARD; VERY FRIABLE; COMMON FINE ROOTS; COMMON VERY FINE PORES; THIN PATCHY CLAY BRIDGES BETWEEN SAND GRAINS; SAND GRAINS MOSTLY COATED; PEDS ARE SLIGHTLY BRITTLE WHEN DRY; COMMON 3-40 MM DIAMETER PEDOTUBULES; VERY STRONGLY ACID; GRADUAL SMOOTH BOUNDARY.
BT2	58-98	RED (2.5YR 4/6) LOAMY SAND; WEAK COARSE PRISMATIC PARTING TO WEAK VERY COARSE SUBANGULAR BLOCKY STRUCTURE; SLIGHTLY HARD; VERY FRIABLE; COMMON FINE ROOTS; COMMON VERY FINE PORES; THIN PATCHY CLAY BRIDGES BETWEEN SAND GRAINS; SAND GRAINS MOSTLY COATED; PEDS ARE SLIHTLY BRITTLE WHEN DRY; COMMON 2-50 MM DIAMETER YELLOWISH RED (5YR 4/8) PEDOTUBULES; STRONGLY ACID; GRADUAL SMOOTH BOUNDARY.

BT3	98-146	RED (2.5YR 4/6) LOAMY SAND, RED (2.5YR 5/8) DRY; WEAK COARSE SUBANGULAR BLOCKY STRUCTURE; SLIGHTLY HARD; VERY FRIABLE; FEW VERY FINE ROOTS; COMMON VERY FINE PORES; THIN PATCHY CLAY BRIDGES BETWEEN SAND GRAINS; SAND GRAINS MOSTLY COATED; PEDS ARE SLIGHTLY BRITTLE WHEN DRY; FEW 2-20 MM DIAMETER PEDOTUBULES WITH THE COARSER ONES HAVING A CLAY LINING; MEDIUM ACID; GRADUAL SMOOTH BOUNDARY.
BT4	146-200	RED (2.5YR 4/8) SAND, RED (2.5YR 5/8) DRY; WEAK COARSE SUBANGULAR BLOCKY STRUCTURE; SLIGHTLY HARD; VERY FRIABLE; FEW VERY FINE ROOTS; FEW VERY FINE PORES; THIN VERY PATCHY CLAY BRIDGES BETWEEN SAND GRAINS; SAND GRAINS MOSTLY COATED, PEDS ARE SLIGHTLY BRITTLE WHEN DRY; NO PEDOTUBULES OBSERVED; MEDIUM ACID.

REMARKS: THIS PEDON IS LOCATED ON A MICROTOPOGRAPHIC HIGH. DEPTH TO DRY SOIL RANGES FROM 58 TO MORE THAN 200 CM. IF THE CATEGORY EXISTED, THIS PEDON WOULD CLASSIFY AS A PSAMMENTIC OXIC PALEUSTALF.

SOIL CHARACTERIZATION LABORATORY
SOIL AND CROP SCIENCES DEPT., THE TEXAS AGRICULTURAL EXPERIMENT STATION

SOIL SERIES: LABUCHERI
SOIL FAMILY: PSAMMENTIC PALEUSTALF; SANDY, SILICEOUS, ISOHYPERTHERMIC
LOCATION: ICRISAT SAHELIAN CENTER

PEDON NUMBER: S82TX-004-02

LAB NO	DEPTH (CM)	HORIZON	PARTICLE SIZE DISTRIBUTION (MM) SAND VC (2.0-1.0)	SAND C (1.0-0.5)	SAND M (0.5-0.25)	SAND F (0.25-0.10)	SAND VF (0.10-0.05)	SAND TOTAL (2.0-0.05)	SILT FINE (0.02-0.002)	SILT TOTAL (0.05-0.002)	CLAY FINE (< 0.0002)	CLAY TOTAL (< 0.002)	TEXTURE CLASS	COARSE FRAGMENTS %
			%											
1479	0- 9	A1	0.0	4.1	24.0	44.3	18.3	90.7	1.4	6.2	2.6	3.2	S	0
1480	9- 30	A2	0.1	3.8	22.4	43.9	20.4	90.6	0.8	5.6	3.1	3.8	S	0
1481	30- 58	BT1	0.1	3.9	21.6	42.4	20.3	88.3	0.8	5.7	4.0	6.1	S	0
1482	58- 78	BT2	0.1	4.7	23.7	42.2	18.0	88.7	1.1	5.5	4.5	5.9	S	0
1483	78- 98	BT2	0.2	4.9	23.7	41.4	17.8	88.0	0.3	5.3	4.5	6.8	LS	0
1484	98-122	BT3	0.2	4.7	23.8	40.9	19.1	88.7	1.0	5.0	4.7	6.4	S	0
1485	122-146	BT3	0.2	5.8	24.9	40.8	16.9	88.6	0.3	3.5	4.9	6.0	LS	0
1486	146-173	BT4	0.2	5.2	24.3	41.6	17.8	89.1	1.2	4.2	5.7	6.8	S	0
1487	173-200	BT4	0.2	4.7	23.1	41.6	19.4	89.0	0.7	4.1	4.6	7.0	S	0

LAB NO	ORGN C %	PH (H2O) 1:1	PH (0.1N KCL)	NH4OAC EXTR BASES CA	MG	NA	K	TOTAL	KCL EXTR AL	NAOAC CEC	ECEC	BASE SAT %	ESP %	EXTR FE %
				MEQ/100G										
1479	0.31	4.9	3.7	0.3	0.1	0.0	0.1	0.5	0.3	1.6	0.8	30	1	0.4
1480	0.18	4.9	3.8	0.1	0.1	0.0	0.1	0.3	0.4	1.1	0.7	28	3	0.4
1481	0.13	4.9	3.9	0.2	0.1	0.0	0.1	0.4	0.3	1.2	0.8	36	2	0.5
1482	0.11	5.0	4.2	0.4	0.2	0.0	0.1	0.6	0.1	1.1	0.8	60	3	0.4
1483	0.10	5.1	4.2	0.3	0.2	0.0	0.1	0.6	0.1	1.1	0.7	55	3	0.6
1484	0.09	5.6	4.5	0.3	0.3	0.0	0.0	0.7	0.0	1.1	0.7	63	3	0.5
1485	0.07	5.5	4.6	0.3	0.3	0.0	0.0	0.6	0.1	1.1	0.7	61	3	0.5
1486	0.10	5.5	4.5	0.3	0.3	0.0	0.0	0.6	0.1	0.9	0.6	66	3	0.5
1487	0.07	5.8	4.6	0.3	0.3	0.0	0.0	0.6	0.1	0.9	0.7	68	3	0.6

LAB NO	BULK DEN 0.10 BAR	BULK DEN AIR DRY	COLE	WATER CONTENT 0.10 BAR	WATER CONTENT 15 BAR	WRD	CLAY MINERALOGY SM	VR	MI	IN	KK	GI	QZ	FD	CA	SKELETAL MINERALOGY QZ	FD	CA
	G/CC		CM/CM	WT%		G/CC												
1479	1.61	1.62	0.002	7.1	1.4	0.09												
1480	1.50	1.53	0.007	10.1	3.1	0.10												
1481	1.50	1.52	0.004	8.0	2.0	0.09												
1482	1.50	1.52	0.004	8.1	1.9	0.09												
1483					2.2													
1484	1.57	1.58	0.002	21.2	2.1	0.30												
1485					2.3													
1486	1.59	1.59	0.000	21.5	2.2	0.30												
1487					2.4													

SOIL CHARACTERIZATION LABORATORY
SOIL AND CROP SCIENCES DEPT., THE TEXAS AGRICULTURAL EXPERIMENT STATION

SOIL SERIES: LABUCHERI
SOIL FAMILY: PSAMMENTIC PALEUSTALF; SANDY, SILICEOUS, ISOHYPERTHERMIC
LOCATION: ICRISAT SAHELIAN CENTER

PEDON NUMBER: S82TX-004-02

LAB NO	PARTICLE SIZE DISTRIBUTION (CLAY-FREE BASIS)												
	SAND						SILT			RATIOS			
	VCS	C	M	F	VF	TOTAL	C	F	TOTAL	S/SI	FSI/CSI	VFS/FS	CEC/C
	%												
1479	0.0	4.2	24.8	43.8	18.9	93.7	5.0	1.4	6.4	14.6	0.3	0.4	0.48
1480	0.1	4.0	23.3	45.6	21.2	94.2	5.0	0.8	5.8	16.2	0.2	0.5	0.29
1481	0.1	4.2	23.0	45.2	21.6	94.0	5.2	0.9	6.1	15.4	0.2	0.5	0.20
1482	0.1	5.0	25.2	44.8	19.1	94.3	4.6	1.2	5.8	16.3	0.3	0.4	0.18
1483	0.2	5.3	25.4	44.4	19.1	94.4	5.4	0.3	5.7	16.6	0.1	0.4	0.16
1484	0.2	5.0	25.4	43.7	20.4	94.8	4.2	1.1	5.3	17.9	0.3	0.5	0.16
1485	0.2	6.3	27.1	44.3	18.4	96.3	3.5	0.3	3.8	25.3	0.1	0.4	0.13
1486	0.2	5.6	26.1	44.6	19.1	95.6	3.2	1.3	4.5	21.2	0.4	0.4	0.13
1487	0.2	5.1	24.8	44.7	20.9	95.7	3.6	0.8	4.4	21.8	0.2	0.5	0.13

SOIL SERIES: LABUCHERI PEDON: S82TX-004-004

PEDON CLASSIFICATION: PSAMMENTIC PALEUSTALF; SANDY, SILICEOUS, ISOHYPERTHERMIC

COUNTY: DATE: 8/ 4/82

LOCATION: ICRISAT SAHELIAN CENTER; APPROXIMATELY 40 KM SOUTH OF NIAMEY, NIGER. THIS SITE IS LOCATED 100 M NE OF THE SOUTHWEST CORNER OF THE CENTER.

LANDFORM: FOOTSLOPE ELEVATION (M): 237

SLOPE: 2% SLOPE ASPECT: S

TOPOGRAPHY: GENTLY SLOPING LAND USE: FALLOW

PARENT MATERIAL: EOLIAN SAND

FORMATION:

DRAINAGE: WELL DRAINED

COLLECTORS: L. T. WEST, L. P. WILDING, AND J. K. LANDECK

HORIZON	DEPTH (CM)	SOIL DESCRIPTION (COLORS FOR MOIST SOIL UNLESS OTHERWISE STATED)
A	0-18	YELLOWISH RED (5YR 4/8) SAND; WEAK MEDIUM SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE; MANY FINE ROOTS; FEW FINE PORES; COMMON FINE BLACK CONCRETIONS; SAND GRAINS MOSTLY UNCOATED; STRONGLY ACID; CLEAR SMOOTH BOUNDARY.
BT1	18-30	YELLOWISH RED (5YR 4/8) SAND, YELLOWISH RED (5YR 4/8) DRY; WEAK COARSE SUBANGULAR BLOCKY STRUCTURE; SLIGHTLY HARD; FRIABLE; COMMON FINE ROOTS; FEW FINE PORES; THIN VERY PATCHY CLAY BRIDGES BETWEEN SAND GRAINS; FEW FINE BLACK CONCRETIONS; SAND GRAINS MOSTLY COATED; PEDS ARE SLIGHTLY BRITTLE WHEN DRY; MANY RED (2.5YR 4/6) PEDOTUBULES; MEDIUM ACID; GRADUAL SMOOTH BOUNDARY.
BT2	30-71	RED (2.5YR 4/8) LOAMY SAND, RED (2.5YR 5/8) DRY; WEAK COARSE PRISMATIC PARTING TO WEAK COARSE SUBANGULAR BLOCKY STRUCTURE; SLIGHTLY HARD; FRIABLE; COMMON FINE ROOTS; COMMON FINE PORES; THIN PATCHY CLAY BRIDGES BETWEEN SAND GRAINS; FEW FINE BLACK CONCRETIONS: SAND GRAINS MOSTLY COATED; PEDS ARE SLIGHTLY BRITTLE WHEN DRY; COMMON REDDISH YELLOW (5YR 7/6,D) PEDOTUBULES; MEDIUM ACID; GRADUAL SMOOTH BOUNDARY.
BT3	71-99	RED (2.5YR 4/8) LOAMY SAND, RED (2.5YR 4/8) DRY; WEAK VERY COARSE PRISMATIC PARTING TO WEAK COARSE SUBANGULAR BLOCKY STRUCTURE; SLIGHTLY HARD; FRIABLE; FEW FINE ROOTS; COMMON FINE PORES; THIN PATCHY CLAY BRIDGES BETWEEN SAND GRAINS; FEW FINE BLACK CONCRETIONS; SAND GRAINS MOSTLY COATED; PEDS ARE SLIGHTLY BRITTLE WHEN DRY; COMMON REDDISH YELLOW (5YR 7/6,D) PEDOTUBULES; STRONGLY ACID; GRADUAL SMOOTH BOUNDARY.

BT4	99-155	RED (2.5YR 4/8) LOAMY SAND, RED (2.5YR 4/8) DRY; WEAK COARSE SUBANGULAR BLOCKY STRUCTURE; SLIGHTLY HARD; FRIABLE; FEW FINE ROOTS; COMMON FINE PORES; THIN PATCHY CLAY BRIDGES BETWEEN SAND GRAINS; SAND GRAINS MOSTLY COATED; PEDS ARE SLIGHTLY BRITTLE WHEN DRY; FEW REDDISH YELLOW (5YR 7/6,D) PEDOTUBULES; STRONGLY ACID; GRADUAL SMOOTH BOUNDARY.
BT5	155-380	RED (2.5YR 4/8) LOAMY SAND; WEAK COARSE SUBANGULAR BLOCKY STRUCTURE; SLIGHTLY HARD; FRIABLE; FEW FINE ROOTS; FEW FINE PORES; THIN PATCHY CLAY BRIDGES BETWEEN SAND GRAINS; SAND GRAINS MOSTLY COATED; OCCASIONAL PEDOTUBULES; STRONGLY ACID.
C	380-480	YELLOWISH RED (5YR 5/8) SAND; 50% OF SAND GRAINS COATED; VERY STRONGLY ACID.
BTB	480-620	RED (2.5YR 4/8) LOAMY SAND; MODERATE MEDIUM SUBANGULAR BLOCKY STRUCTURE; STRONGLY ACID.

REMARKS: DEPTH OF MOIST SOIL WAS 18 CM. MOIST SOIL ENCOUNTERED AGAIN AT 175 CM. NUMEROUS ARTIFACTS WERE OBSERVED THROUGHOUT THE PEDON. SMALL FRAGMENTS OF CHARCOAL WERE OBSERVED THROUGHOUT THE PEDON. DESSICATION CRACKS EXTEND FROM THE SURFACE TO 99 CM (BASE OF BT3). A DEEP BORING AT THIS SITE INDICATED THE SOLUM TO EXTEND TO 3.8 M. A C HORIZON TO OCCUR FROM 3.8 TO 4.8 M, AND A RELATIVELY WELL DEVELOPED PALEOSOL (LS TEXTURE, MODERATE SUBANGULAR BLOCKY STRUCTURE) TO OCCUR FROM 4.8 TO MORE THAN 6.2 M. PENETROMETER READINGS TAKEN ON A PIT WALL WERE; MOIST SURFACE OF A MICROHIGH - 0.2 TO 0.5 KG.CM2; MOIST B HORIZON - 1 KG/CM2; DRY B HORIZON - 3 TO > 4.5 KG/CM2. HORIZONS DEEPER THAN 2 M WERE DESCRIBED AND SAMPLED FROM A BUCKET AUGER. IF THE CATEGORY EXISTED, THIS PEDON WOULD CLASSIFY AS A PSAMMENTIC OXIC PALEUSTALF.

SOIL CHARACTERIZATION LABORATORY
SOIL AND CROP SCIENCES DEPT., THE TEXAS AGRICULTURAL EXPERIMENT STATION

SOIL SERIES: LABUCHERI
SOIL FAMILY: PSAMMENTIC PALEUSTALF; SANDY, SILICEOUS, ISOHYPERTHERMIC
LOCATION: ICRISAT SAHELIAN CENTER

PEDON NUMBER: S82TX-004-04

LAB NO	DEPTH (CM)	HORIZON	PARTICLE SIZE DISTRIBUTION (MM) SAND VC (2.0-1.0)	SAND C (1.0-0.5)	SAND M (0.5-0.25)	SAND F (0.25-0.10)	SAND VF (0.10-0.05)	SAND TOTAL (2.0-0.05)	SILT FINE (0.02-0.002)	SILT TOTAL (0.05-0.002)	CLAY FINE (< 0.0002)	CLAY TOTAL (< 0.002)	TEXTURE CLASS	COARSE FRAGMENTS %
			%											
1496	0- 18	A1	0.0	5.4	26.8	44.3	17.3	93.8	0.9	3.3	2.3	2.9	S	0
1497	18- 30	A2	0.0	4.4	24.8	44.3	17.5	91.0	0.8	3.8	2.7	5.3	S	0
1498	30- 51	BT1	0.2	6.0	26.3	39.4	15.5	87.4	1.4	5.6	4.3	7.0	LS	0
1499	51- 71	BT2	0.1	5.9	26.7	39.0	13.5	85.2	0.1	4.3	5.4	10.5	LS	0
1500	71- 99	BT3	0.1	5.8	26.1	38.4	13.6	84.0	0.7	5.9	5.7	10.1	LS	0
1501	99-127	BT4	0.1	5.0	25.2	41.8	15.5	87.6	1.3	3.3	4.4	9.1	LS	0
1502	127-155	BT4	0.1	5.1	26.7	41.6	13.8	87.3	1.7	4.5	4.5	8.2	LS	0
1503	155-178	BT5	0.1	4.6	24.2	43.7	14.6	87.2	1.3	4.5	4.2	8.3	LS	0
1504	178-200	BT5	0.1	4.4	23.4	41.9	15.7	85.5	1.4	5.8	4.7	8.7	LS	0
1505	250-280	BT5	0.0	4.9	23.3	40.7	17.6	86.5	1.0	5.5	4.5	8.0	LS	0
1506	430-460	C	0.1	5.4	23.7	39.9	20.9	90.0	0.8	4.9	2.8	5.1	S	0
1507	620-640	BTB	1.0	5.7	21.5	38.4	16.6	83.2	2.1	7.3	5.4	9.5	LS	0

LAB NO	ORGN C %	PH (H2O) 1:1	PH (0.1N KCL)	NH4OAC EXTR BASES CA	MG	NA	K	TOTAL	KCL EXTR AL	NAOAC CEC	ECEC	BASE SAT	ESP	EXTR FE
				MEQ/100G								%		
1496	0.17	5.4	5.2	0.6	0.2	0.0	0.1	0.9	0.1	1.0	1.0	91	3	0.5
1497	0.12	5.6	5.0	0.4	0.2	0.0	0.1	0.8	0.0	1.0	0.8	77	2	0.6
1498	0.14	5.7	4.9	0.6	0.2	0.0	0.2	0.9	0.1	1.2	1.1	77	2	0.7
1499	0.12	5.3	4.3	0.3	0.3	0.0	0.1	0.8	0.3	1.3	1.1	63	3	0.8
1500	0.10	5.0	4.1	0.2	0.3	0.0	0.1	0.6	0.4	1.2	1.0	50	1	0.9
1501	0.09	5.2	4.2	0.2	0.1	0.0	0.2	0.6	0.2	1.2	0.8	52	3	0.9
1502	0.08	5.2	4.4	0.3	0.1	0.0	0.2	0.6	0.1	1.4	0.6	41	2	0.9
1503	0.08	5.2	4.5	0.3	0.1	0.0	0.2	0.6	0.1	1.4	0.7	44	1	0.9
1504	0.08	5.2	4.6	0.4	0.5	0.0	0.1	1.0	0.0	1.6	1.1	66	1	0.9
1505	0.05	5.1	4.5	0.4	0.2	0.0	0.1	0.7	0.1	1.6	0.8	43	1	0.8
1506	0.04	5.0	4.2	0.3	0.2	0.0	0.1	0.5	0.1	1.2	0.6	39	2	0.5
1507	0.05	5.1	4.7	0.6	0.2	0.0	0.1	0.9	0.1	1.8	1.0	50	2	1.0

SOIL CHARACTERIZATION LABORATORY
SOIL AND CROP SCIENCES DEPT., THE TEXAS AGRICULTURAL EXPERIMENT STATION

SOIL SERIES: LABUCHERI
SOIL FAMILY: PSAMMENTIC PALEUSTALF; SANDY, SILICEOUS, ISOHYPERTHERMIC
LOCATION: ICRISAT SAHELIAN CENTER

PEDON NUMBER: S82TX-004-04

LAB NO	BULK DEN 0.10 BAR ---G/CC--	BULK DEN AIR DRY ---G/CC--	COLE CM/CM	WATER CONTENT 0.10 BAR ---WT%---	WATER CONTENT 15 BAR ---WT%---	WRD G/CC	CLAY MINERALOGY SM	VR	MI	IN	KK	GI	QZ	FD	CA	SKELETAL MINERALOGY QZ	FD	CA
1496	1.64	1.64	0.000	12.1	1.1	0.18					***		**			***		
1497	1.53	1.63	0.021	16.3	1.5	0.22					***		**			***		
1498	1.44	1.51	0.016	16.5	2.1	0.20												
1499					3.2													
1500					3.3													
1501	1.50	1.73	0.049	12.6	3.1	0.14												
1502					2.8													
1503					2.9						***		*			***		
1504					3.1													
1505					2.6													
1506					1.8						***		*			***		
1507					3.3													

SM=SMECTITE VR=VERMICULITE MI=MICA IN=INTERSTRATIFIED
KK=KAOLINITE GI=GIBBSITE QZ=QUARTZ FD=FELDSPAR CA=CALCITE
T=TRACE *=0-10% **=10-50% ***=GREATER THAN 50%

PARTICLE SIZE DISTRIBUTION (CLAY-FREE BASIS)

LAB NO	SAND VCS	SAND C	SAND M	SAND F	SAND VF	SAND TOTAL	SILT C	SILT F	SILT TOTAL	RATIOS S/SI	RATIOS FSI/CSI	RATIOS VFS/FS	CEC/C
	%	%	%	%	%	%	%	%	%				
1496	0.0	5.6	27.6	45.6	17.8	96.6	2.5	0.9	3.4	28.4	0.4	0.4	0.34
1497	0.0	4.6	26.2	46.8	18.5	96.1	3.2	0.8	4.0	24.0	0.3	0.4	0.19
1498	0.2	6.5	28.3	42.4	16.7	94.0	4.5	1.5	6.0	15.7	0.3	0.4	0.17
1499	0.1	6.6	29.8	43.6	15.1	95.2	4.7	0.1	4.8	19.8	0.0	0.3	0.13
1500	0.1	6.5	29.0	42.7	15.1	93.4	5.8	0.8	6.6	14.2	0.1	0.4	0.12
1501	0.1	5.5	27.7	46.0	17.1	96.4	2.2	1.4	3.6	26.8	0.6	0.4	0.13
1502	0.1	5.6	29.1	45.3	15.0	95.1	3.0	1.9	4.9	19.4	0.6	0.3	0.17
1503	0.1	5.0	26.4	47.7	15.9	95.1	3.5	1.4	4.9	19.4	0.4	0.3	0.17
1504	0.1	4.8	25.6	45.9	17.2	93.6	4.9	1.5	6.4	14.6	0.3	0.4	0.18
1505	0.0	5.3	25.3	44.2	19.1	94.0	4.9	1.1	6.0	15.7	0.2	0.4	0.20
1506	0.1	5.7	25.0	42.0	22.0	94.8	4.4	0.8	5.2	18.2	0.2	0.5	0.24
1507	1.1	6.3	23.8	42.4	18.3	91.9	5.8	2.3	8.1	11.3	0.4	0.4	0.19

SOIL CHARACTERIZATION LABORATORY
SOIL AND CROP SCIENCES DEPT., THE TEXAS AGRICULTURAL EXPERIMENT STATION

SOIL SERIES: LABUCHERI (MICROLOW)
SOIL FAMILY: PSAMMENTIC PALEUSTALF; SANDY, SILICEOUS, ISOHYPERTHERMIC
LOCATION: ICRISAT SAHELIAN CENTER

PEDON NUMBER: S32TX-004-08

LAB NO	DEPTH (CM)	HORIZON	PARTICLE SIZE DISTRIBUTION (MM) SAND VC (2.0-1.0)	SAND C (1.0-0.5)	SAND M (0.5-0.25)	SAND F (0.25-0.10)	SAND VF (0.10-0.05)	SAND TOTAL (2.0-0.05)	SILT FINE (0.02-0.002)	SILT TOTAL (0.05-0.002)	CLAY FINE (< 0.0002)	CLAY TOTAL (< 0.002)	TEXTURE CLASS	COARSE FRAGMENTS %
			%											
573	0- 19	A	0.1	5.7	23.5	45.5	16.1	90.9	1.4	4.5	2.9	4.6	S	0
574	19- 41	BT1	0.1	5.8	23.1	45.4	14.7	89.1	1.0	3.9	4.1	7.0	S	0
575	41- 95	BT2	0.1	4.9	23.6	46.6	14.5	89.7	0.6	3.8	4.3	6.6	S	0
576	95-150	BT3	0.1	4.3	21.0	42.8	21.9	90.1	1.7	3.0	5.1	6.9	S	0
577	150-200	BT3	0.0	4.6	20.8	42.5	21.7	89.6	1.4	4.2	5.1	6.2	S	0

LAB NO	ORGN C %	PH (H2O) 1:1	PH (0.1N KCL)	NH4OAC EXTR BASES CA	MG	NA	K	TOTAL	KCL EXTR AL	NAOAC CEC	ECEC	BASE SAT %	ESP %	EXTR FE %
				MEQ/100G										
573	0.23	4.7		0.2	0.1	0.0	0.0	0.4	0.5	1.5	0.9	27	2	
574	0.16	4.7		0.2	0.1	0.0	0.0	0.4	0.6	1.7	1.0	22	2	
575	0.09	4.6		0.2	0.2	0.0	0.0	0.4	0.2	1.2	0.6	31	2	
576	0.07	4.8		0.2	0.2	0.0	0.0	0.5	0.2	1.2	0.7	37	2	
577	0.05	4.7		0.2	0.3	0.0	0.0	0.5	0.2	1.1	0.7	43	1	

LAB NO	BULK DEN 0.10 BAR G/CC	BULK DEN AIR DRY G/CC	COLE CM/CM	WATER CONTENT 0.10 BAR WT%	WATER CONTENT 15 BAR WT%	WRD G/CC	CLAY MINERALOGY SM	VR	MI	IN	KK	GI	QZ	FD	CA	SKELETAL MINERALOGY QZ	FD	CA
573																		
574																		
575																		
576																		
577																		

SM=SMECTITE VR=VERMICULITE MI=MICA IN=INTERSTRATIFIED
KK=KAOLINITE GI=GIBBSITE QZ=QUARTZ FD=FELDSPAR CA=CALCITE
T=TRACE *=0-10% **=10-50% ***=GREATER THAN 50%

SOIL CHARACTERIZATION LABORATORY
SOIL AND CROP SCIENCES DEPT., THE TEXAS AGRICULTURAL EXPERIMENT STATION

SOIL SERIES: LABUCHERI (MICROLOW)
SOIL FAMILY: PSAMMENTIC PALEUSTALF; SANDY, SILICEOUS, ISOHYPERTHERMIC
LOCATION: ICRISAT SAHELIAN CENTER

PEDON NUMBER: S82TX-004-08

LAB NO	PARTICLE SIZE DISTRIBUTION (CLAY-FREE BASIS)												
	SAND						SILT			RATIOS			
	VCS	C	M	F	VF	TOTAL	C	F	TOTAL	S/SI	FSI/CSI	VFS/FS	CEC/C
	%												
573	0.1	6.0	24.6	47.7	16.9	95.3	3.2	1.5	4.7	20.3	0.5	0.4	0.32
574	0.1	6.2	24.8	48.8	15.8	95.8	3.1	1.1	4.2	22.8	0.4	0.3	0.25
575	0.1	5.2	25.3	49.9	15.5	96.0	3.5	0.6	4.1	23.4	0.2	0.3	0.18
576	0.1	4.6	22.6	46.0	23.5	96.8	1.4	1.8	3.2	30.2	1.3	0.5	0.18
577	0.0	4.9	22.2	45.3	23.1	95.5	3.0	1.5	4.5	21.2	0.5	0.5	0.18

SOIL CHARACTERIZATION LABORATORY
SOIL AND CROP SCIENCES DEPT., THE TEXAS AGRICULTURAL EXPERIMENT STATION

SOIL SERIES: LABUCHERI (LA-1)
SOIL FAMILY: USTOXIC QUARTZIPSAMMENT; ISOHYPERTHERMIC, COATED
LOCATION: ICRISAT SAHELIAN CENTER

PEDON NUMBER: S82TX-006-07

LAB NO	DEPTH (CM)	HORIZON	PARTICLE SIZE DISTRIBUTION (MM) SAND VC (2.0-1.0)	SAND C (1.0-0.5)	SAND M (0.5-0.25)	SAND F (0.25-0.10)	SAND VF (0.10-0.05)	SAND TOTAL (2.0-0.05)	SILT FINE (0.02-0.002)	SILT TOTAL (0.05-0.002)	CLAY FINE (< 0.0002)	CLAY TOTAL (< 0.002)	TEXTURE CLASS	COARSE FRAGMENTS %
			%											
592	0- 25	A	0.2	6.6	23.4	40.7	20.3	91.2	0.7	4.4	2.4	4.4	S	0
593	30- 40	BT	0.1	7.7	25.7	38.6	17.2	89.3	1.2	4.0	4.0	6.7	S	0
594	174-184	BT	0.2	6.1	20.8	39.4	21.7	88.2	1.1	5.2	3.7	6.6	LS	0

LAB NO	ORGN C %	PH (H2O) 1:1	PH (0.1N KCL)	NH4OAC EXTR BASES CA	MG	NA	K	TOTAL	KCL EXTR AL	NAOAC CEC	ECEC	BASE SAT %	ESP %	EXTR FE %
				MEQ/100G										
592	0.18	4.7		0.3	0.1	0.0	0.1	0.5	0.3	1.4	0.8	38	2	
593	0.12	4.6		0.2	0.1	0.1	0.1	0.4	0.6	1.5	1.0	29	3	
594	0.10	4.8		0.3	0.4	0.0	0.0	0.8	0.4	1.2	1.2	63	2	

LAB NO	BULK DEN 0.10 BAR G/CC	BULK DEN AIR DRY G/CC	BULK DEN COLE CM/CM	WATER CONTENT 0.10 BAR WT%	WATER CONTENT 15 BAR WT%	WRD G/CC	CLAY MINERALOGY SM	VR	MI	IN	KK	GI	QZ	FD	CA	SKELETAL MINERALOGY QZ	FD	CA
592																		
593																		
594																		

SM=SMECTITE VR=VERMICULITE MI=MICA IN=INTERSTRATIFIED
KK=KAOLINITE GI=GIBBSITE QZ=QUARTZ FD=FELDSPAR CA=CALCITE
T=TRACE *=0-10% **=10-50% ***=GREATER THAN 50%

LAB NO	PARTICLE SIZE DISTRIBUTION (CLAY-FREE BASIS) SAND VCS	SAND C	SAND M	SAND F	SAND VF	SAND TOTAL	SILT C	SILT F	SILT TOTAL	RATIOS S/SI	FSI/CSI	VFS/FS	CEC/C
	%												
592	0.2	6.9	24.5	42.6	21.2	95.4	3.9	0.7	4.6	20.7	0.2	0.5	0.31
593	0.1	8.3	27.5	41.4	18.4	95.7	3.0	1.3	4.3	22.3	0.4	0.4	0.22
594	0.2	6.5	22.3	42.2	23.2	94.4	4.4	1.2	5.6	16.9	0.3	0.5	0.19

SOIL CHARACTERIZATION LABORATORY
SOIL AND CROP SCIENCES DEPT., THE TEXAS AGRICULTURAL EXPERIMENT STATION

SOIL SERIES: LABUCHERI (LA-2)
SOIL FAMILY: PSAMMENTIC PALEUSTALF; SANDY, SILICEOUS, ISOHYPERTHERMIC
LOCATION: ICRISAT SAHELIAN CENTER

PEDON NUMBER: S82TX-006-11

LAB NO	DEPTH (CM)	HORIZON	PARTICLE SIZE DISTRIBUTION (MM) SAND VC (2.0-1.0)	C (1.0-0.5)	M (0.5-0.25)	F (0.25-0.10)	VF (0.10-0.05)	TOTAL (2.0-0.05)	SILT FINE (0.02-0.002)	SILT TOTAL (0.05-0.002)	CLAY FINE (< 0.0002)	CLAY TOTAL (< 0.002)	TEXTURE CLASS	COARSE FRAGMENTS %
			%											
604	0- 23	A	0.2	8.2	26.1	36.8	14.7	86.0	2.5	6.3	3.9	7.7	LS	0
605	23- 36	BT	0.2	9.4	27.5	33.2	11.9	82.2	2.8	6.2	7.0	11.6	LS	0
606	160-170	BT	0.2	9.3	27.6	30.4	11.4	78.9	2.0	7.8	7.8	13.3	FSL	0

LAB NO	ORGN C %	PH (H2O) 1:1	PH (0.1N KCL)	NH4OAC EXTR BASES CA	MG	NA	K	TOTAL	KCL EXTR NAOAC AL	CEC	ECEC	BASE SAT	ESP	EXTR FE
				MEQ/100G								%		
604	0.18	4.7		0.3	0.1	0.0	0.1	0.5	0.8	2.5	1.3	20	1	
605	0.09	4.6		0.2	0.1	0.1	0.0	0.5	0.8	2.5	1.3	20	5	
606	0.07	4.7		0.2	0.2	0.1	0.0	0.5	0.7	2.3	1.2	21	2	

LAB NO	BULK DEN 0.10 BAR	AIR DRY	COLE	WATER CONTENT 0.10 BAR	15 BAR	WRD	CLAY MINERALOGY SM	VR	MI	IN	KK	GI	QZ	FD	CA	SKELETAL MINERALOGY QZ	FD	CA
	G/CC		CM/CM	WT%		G/CC												
604																		
605																		
606																		

SM=SMECTITE VR=VERMICULITE MI=MICA IN=INTERSTRATIFIED
KK=KAOLINITE GI=GIBBSITE QZ=QUARTZ FD=FELDSPAR CA=CALCITE
T=TRACE *=0-10% **=10-50% ***=GREATER THAN 50%

LAB NO	PARTICLE SIZE DISTRIBUTION (CLAY-FREE BASIS) SAND VCS	C	M	F	VF	TOTAL	SILT C	F	TOTAL	RATIOS S/SI	FSI/CSI	VFS/FS	CEC/C
	%												
604	0.2	8.9	28.3	39.9	15.9	93.2	4.1	2.7	6.8	13.7	0.7	0.4	0.33
605	0.2	10.6	31.1	37.6	13.5	93.0	3.8	3.2	7.0	13.3	0.8	0.4	0.22
606	0.2	10.7	31.8	35.1	13.1	91.0	6.7	2.3	9.0	10.1	0.3	0.4	0.17

SOIL CHARACTERIZATION LABORATORY
SOIL AND CROP SCIENCES DEPT., THE TEXAS AGRICULTURAL EXPERIMENT STATION

SOIL SERIES: LABUCHERI (LAA-1)
SOIL FAMILY: PSAMMENTIC PALEUSTALF; SANDY, SILICEOUS, ISOHYPERTHERMIC
LOCATION: ICRISAT SAHELIAN CENTER

PEDON NUMBER: S82TX-006-05

LAB NO	DEPTH (CM)	HORIZON	PARTICLE SIZE DISTRIBUTION (MM) SAND VC (2.0-1.0)	C (1.0-0.5)	M (0.5-0.25)	F (0.25-0.10)	VF (0.10-0.05)	TOTAL (2.0-0.05)	SILT FINE (0.02-0.002)	TOTAL (0.05-0.002)	CLAY FINE (< 0.0002)	TOTAL (< 0.002)	TEXTURE CLASS	COARSE FRAGMENTS %
			%											
586	0- 29	A	0.0	9.2	29.2	38.9	15.3	92.6	0.8	3.4	1.4	4.0	S	0
587	29- 39	BT	0.1	8.8	26.1	40.3	17.5	92.8	0.8	1.2	2.2	6.0	S	0
588	180-190	BT	0.2	9.2	25.3	36.5	17.3	88.5	0.3	4.3	3.6	7.2	LS	0

LAB NO	ORGN C %	PH (H2O) 1:1	PH (0.1N KCL)	NH4OAC EXTR BASES CA	MG	NA	K	TOTAL	KCL EXTR NAOAC AL	CEC	ECEC	BASE SAT	ESP	EXTR FE
				MEQ/100G								%		
586	0.12	5.1		0.4	0.2	0.0	0.1	0.7	0.0	1.1	0.7	64	2	
587	0.10	5.3		0.6	0.3	0.1	0.1	1.0	0.0	1.3	1.0	76	4	
588	0.08	5.0		0.3	0.2	0.1	0.1	0.6	0.1	1.1	0.8	56	7	

LAB NO	BULK DEN 0.10 BAR	AIR DRY	COLE	WATER CONTENT 0.10 BAR	15 BAR	WRD	CLAY MINERALOGY SM	VR	MI	IN	KK	GI	QZ	FD	CA	SKELETAL MINERALOGY QZ	FD	CA
	G/CC		CM/CM	WT%		G/CC												
586																		
587																		
588																		

SM=SMECTITE VR=VERMICULITE MI=MICA IN=INTERSTRATIFIED
KK=KAOLINITE GI=GIBBSITE QZ=QUARTZ FD=FELDSPAR CA=CALCITE
T=TRACE *=0-10% **=10-50% ***=GREATER THAN 50%

LAB NO	PARTICLE SIZE DISTRIBUTION (CLAY-FREE BASIS) SAND VCS	C	M	F	VF	TOTAL	SILT C	F	TOTAL	RATIOS S/SI	FSI/CSI	VFS/FS	CEC/C
	%												
586	0.0	9.6	30.4	40.5	15.9	96.5	2.7	0.8	3.5	27.6	0.3	0.4	0.27
587	0.1	9.4	27.8	42.9	18.6	98.7	0.4	0.9	1.3	75.9	2.3	0.4	0.22
588	0.2	9.9	27.3	39.3	18.6	95.4	4.3	0.3	4.6	20.7	0.1	0.5	0.15

SOIL CHARACTERIZATION LABORATORY
SOIL AND CROP SCIENCES DEPT., THE TEXAS AGRICULTURAL EXPERIMENT STATION

SOIL SERIES: LABUCHERI (LAA-2)
SOIL FAMILY: PSAMMENTIC PALEUSTALF; SANDY, SILICEOUS, ISOHYPERTHERMIC
LOCATION: ICRISAT SAHELIAN CENTER

PEDON NUMBER: S82TX-006-10

LAB NO	DEPTH (CM)	HORIZON	PARTICLE SIZE DISTRIBUTION (MM) SAND VC (2.0-1.0)	C (1.0-0.5)	M (0.5-0.25)	F (0.25-0.10)	VF (0.10-0.05)	TOTAL (2.0-0.05)	SILT FINE (0.02-0.002)	TOTAL (0.05-0.002)	CLAY FINE (< 0.0002)	TOTAL (< 0.002)	TEXTURE CLASS	COARSE FRAGMENTS %
			%											
601	0- 24	A	0.0	3.8	22.2	45.0	20.6	91.6	1.1	4.7	2.5	3.7	S	0
602	36- 46	BT	0.2	4.9	21.2	38.4	18.9	83.6	1.7	5.4	7.0	11.0	LS	0
603	175-185	BT	0.2	5.8	24.9	37.6	17.8	86.3	1.0	4.8	6.5	8.9	LS	0

LAB NO	ORGN C %	PH (H2O) 1:1	PH (0.1N KCL)	NH4OAC EXTR BASES CA	MG	NA	K	TOTAL	KCL EXTR AL	NAOAC CEC	ECEC	BASE SAT	ESP	EXTR FE
				MEQ/100G								%		
601	0.15	4.8		0.2	0.1	0.0	0.3	0.6	0.4	1.2	1.0	51	3	
602	0.13	4.5		0.4	0.2	0.1	0.1	0.8	0.6	1.7	1.4	48	3	
603	0.06	4.8		0.6	0.2	0.0	0.0	0.9	0.1	1.4	1.0	63	2	

LAB NO	BULK DEN 0.10 BAR	AIR DRY	COLE	WATER CONTENT 0.10 BAR	15 BAR	WRD	CLAY MINERALOGY SM	VR	MI	IN	KK	GI	QZ	FD	CA	SKELETAL MINERALOGY QZ	FD	CA
	G/CC		CM/CM	WT%		G/CC												
601																		
602																		
603																		

SM=SMECTITE VR=VERMICULITE MI=MICA IN=INTERSTRATIFIED
KK=KAOLINITE GI=GIBBSITE QZ=QUARTZ FD=FELDSPAR CA=CALCITE
T=TRACE *=0-10% **=10-50% ***=GREATER THAN 50%

LAB NO	PARTICLE SIZE DISTRIBUTION (CLAY-FREE BASIS) SAND VCS	C	M	F	VF	TOTAL	SILT C	F	TOTAL	RATIOS S/SI	FSI/CSI	VFS/FS	CEC/C
	%												
601	0.0	3.9	23.1	46.7	21.4	95.1	3.8	1.1	4.9	19.4	0.3	0.5	0.31
602	0.2	5.5	23.8	43.1	21.2	93.9	4.2	1.9	6.1	15.4	0.5	0.5	0.15
603	0.2	6.4	27.3	41.3	19.5	94.7	4.2	1.1	5.3	17.9	0.3	0.5	0.16

SOIL CHARACTERIZATION LABORATORY
SOIL AND CROP SCIENCES DEPT., THE TEXAS AGRICULTURAL EXPERIMENT STATION

SOIL SERIES: LABUCHERI (LAA-3)
SOIL FAMILY: USTOXIC QUARTZIPSAMMENT; ISOHYPERTHERMIC, COATED
LOCATION: ICRISAT SAHELIAN CENTER

PEDON NUMBER: S82TX-006-08

LAB NO	DEPTH (CM)	HORIZON	PARTICLE SIZE DISTRIBUTION (MM) SAND VC (2.0-1.0)	SAND C (1.0-0.5)	SAND M (0.5-0.25)	SAND F (0.25-0.10)	SAND VF (0.10-0.05)	SAND TOTAL (2.0-0.05)	SILT FINE (0.02-0.002)	SILT TOTAL (0.05-0.002)	CLAY FINE (< 0.0002)	CLAY TOTAL (< 0.002)	TEXTURE CLASS	COARSE FRAGMENTS %
			%											
595	0- 26	A	0.1	4.5	27.4	43.0	16.9	91.9	0.6	3.8	2.1	4.3	S	0
596	30- 40	BT	0.0	5.4	28.2	40.6	15.9	90.1	0.3	3.5	3.7	6.4	S	0
597	160-170	BT	0.2	4.9	26.8	40.3	18.1	90.3	0.4	3.9	3.6	5.8	S	0

LAB NO	ORGN C %	PH (H2O) 1:1	PH (0.1N KCL)	NH4OAC EXTR BASES CA	MG	NA	K	TOTAL	KCL EXTR AL	NAOAC CEC	ECEC	BASE SAT	ESP	EXTR FE
				MEQ/100G								%		
595	0.14	4.4		0.1	0.0	0.0	0.1	0.2	0.6	1.3	0.8	14	2	
596	0.10	4.5		0.1	0.1	0.0	0.1	0.3	0.6	1.4	0.9	20	2	
597	0.06	4.6		0.2	0.1	0.0	0.0	0.4	0.3	1.0	0.7	36	2	

LAB NO	BULK DEN 0.10 BAR	BULK DEN AIR DRY	COLE	WATER CONTENT 0.10 BAR	WATER CONTENT 15 BAR	WRD	CLAY MINERALOGY SM	VR	MI	IN	KK	GI	QZ	FD	CA	SKELETAL MINERALOGY QZ	FD	CA
	G/CC		CM/CM	WT%		G/CC												
595																		
596																		
597																		

SM=SMECTITE VR=VERMICULITE MI=MICA IN=INTERSTRATIFIED
KK=KAOLINITE GI=GIBBSITE QZ=QUARTZ FD=FELDSPAR CA=CALCITE
T=TRACE *=0-10% **=10-50% ***=GREATER THAN 50%

LAB NO	PARTICLE SIZE DISTRIBUTION (CLAY-FREE BASIS) SAND VCS	SAND C	SAND M	SAND F	SAND VF	SAND TOTAL	SILT C	SILT F	SILT TOTAL	RATIOS S/SI	FSI/CSI	VFS/FS	CEC/C
	%												
595	0.1	4.7	28.6	44.9	17.7	96.0	3.4	0.6	4.0	24.0	0.2	0.4	0.29
596	0.0	5.8	30.1	43.4	17.0	96.3	3.4	0.3	3.7	26.0	0.1	0.4	0.21
597	0.2	5.2	28.5	42.8	19.2	95.9	3.7	0.4	4.1	23.4	0.1	0.4	0.17

SOIL CHARACTERIZATION LABORATORY
SOIL AND CROP SCIENCES DEPT., THE TEXAS AGRICULTURAL EXPERIMENT STATION

SOIL SERIES: LABUCHERI (LAB-1)
SOIL FAMILY: PSAMMENTIC PALEUSTALF; SANDY, SILICEOUS, ISOHYPERTHERMIC
LOCATION: ICRISAT SAHELIAN CENTER

PEDON NUMBER: S82TX-006-06

LAB NO	DEPTH (CM)	HORIZON	PARTICLE SIZE DISTRIBUTION (MM) SAND VC (2.0-1.0)	C (1.0-0.5)	M (0.5-0.25)	F (0.25-0.10)	VF (0.10-0.05)	TOTAL (2.0-0.05)	SILT FINE (0.02-0.002)	SILT TOTAL (0.05-0.002)	CLAY FINE (<0.0002)	CLAY TOTAL (<0.002)	TEXTURE CLASS	COARSE FRAGMENTS %
			%											
589	0- 21	A	0.1	5.2	22.4	46.2	15.6	89.5	1.6	5.9	1.6	4.6	S	0
590	21- 37	BT	0.2	6.6	26.1	42.2	11.6	86.7	1.1	4.9	4.0	8.4	LS	0
591	190-210	BT	0.1	5.5	25.7	41.4	12.6	85.3	1.5	4.4	4.9	10.3	LS	0

LAB NO	ORGN C %	PH (H2O) 1:1	PH (0.1N KCL)	NH4OAC EXTR BASES CA	MG	NA	K	TOTAL	KCL EXTR AL	NAOAC CEC	ECEC	BASE SAT	EXTR ESP	EXTR FE
				MEQ/100G								%		
589	0.19	5.0		0.2	0.1	0.0	0.1	0.5	0.3	1.2	0.7	36	3	
590	0.17	4.6		0.2	0.1	0.1	0.1	0.4	0.6	1.5	1.0	27	3	
591	0.08	4.4		0.2	0.2	0.0	0.0	0.4	0.4	1.2	0.8	34	3	

LAB NO	BULK DEN 0.10 BAR	BULK DEN AIR DRY	COLE	WATER CONTENT 0.10 BAR	15 BAR	WRD	CLAY MINERALOGY SM	VR	MI	IN	KK	GI	QZ	FD	CA	SKELETAL MINERALOGY QZ	FD	CA
	G/CC		CM/CM	WT%		G/CC												
589																		
590																		
591																		

SM=SMECTITE VR=VERMICULITE MI=MICA IN=INTERSTRATIFIED
KK=KAOLINITE GI=GIBBSITE QZ=QUARTZ FD=FELDSPAR CA=CALCITE
T=TRACE *=0-10% **=10-50% ***=GREATER THAN 50%

LAB NO	PARTICLE SIZE DISTRIBUTION (CLAY-FREE BASIS) SAND VCS	C	M	F	VF	TOTAL	SILT C	F	TOTAL	RATIOS S/SI	FSI/CSI	VFS/FS	CEC/C
	%												
589	0.1	5.5	23.5	48.4	16.4	93.6	4.5	1.7	6.2	15.1	0.4	0.3	0.27
590	0.2	7.2	28.5	46.1	12.7	94.7	4.2	1.2	5.4	17.5	0.3	0.3	0.18
591	0.1	6.1	28.7	46.2	14.0	95.1	3.2	1.7	4.9	19.4	0.5	0.3	0.11

SOIL CHARACTERIZATION LABORATORY
SOIL AND CROP SCIENCES DEPT., THE TEXAS AGRICULTURAL EXPERIMENT STATION

SOIL SERIES: LABUCHERI (LAB-2)
SOIL FAMILY: PSAMMENTIC PALEUSTALF; SANDY, SILICEOUS, ISOHYPERTHERMIC
LOCATION: ICRISAT SAHELIAN CENTER

PEDON NUMBER: S82TX-006-09

LAB NO	DEPTH (CM)	HORIZON	PARTICLE SIZE DISTRIBUTION (MM) SAND VC (2.0-1.0)	C (1.0-0.5)	M (0.5-0.25)	F (0.25-0.10)	VF (0.10-0.05)	TOTAL (2.0-0.05)	SILT FINE (0.02-0.002)	TOTAL (0.05-0.002)	CLAY FINE (<0.0002)	TOTAL (<0.002)	TEXTURE CLASS	COARSE FRAGMENTS %
			%											
598	0- 31	A	0.0	9.6	32.5	36.3	15.0	93.4	0.8	4.1	2.1	3.0	S	0
599	31- 41	BT	0.1	7.1	29.5	37.6	17.2	91.5	0.7	3.4	3.2	5.1	S	0
600	190-210	BT	0.1	8.4	25.0	39.2	18.7	91.4	0.8	4.2	2.4	4.4	S	0

LAB NO	ORGN C %	PH (H2O) 1:1	PH (0.1N KCL)	NH4OAC EXTR BASES CA	MG	NA	K	TOTAL	KCL EXTR AL	NAOAC CEC	ECEC	BASE SAT	ESP	EXTR FE
				MEQ/100G								%		
598	0.21	4.6		0.1	0.1	0.0	0.1	0.3	0.4	1.3	0.7	22	2	
599	0.11	4.4		0.0	0.0	0.0	0.0	0.1	0.7	1.2	0.9	10	3	
600	0.06	4.6		0.2	0.1	0.0	0.0	0.3	0.3	1.0	0.7	31	2	

LAB NO	BULK DEN 0.10 BAR	AIR DRY	COLE	WATER CONTENT 0.10 BAR	15 BAR	WRD	CLAY MINERALOGY SM	VR	MI	IN	KK	GI	QZ	FD	CA	SKELETAL MINERALOGY QZ	FD	CA
	G/CC		CM/CM	WT%		G/CC												
598																		
599																		
600																		

SM=SMECTITE VR=VERMICULITE MI=MICA IN=INTERSTRATIFIED
KK=KAOLINITE GI=GIBBSITE QZ=QUARTZ FD=FELDSPAR CA=CALCITE
T=TRACE *=0-10% **=10-50% ***=GREATER THAN 50%

LAB NO	PARTICLE SIZE DISTRIBUTION (CLAY-FREE BASIS) SAND VCS	C	M	F	VF	TOTAL	SILT C	F	TOTAL	RATIOS S/SI	FSI/CSI	VFS/FS	CEC/C
	%												
598	0.0	9.9	33.5	37.4	15.5	96.3	3.4	0.8	4.2	22.9	0.2	0.4	0.42
599	0.1	7.5	31.1	39.6	18.1	96.4	2.9	0.7	3.6	26.8	0.2	0.5	0.24
600	0.1	8.8	26.2	41.0	19.6	95.6	3.6	0.8	4.4	21.7	0.2	0.5	0.23

SOIL CHARACTERIZATION LABORATORY
SOIL AND CROP SCIENCES DEPT., THE TEXAS AGRICULTURAL EXPERIMENT STATION

SOIL SERIES: LABUCHERI (LAB-3)
SOIL FAMILY: PSAMMENTIC PALEUSTALF; SANDY, SILICEOUS, ISOHYPERTHERMIC
LOCATION: ICRISAT SAHELIAN CENTER

PEDON NUMBER: S82TX-006-12

LAB NO	DEPTH (CM)	HORIZON	PARTICLE SIZE DISTRIBUTION (MM) SAND VC (2.0-1.0)	SAND C (1.0-0.5)	SAND M (0.5-0.25)	SAND F (0.25-0.10)	SAND VF (0.10-0.05)	SAND TOTAL (2.0-0.05)	SILT FINE (0.02-0.002)	SILT TOTAL (0.05-0.002)	CLAY FINE (<0.0002)	CLAY TOTAL (<0.002)	TEXTURE CLASS	COARSE FRAGMENTS %
			%											
608	0- 29	A	0.1	6.3	27.5	43.0	15.6	92.5	0.9	4.8	2.1	2.7	S	0
609	38- 56	BT	0.0	7.7	25.4	39.1	17.3	89.5	1.0	5.8	2.8	4.7	S	0
610	170-180	BT	0.1	10.6	28.1	35.4	13.4	87.6	1.9	6.4	4.7	6.0	LS	0

LAB NO	ORGN C %	PH (H2O) 1:1	PH (0.1N KCL)	NH4OAC EXTR BASES CA	MG	NA	K	TOTAL	KCL EXTR AL	NAOAC CEC	ECEC	BASE SAT %	ESP %	EXTR FE
				MEQ/100G										
608	0.21	5.0		0.3	0.1	0.0	0.1	0.6	0.1	1.2	0.7	47	3	
609	0.10	4.7		0.4	0.2	0.1	0.0	0.7	0.3	1.3	1.0	50	8	
610	0.06	4.7		0.3	0.2	0.0	0.0	0.5	0.2	1.2	0.7	43	3	

LAB NO	BULK DEN 0.10 BAR	BULK DEN AIR DRY	COLE	WATER CONTENT 0.10 BAR	WATER CONTENT 15 BAR	WRD	CLAY MINERALOGY SM	VR	MI	IN	KK	GI	QZ	FD	CA	SKELETAL MINERALOGY QZ	FD	CA
	G/CC		CM/CM	WT%		G/CC												
608																		
609																		
610																		

SM=SMECTITE VR=VERMICULITE MI=MICA IN=INTERSTRATIFIED
KK=KAOLINITE GI=GIBBSITE QZ=QUARTZ FD=FELDSPAR CA=CALCITE
T=TRACE *=0-10% **=10-50% ***=GREATER THAN 50%

LAB NO	PARTICLE SIZE DISTRIBUTION (CLAY-FREE BASIS) SAND VCS	SAND C	SAND M	SAND F	SAND VF	SAND TOTAL	SILT C	SILT F	SILT TOTAL	RATIOS S/SI	FSI/CSI	VFS/FS	CEC/C
	%												
608	0.1	6.5	28.3	44.2	16.0	95.1	4.0	0.9	4.9	19.4	0.2	0.4	0.44
609	0.0	8.1	26.7	41.0	18.2	93.9	5.0	1.1	6.1	15.4	0.2	0.4	0.28
610	0.1	11.3	29.9	37.7	14.3	93.2	4.8	2.0	6.8	13.7	0.4	0.4	0.21

SOIL SERIES: TONDI PEDON: S82TX-004-005

PEDON CLASSIFICATION: PETROFERRIC HAPLUSULT; SANDY, SILICEOUS, ISOHYPERTHERMIC

COUNTY: DATE: 8/10/82

LOCATION: ICRISAT SAHELIAN CENTER; 40 KM SOUTH OF NIAMEY NIGER. THIS PEDON IS LOCATED 900 M SOUTH OF THE NORTH FENCE AND 200 M EAST OF THE WEST FENCE.

LANDFORM: BACKSLOPE ELEVATION (M): 247

SLOPE: 1% SLOPE ASPECT: NW

TOPOGRAPHY: GENTLY SLOPING LAND USE: FALLOW

PARENT MATERIAL: EOLIAN SAND OVER LATERITE

FORMATION.

DRAINAGE: WELL DRAINED

COLLECTORS: L T. WEST, L. P. WILDING, AND J. K. LANDECK

HORIZON	DEPTH (CM)	SOIL DESCRIPTION (COLORS FOR MOIST SOIL UNLESS OTHERWISE STATED)
A1	0-7	YELLOWISH RED (5YR 4/6) SAND, YELLOWISH RED (5YR 5/6) DRY; MASSIVE AND WEAK THIN PLATY STRUCTURE; SLIGHTLY HARD; VERY FRIABLE; MANY VERY FINE ROOTS; FEW VERY FINE PORES; PEDS ARE SLIGHTLY BRITTLE WHEN DRY; SAND GRAINS MOSTLY UNCOATED; COMMON RED (2.5YR 5/8,M) PEDOTUBULES RANGING IN SIZE FROM 0.5 TO 2.0 CM; STRONGLY ACID; CLEAR SMOOTH BOUNDARY.
A2	7-19	YELLOWISH RED (5YR 4/8) LOAMY SAND, YELLOWISH RED (5YR 5/6) DRY; WEAK COARSE SUBANGULAR BLOCKY STRUCTURE; SLIGHTLY HARD; VERY FRIABLE; COMMON VERY FINE ROOTS; COMMON VERY FINE PORES; PEDS ARE SLIGHTLY BRITTLE WHEN DRY; 50% OF SAND GRAINS COATED; FEW RED (2.5YR 5/8,M) PEDOTUBULES UP TO 3 CM IN DIAMETER; VERY STRONGLY ACID; CLEAR SMOOTH BOUNDARY.
BT1	19-33	RED (2.5YR 4/6) LOAMY SAND, YELLOWISH RED (5YR 5/6) DRY; WEAK COARSE SUBANGULAR BLOCKY STRUCTURE; SLIGHTLY HARD; VERY FRIABLE; COMMON VERY FINE ROOTS; COMMON VERY FINE PORES; THIN PATCHY CLAY BRIDGES BETWEEN SAND GRAINS; PEDS ARE SLIGHTLY BRITTLE WHEN DRY; SAND GRAINS MOSTLY COATED; 1% IRONSTONE GRAVELS UP TO 1 CM IN DIAMETER; FEW PEDOTUBULES; VERY STRONGLY ACID; GRADUAL SMOOTH BOUNDARY.
BT2	33-77	RED (2.5YR 4/6) LOAMY SAND; WEAK COARSE PRISMATIC PARTING TO WEAK COARSE SUBANGULAR BLOCKY STRUCTURE; SLIGHTLY HARD; VERY FRIABLE; FEW VERY FINE ROOTS; COMMON VERY FINE PORES; THIN PATCHY CLAY BRIDGES BETWEEN SAND GRAINS; PEDS ARE SLIGHTLY BRITTLE WHEN DRY. SAND GRAINS MOSTLY COATED; FEW PEDOTUBULES; VERY STRONGLY ACID; CLEAR SMOOTH BOUNDARY.

2BT	77-83	RED (2.5YR 4/6) VERY GRAVELLY LOAMY SAND; STRUCTURE, CONSISTENCY, AND OTHER PROPERTIES NOT OBSERVABLE BECAUSE OF GRAVELS; 50% IRONSTONE GRAVELS UP TO 2 CM IN DIAMETER; ABRUPT WAVY BOUNDARY.
2BSM	83-85	REDDISH BROWN (2.5YR 4/4) LATERITE; MANY MEDIUM RED (2.5YR 5/6) AND MANY MEDIUM STRONG BROWN (7.5YR 5/6) MOTTLES; MATERIAL HAS HARDNESS ABOUT 3 ON MHO'S SCALE AND A DISTINCT LAMINAR CHARACTER; MANY FE-MN STAINS ON FRACTURE PLANES.

REMARKS: IF THE CATEGORY EXISTED, THIS PEDON WOULD CLASSIFY AS A PETROFERRIC OXIC HAPLUSTULT. THE 2BT HORIZON WAS NOT SAMPLED.

SOIL CHARACTERIZATION LABORATORY
SOIL AND CROP SCIENCES DEPT., THE TEXAS AGRICULTURAL EXPERIMENT STATION

SOIL SERIES: TONDI
SOIL FAMILY: PETROFERRIC HAPLUSTULT; SANDY, SILICEOUS, ISOHYPERTHERMIC
LOCATION: ICRISAT SAHELIAN CENTER

PEDON NUMBER: S82TX-004-05

LAB NO	DEPTH (CM)	HORIZON	PARTICLE SIZE DISTRIBUTION (MM) SAND VC (2.0-1.0)	C (1.0-0.5)	M (0.5-0.25)	F (0.25-0.10)	VF (0.10-0.05)	TOTAL (2.0-0.05)	SILT FINE (0.02-0.002)	TOTAL (0.05-0.002)	CLAY FINE (<0.0002)	TOTAL (<0.002)	TEXTURE CLASS	COARSE FRAGMENTS %
			%											
1508	0- 7	A1	0.1	6.2	23.0	37.4	22.7	89.4	1.6	6.8	1.8	3.8	S	0
1509	7- 19	A2	0.1	6.4	23.2	35.7	22.1	87.5	2.0	5.6	3.7	6.9	LS	0
1510	19- 33	BT1	0.1	7.6	25.6	35.4	17.8	86.5	1.3	4.3	5.6	9.2	LS	0
1511	33- 55	BT2	0.1	7.1	24.9	35.5	17.7	85.3	1.2	5.4	5.8	9.3	LS	0
1512	55- 77	BT2	0.0	6.9	23.3	34.3	17.9	82.4	1.3	7.5	6.4	10.1	LS	0
1513	83- 84	BSM												0

LAB NO	ORGN C %	PH (H2O) 1:1	PH (0.1N KCL)	NH4OAC EXTR BASES CA	MG	NA	K	TOTAL	KCL EXTR AL	NAOAC CEC	ECEC	BASE SAT %	ESP %	EXTR FE
				MEQ/100G										
1508	0.37	5.1	4.0	0.4	0.2	0.0	0.1	0.7	0.3	2.2	0.9	31	0	0.5
1509	0.20	4.7	3.8	0.1	0.1	0.0	0.0	0.2	0.9	2.0	1.1	12	1	0.5
1510	0.18	4.7	3.7	0.1	0.1	0.0	0.0	0.2	1.1	2.2	1.3	10	1	0.7
1511	0.13	4.3	3.8	0.1	0.1	0.0	0.0	0.3	0.9	2.0	1.1	13	2	0.7
1512	0.16	4.6	3.9	0.2	0.1	0.0	0.0	0.4	0.7	2.0	1.0	18	1	0.9
1513														

LAB NO	BULK DEN 0.10 BAR	AIR DRY	COLE	WATER CONTENT 0.10 BAR	15 BAR	WRD	CLAY MINERALOGY SM	VR	MI	IN	KK	GI	QZ	FD	CA	SKELETAL MINERALOGY QZ	FD	CA
	G/CC		CM/CM	WT%		G/CC												
1508	1.57	1.63	0.013	17.6	1.4	0.25					***		**			***		
1509	1.62	1.63	0.002	10.4	2.0	0.13												
1510	1.47	1.54	0.016	8.2	2.6	0.08					***		**			***		
1511	1.48	1.52	0.009	8.4	2.8	0.08												
1512					3.2						***		*			***		
1513																		

SM=SMECTITE VR=VERMICULITE MI=MICA IN=INTERSTRATIFIED
KK=KAOLINITE GI=GIBBSITE QZ=QUARTZ FD=FELDSPAR CA=CALCITE
T=TRACE *=0-10% **=10-50% ***=GREATER THAN 50%

SOIL CHARACTERIZATION LABORATORY
SOIL AND CROP SCIENCES DEPT., THE TEXAS AGRICULTURAL EXPERIMENT STATION

SOIL SERIES: TONDI
SOIL FAMILY: PETROFERRIC HAPLUSTULT; SANDY, SILICEOUS, ISOHYPERTHERMIC
LOCATION: ICRISAT SAHELIAN CENTER

PEDON NUMBER: S82TX-004-05

LAB NO	PARTICLE SIZE DISTRIBUTION (CLAY-FREE BASIS)												
	SAND						SILT			RATIOS			
	VCS	C	M	F	VF	TOTAL	C	F	TOTAL	S/SI	FSI/CSI	VFS/FS	CEC/C
	%												
1508	0.1	6.4	23.9	38.9	23.6	92.9	5.4	1.7	7.1	13.1	0.3	0.6	0.57
1509	0.1	6.9	24.9	38.3	23.7	94.0	3.9	2.1	6 0	15.7	0.5	0.6	0.29
1510	0.1	8.4	28.2	39.0	19.6	95.3	3.3	1.4	4.7	20.3	0.4	0.5	0.24
1511	0.1	7.8	27.5	39.1	19.5	94.0	4.7	1.3	6.0	15.7	0.3	0.5	0.22
1512	0.0	7.7	25.9	38.2	1[illegible].9	91.7	6.9	1.4	8.3	11.0	0.2	0.5	0.20

SOIL CHARACTERIZATION LABORATORY
SOIL AND CROP SCIENCES DEPT., THE TEXAS AGRICULTURAL EXPERIMENT STATION

SOIL SERIES: TONDI (TO-1)
SOIL FAMILY: USTOXIC QUARTZIPSAMMENT; ISOHYPERTHERMIC, COATED
LOCATION: ICRISAT SAHELIAN CENTER

PEDON NUMBER: S82TX-006-04

LAB NO	DEPTH (CM)	HORIZON	PARTICLE SIZE DISTRIBUTION (MM) SAND VC (2.0-1.0)	SAND C (1.0-0.5)	SAND M (0.5-0.25)	SAND F (0.25-0.10)	SAND VF (0.10-0.05)	SAND TOTAL (2.0-0.05)	SILT FINE (0.02-0.002)	SILT TOTAL (0.05-0.002)	CLAY FINE (<0.0002)	CLAY TOTAL (<0.002)	TEXTURE CLASS	COARSE FRAGMENTS %
			%											
584	0- 17	A	0.1	13.4	24.2	31.8	18.4	87.9	1.9	4.3	3.4	7.8	LS	0
585	65- 75	BT	0.1	17.6	28.3	27.7	15.6	89.3	1.6	2.4	3.8	8.3	S	0

LAB NO	ORGN C %	PH (H2O) 1:1	PH (0.1N KCL)	NH4OAC EXTR BASES CA	MG	NA	K	TOTAL	KCL EXTR AL	NAOAC CEC	ECEC	BASE SAT	ESP	EXTR FE
				MEQ/100G								%		
584	0.25	4.5		0.1	0.1	0.0	0.1	0.3	0.9	2.3	1.2	13	1	
585	0.12	4.6		0.1	0.0	0.0	0.0	0.2	0.6	1.5	0.8	14	2	

LAB NO	BULK DEN 0.10 BAR	BULK DEN AIR DRY	COLE	WATER CONTENT 0.10 BAR	WATER CONTENT 15 BAR	WRD	CLAY MINERALOGY SM	VR	MI	IN	KK	GI	QZ	FD	CA	SKELETAL MINERALOGY QZ	FD	CA
	G/CC		CM/CM	WT%		G/CC												
584																		
585																		

SM=SMECTITE VR=VERMICULITE MI=MICA IN=INTERSTRATIFIED
KK=KAOLINITE GI=GIBBSITE QZ=QUARTZ FD=FELDSPAR CA=CALCITE
T=TRACE *=0-10% **=10-50% ***=GREATER THAN 50%

LAB NO	PARTICLE SIZE DISTRIBUTION (CLAY-FREE BASIS) SAND VCS	SAND C	SAND M	SAND F	SAND VF	SAND TOTAL	SILT C	SILT F	SILT TOTAL	RATIOS S/SI	FSI/CSI	VFS/FS	CEC/C
	%												
584	0.1	14.5	26.2	34.5	20.0	95.3	2.6	2.1	4.7	20.3	0.8	0.6	0.29
585	0.1	19.2	30.9	30.2	17.0	97.4	0.9	1.7	2.6	37.5	1.9	0.6	0.18

SOIL SERIES: ZOGOTI PEDON: S82TX-004-003

PEDON CLASSIFICATION: PSAMMENTIC PALEUSTALF; SANDY, SILICEOUS, ISOHYPERTHERMIC

COUNTY: DATE: 8/ 9/82

LOCATION: ICRISAT SAHELIAN CENTER; APPROXIMATELY 40 KM SOUTH OF NIAMEY, NIGER. THIS PEDON IS LOCATED 500 M EAST OF THE WEST FENCE AND 650 M SOUTH OF THE NORTH FENCE.

LANDFORM: BACKSLOPE ELEVATION (M): 246

SLOPE: 1.5% SLOPE ASPECT: W

TOPOGRAPHY: GENTLY SLOPING LAND USE: FALLOW

PARENT MATERIAL: EOLIAN SAND OVER LATERITIC GRAVEL

FORMATION:

DRAINAGE: WELL DRAINED

COLLECTORS: L. T. WEST, L.P. WILDING, AND J. K. LANDECK

HORIZON	DEPTH (CM)	SOIL DESCRIPTION (COLORS FOR MOIST SOIL UNLESS OTHERWISE STATED)
A1	0-17	YELLOWISH RED (5YR 5/6) SAND, REDDISH YELLOW (5YR 6/6) DRY; MASSIVE AND WEAK MEDIUM SUBANGULAR BLOCKY STRUCTURE; SOFT; VERY FRIABLE; COMMON VERY FINE ROOTS; FEW VERY FINE PORES; SAND GRAINS MOSTLY UNCOATED; COMMON PEDOTUBULES; VERY STRONGLY ACID; ABRUPT SMOOTH BOUNDARY.
A2	17-32	YELLOWISH RED (5YR 5/6) SAND, RED (2.5YR 4/6) DRY; FEW FINE FAINT DARK RED (2.5YR 3/6) MOTTLES; MASSIVE AND WEAK MEDIUM SUBANGULAR BLOCKY STRUCTURE; SOFT; VERY FRIABLE; COMMON VERY FINE ROOTS; FEW FINE PORES; 50% OF SAND GRAINS COATED; COMMON PEDOTUBULES FILLED WITH UNCOATED SAND GRAINS; VERY STRONGLY ACID; CLEAR SMOOTH BOUNDARY.
BT1	32-59	RED (2.5YR 4/6) LOAMY SAND, RED (2.5YR 5/8) DRY; WEAK COARSE SUBANGULAR BLOCKY STRUCTURE; SLIGHTLY HARD; FRIABLE; FEW VERY FINE ROOTS; FEW FINE PORES; THIN PATCHY CLAY BRIDGES BETWEEN SAND GRAINS; SAND GRAINS MOSTLY COATED; COMMON 2-5 MM PEDOTUBULES FILLED WITH UNCOATED SAND; VERY STRONGLY ACID; GRADUAL SMOOTH BOUNDARY.
BT2	59-85	RED (2.5YR 4/8) LOAMY SAND, RED (2.5YR 5/8) DRY; WEAK VERY COARSE SUBANGULAR BLOCKY STRUCTURE; SLIGHTLY HARD; FRIABLE; FEW VERY FINE ROOTS; COMMON FINE PORES; THIN PATCHY CLAY BRIDGES BETWEEN SAND GRAINS; SAND GRAINS MOSTLY COATED; COMMON PEDOTUBULES; LESS THAN 1% IRONSTONE GRAVELS; FEW COARSE (5 CM) TERMITE CAVITIES; FEW DECAYED ROOT SHELLS WITH SAND INFILLING; VERY STRONGLY ACID; GRADUAL SMOOTH BOUNDARY.

BT3	85-126	RED (2.5YR 4/8) SAND, RED (2.5YR 5/8) DRY; MASSIVE AND WEAK VERY COARSE SUBANGULAR BLOCKY STRUCTURE; HARD; FRIABLE; FEW VERY FINE ROOTS; COMMON FINE PORES; THIN VERY PATCHY CLAY BRIDGES BETWEEN SAND GRAINS; SAND GRAINS MOSTLY COATED; COMMON PEDOTUBULES; FEW COARSE TERMITE CAVITES; PEDS ARE SLIGHTLY BRITTLE WHEN DRY; STRONGLY ACID; ABRUPT WAVY BOUNDARY.
2BT	126-225	RED (2.5YR 4/6) VERY GRAVELLY SANDY LOAM, RED (2.5YR 5/6) DRY; MASSIVE; FEW FINE ROOTS; 50% 2 TO 25 MM IRONSTONE GRAVELS; GRAVELS INCREASE IN SIZE WITH DEPTH AND SOME HAVE A PISOLITIC STRUCTURE; GRAVELS ARE WEAKLY CEMENTED IN SOME AREAS OF THE PEDON; 5% LARGE (30 CM) BLOCKS OF INDURATED LATERITE; STRONGLY ACID.

REMARKS: THE GRAVELS COULD NOT BE AUGERED DEEPER THAN 225 CM, BUT INDICATIONS WERE THAT REFUSAL WAS NOT BECAUSE OF INDURATED LATERITE. APPROXIMATLEY 10% OF THE GRAVEL IN THIS PEDON WAS FERRIGINOUS SANDSTONE. IF THE CATEGORY EXISTED, THIS PEDON WOULD CLASSIFY AS A PSAMMENTIC OXIC PALEUSTALF.

SOIL CHARACTERIZATION LABORATORY
SOIL AND CROP SCIENCES DEPT., THE TEXAS AGRICULTURAL EXPERIMENT STATION

SOIL SERIES: ZOGOTI
SOIL FAMILY: PSAMMENTIC PALEUSTALF; SANDY, SILICEOUS, ISOHYPERTHERMIC
LOCATION: ICRISAT SAHELIAN CENTER

PEDON NUMBER: S82TX-004-03

LAB NO	DEPTH (CM)	HORIZON	PARTICLE SIZE DISTRIBUTION (MM) SAND VC (2.0-1.0)	C (1.0-0.5)	M (0.5-0.25)	F (0.25-0.10)	VF (0.10-0.05)	TOTAL (2.0-0.05)	SILT FINE (0.02-0.002)	TOTAL (0.05-0.002)	CLAY FINE (< 0.0002)	TOTAL (< 0.002)	TEXTURE CLASS	COARSE FRAGMENTS %
			%											
1488	0- 17	A1	0.1	5.4	25.9	41.1	20.2	92.7	0.5	3.3	2.6	4.1	S	0
1489	17- 32	A2	0.1	5.7	24.9	38.0	20.0	88.7	0.8	3.9	4.6	7.4	S	0
1490	32- 59	BT1	0.1	6.3	25.4	34.2	18.4	84.4	0.6	4.4	7.1	11.2	LS	0
1491	59- 85	BT2	0.1	6.3	24.3	34.0	19.7	84.4	1.0	4.7	7.7	10.9	LS	0
1492	85- 96	BT3	0.0	5.9	23.0	32.9	21.6	83.4	1.7	5.6	7.7	11.0	LS	0
1493	96-126	BT3	0.3	5.4	20.9	31.3	22.4	80.3	2.3	7.1	8.2	12.6	FSL	0
1494	126-176	2BT	1.5	9.4	28.8	24.6	17.0	81.3	1.9	6.2	8.7	12.5	SL	80
1495	176-225	2BT	1.3	10.2	28.6	22.7	17.5	80.3	2.1	7.3	8.6	12.4	SL	81

LAB NO	ORGN C %	PH (H2O) 1:1	PH (0.1N KCL)	NH4OAC EXTR BASES CA	MG	NA	K	TOTAL	KCL EXTR AL	NAOAC CEC	ECEC	BASE SAT %	ESP %	EXTR FE
				MEQ/100G										
1488	0.20	4.9	3.7	0.1	0.1	0.0	0.0	0.2	0.3	1.2	0.6	21	3	0.5
1489	0.25	4.5	3.7	0.2	0.1	0.0	0.0	0.3	0.8	1.4	1.1	22	1	0.6
1490	0.16	4.6	3.7	0.2	0.1	0.0	0.0	0.4	0.9	1.5	1.3	24	2	0.9
1491	0.11	4.9	4.0	0.5	0.3	0.0	0.0	0.9	0.3	1.6	1.2	55	3	0.9
1492	0.12	5.2	4.1	0.6	0.3	0.0	0.0	1.0	0.3	1.6	1.3	63	3	0.8
1493	0.12	5.1	4.2	0.8	0.5	0.2	0.1	1.5	0.2	1.6	1.7	91	13	0.9
1494	0.16	5.7	4.6	1.1	0.3	0.0	0.0	1.5	0.1	1.8	1.6	83	2	1.0
1495	0.17	4.8	4.1	0.6	0.2	0.1	0.0	0.9	0.4	1.8	1.3	51	3	1.4

LAB NO	BULK DEN 0.10 BAR	AIR DRY	COLE	WATER CONTENT 0.10 BAR	15 BAR	WRD	CLAY MINERALOGY SM	VR	MI	IN	KK	GI	QZ	FD	CA	SKELETAL MINERALOGY QZ	FD	CA
	---G/CC--		CM/CM	---WT%---		G/CC												
1488	1.55	1.63	0.017	16.5	1.5	0.23												
1489	1.50	1.54	0.009	7.4	2.5	0.07												
1490	1.48	1.50	0.004	8.3	3.4	0.07												
1491	1.57	1.57	0.000	8.9	3.8	0.08												
1492	1.54	1.58	0.009	10.4	3.7	0.10												
1493					3.7													
1494					3.6													
1495					4.0													

SM=SMECTITE VR=VERMICULITE MI=MICA IN=INTERSTRATIFIED
KK=KAOLINITE GI=GIBBSITE QZ=QUARTZ FD=FELDSPAR CA=CALCITE
T=TRACE *=0-10% **=10-50% ***=GREATER THAN 50%

SOIL CHARACTERIZATION LABORATORY
SOIL AND CROP SCIENCES DEPT., THE TEXAS AGRICULTURAL EXPERIMENT STATION

SOIL SERIES: ZOGOTI
SOIL FAMILY: PSAMMENTIC PALEUSTALF; SANDY, SILICEOUS, ISOHYPERTHERMIC
LOCATION: ICRISAT SAHELIAN CENTER

PEDON NUMBER: S82TX-004-03

LAB NO	PARTICLE SIZE DISTRIBUTION (CLAY-FREE BASIS)												
	SAND						SILT			RATIOS			
	VCS	C	M	F	VF	TOTAL	C	F	TOTAL	S/SI	FSI/CSI	VFS/FS	CEC/C
	%												
1488	0.1	5.6	27.0	42.9	21.1	96.7	2.9	0.5	3.4	28.4	0.2	0.5	0.29
1489	0.1	6.2	26.9	41.0	21.6	95.8	3.3	0.9	4.2	22.8	0.3	0.5	0.19
1490	0.1	7.1	28.6	38.5	20.7	95.0	4.3	0.7	5.0	19.0	0.2	0.5	0.14
1491	0.1	7.1	27.3	38.2	22.1	94.7	4.2	1.1	5.3	17.9	0.3	0.6	0.15
1492	0.0	6.6	25.8	37.0	24.3	93.7	4.4	1.9	6.3	14.9	0.4	0.7	0.14
1493	0.3	6.2	23.9	35.8	25.6	91.9	5.5	2.6	8.1	11.3	0.5	0.7	0.13
1494	1.7	10.7	32.9	28.1	19.4	92.9	4.9	2.2	7.1	13.1	0.4	0.7	0.14
1495	1.5	11.6	32.6	25.9	20.0	91.7	5.9	2.4	8.3	11.0	0.4	0.8	0.14

SOIL CHARACTERIZATION LABORATORY
SOIL AND CROP SCIENCES DEPT., THE TEXAS AGRICULTURAL EXPERIMENT STATION

SOIL SERIES: ZOGOTI (ZO-1)
SOIL FAMILY: PSAMMENTIC PALEUSTALF; SANDY, SILICEOUS, ISOHYPERTHERMIC
LOCATION: ICRISAT SAHELIAN CENTER

PEDON NUMBER: S82TX-006-03

LAB NO	DEPTH (CM)	HORIZON	PARTICLE SIZE DISTRIBUTION (MM) SAND VC (2.0-1.0)	SAND C (1.0-0.5)	SAND M (0.5-0.25)	SAND F (0.25-0.10)	SAND VF (0.10-0.05)	SAND TOTAL (2.0-0.05)	SILT FINE (0.02-0.002)	SILT TOTAL (0.05-0.002)	CLAY FINE (<0.0002)	CLAY TOTAL (<0.002)	TEXTURE CLASS	COARSE FRAGMENTS %
			%											
581	0- 21	A	0.1	5.5	20.6	41.2	22.3	89.7	1.9	5.1	4.0	5.2	S	0
582	21- 31	BT	0.1	4.4	20.1	38.2	20.3	83.1	0.4	4.0	7.6	12.9	LFS	0
583	107-117	BT	3.2	4.2	17.1	33.5	22.4	80.4	1.8	7.3	7.9	12.3	FSL	0

LAB NO	ORGN C %	PH (H2O) 1:1	PH (0.1N KCL)	NH4OAC EXTR BASES CA	MG	NA	K	TOTAL	KCL EXTR AL	NAOAC CEC	ECEC	BASE SAT	ESP	EXTR FE
				MEQ/100G								%		
581	0.17	4.7		0.2	0.1	0.0	0.0	0.3	0.5	1.5	0.8	21	1	
582	0.16	4.4		0.2	0.1	0.0	0.1	0.4	0.3	2.3	0.7	15	1	
583	0.21	4.8		0.4	0.6	0.1	0.0	1.1	0.9	2.5	2.0	46	3	

LAB NO	BULK DEN 0.10 BAR	BULK DEN AIR DRY	COLE	WATER CONTENT 0.10 BAR	WATER CONTENT 15 BAR	WRD	CLAY MINERALOGY SM	VR	MI	IN	KK	GI	QZ	FD	CA	SKELETAL MINERALOGY QZ	FD	CA
	G/CC		CM/CM	WT%		G/CC												
581																		
582																		
583																		

SM=SMECTITE VR=VERMICULITE MI=MICA IN=INTERSTRATIFIED
KK=KAOLINITE GI=GIBBSITE QZ=QUARTZ FD=FELDSPAR CA=CALCITE
T=TRACE *=0-10% **=10-50% ***=GREATER THAN 50%

LAB NO	PARTICLE SIZE DISTRIBUTION (CLAY-FREE BASIS) SAND VCS	SAND C	SAND M	SAND F	SAND VF	SAND TOTAL	SILT C	SILT F	SILT TOTAL	RATIOS S/SI	FSI/CSI	VFS/FS	CEC/C
	%												
581	0.1	5.8	21.7	43.5	23.5	94.6	3.4	2.0	5.4	17.5	0.6	0.5	0.29
582	0.1	5.1	23.1	43.9	23.3	95.4	4.1	0.5	4.6	20.7	0.1	0.5	0.18
583	3.6	4.8	19.5	38.2	25.5	91.7	6.2	2.1	8.3	11.0	0.3	0.7	0.20

SOIL SERIES: TERMITE MOUND PEDON: S82TX-004-007

PEDON CLASSIFICATION:

COUNTY: DATE: 8/20/82

LOCATION: ICRISAT SAHELIAN CENTER; 40 KM SOUTH OF NIAMEY, NIGER. THIS PEDON IS 800 M SOUTH OF THE NORTH FENCE AND 300 M WEST OF THE EAST FENCE.

LANDFORM: BACKSLOPE ELEVATION (M): 236

SLOPE: 1% SLOPE ASPECT: W

TOPOGRAPHY: GENTLY SLOPING LAND USE: FALLOW

PARENT MATERIAL: EOLIAN SAND

FORMATION:

DRAINAGE: WELL DRAINED

COLLECTORS: L. T. WEST AND J. K. LANDECK

HORIZON	DEPTH (CM)	SOIL DESCRIPTION (COLORS FOR MOIST SOIL UNLESS OTHERWISE STATED)
C1	64-21	YELLOWISH RED (5YR 5/6) SANDY CLAY LOAM, REDDISH YELLOW (5YR 6/6) DRY; COMMON FINE RED (2.5YR 4/8) AND COMMON FINE PINKISH GRAY (5YR 7/2) MOTTLES; MASSIVE; VERY HARD; VERY FIRM; COMMON PORES AND VUGS RANGING IN SIZE FROM 5 MM TO 5 CM, SOME ARE CLAY LINED AND TUBULAR. MOTTLES FORM SWIRLING PATTERN AROUND PEDOTUBULES; VERY STRONGLY ACID; CLEAR WAVY BOUNDARY.
C2	21-38	YELLOWISH RED (5YR 5/6) CLAY LOAM, REDDISH YELLOW (5YR 6/6) DRY; FEW MEDIUM REDDISH BROWN (2.5YR 4/4) AND FEW FINE PINKISH GRAY (5YR 7/2) MOTTLES; MASSIVE; HARD; FIRM; MANY LIGHT YELLOW RECENT TERMITE CASTS; MANY VUGS FROM 5 MM TO 10 CM IN DIAMETER MANY OF WHICH ARE CLAY LINED OR FILLED WITH ORGANIC MATERIAL; MOTTLES FORM SWIRLING PATTERN AROUND VUGS AND PEDOTUBULES; THIS IS THE ZONE OF MOST TERMITE ACTIVITY; STRONGLY ACID; CLEAR WAVY BOUNDARY.
C3	38-90	RED (2.5YR 5/6) SANDY CLAY LOAM, YELLOWISH RED (5YR 5/6) DRY; MANY MEDIUM RED (2.5YR 4/6) AND FEW COARSE PINKISH GRAY (5YR 6/2) MOTTLES; WEAK THIN PLATY STRUCTURE; HARD; FIRM; PLATY STRUCTURE IS NOT HORIZONTAL BUT SWIRLS AROUND PEDOTUBULES; MANY PEDOTUBULES; COMMON VUGS 3 MM TO 3 CM IN DIAMETER; STRONGLY ACID; CLEAR WAVY BOUNDARY.
BTB1	90-135	RED (2.5YR 5/6) LOAMY SAND, YELLOWISH RED (5YR 5/6) DRY; WEAK COARSE SUBANGULAR BLOCKY STRUCTURE; SLIGHTLY HARD; FIRM; COMMON VERY FINE PORES; FEW THIN VERY PATCHY CLAY BRIDGES BETWEEN SAND GRAINS; PEDS ARE SLIGHTLY BRITTLE WHEN DRY; COMMON 3MM TO 2 CM PEDOTUBULES; VERY STRONGLY ACID; GRADUAL SMOOTH BOUNDARY.

BTB2	135-200	YELLOWISH RED (5YR 4/6) LOAMY SAND, RED (2.5YR 5/8) DRY; WEAK COARSE SUBANGULAR BLOCKY STRUCTURE; SLIGHTLY HARD; FIRM; COMMON VERY FINE ROOTS; COMMON VERY FINE PORES; FEW THIN PATCHY CLAY BRIDGES BETWEEN SAND GRAINS; PEDS ARE SLIGHTLY BRITTLE WHEN DRY; COMMON 5 TO 15 MM PEDOTUBULES; EXTREMELY ACID.

REMARKS: THE TERMITE MOUND ROSE 75 CM ABOVE THE SOIL SURFACE. THE AREA OF TERMITE ACTIVITY IN THE MOUND WAS DENSE AND EXTREMELY DIFFICULT TO DIG. THE C2 HORIZON EXTENDS FROM 21 CM ABOVE THE SOIL SURFACE TO 38 CM BELOW THE SURFACE.

SOIL CHARACTERIZATION LABORATORY
SOIL AND CROP SCIENCES DEPT., THE TEXAS AGRICULTURAL EXPERIMENT STATION

SOIL SERIES: TERMITE MOUND
SOIL FAMILY:
LOCATION: ICRICAT SEHELIAN CENTER

PEDON NUMBER: S82TX-004-07

LAB NO	DEPTH (CM)	HORIZON	PARTICLE SIZE DISTRIBUTION (MM) SAND VC (2.0-1.0)	C (1.0-0.5)	M (0.5-0.25)	F (0.25-0.10)	VF (0.10-0.05)	TOTAL (2.0-0.05)	SILT FINE (0.02-0.002)	TOTAL (0.05-0.002)	CLAY FINE (< 0.0002)	TOTAL (< 0.002)	TEXTURE CLASS	COARSE FRAGMENTS %
			%											
1518	64- 21	C1	0.0	2.7	13.7	25.9	14.4	56.7	7.2	14.5	11.6	28.8	SCL	0
1519	21- 38	C2	0.0	2.2	10.5	20.3	11.4	44.4	11.7	17.5	12.9	38.1	CL	0
1520	38- 90	C3	0.2	4.1	18.5	30.2	14.7	67.7	6.5	11.1	8.3	21.2	SCL	0
1521	90-135	BTB1	0.1	5.7	23.3	38.6	16.7	84.4	2.1	4.4	5.9	11.2	LS	0
1522	135-168	BTB2	0.1	5.6	24.3	36.8	16.3	83.1	1.5	5.7	6.1	11.2	LS	0
1523	168-200	BTB2	0.1	6.1	22.3	39.1	17.9	85.5	1.0	4.0	5.8	10.5	LS	0

LAB NO	ORGN C %	PH (H2O) 1:1	PH (0.1N KCL)	NH4OAC EXTR BASES CA	MG	NA	K	TOTAL	KCL EXTR AL	NAOAC CEC	ECEC	BASE SAT	ESP	EXTR FE
				MEQ/100G								%		
1518	0.24	4.9	4.9	1.5	0.6	0.1	1.0	3.1	0.1	2.9	3.2		1	1.1
1519	0.58	5.5	5.1	2.0	0.6	0.0	0.8	3.4	0.1	4.4	3.5	78	0	1.6
1520	0.26	5.2	4.7	2.1	0.5	0.1	0.3	2.9	0.0	2.9	2.9		2	0.9
1521	0.12	4.9	4.2	0.9	0.4	0.1	0.1	1.5	0.1	2.0	1.6	72	2	0.6
1522	0.11	4.0	3.5	0.9	0.4	0.0	0.1	1.4	0.2	2.0	1.6	70	1	0.6
1523	0.09	4.1	3.9	0.8	0.5	0.0	0.1	1.5	0.2	1.7	1.6	85	1	0.6

LAB NO	BULK DEN 0.10 BAR	AIR DRY	COLE	WATER CONTENT 0.10 BAR	15 BAR	WRD	CLAY MINERALOGY SM	VR	MI	IN	KK	GI	QZ	FD	CA	SKELETAL MINERALOGY QZ	FD	CA
	---G/CC--		CM/CM	---WT%---		G/CC												
1518	1.79	1.83	0.007	13.3	9.9	0.06												
1519	1.63	1.72	0.018	19.4	12.9	0.10												
1520	1.70	1.77	0.014	17.0	7.1	0.16												
1521	1.56	1.60	0.008	8.7	3.2	0.08												
1522	1.60	1.63	0.006	7.0	3.4	0.05												
1523					2.9													

SM=SMECTITE VR=VERMICULITE MI=MICA IN=INTERSTRATIFIED
KK=KAOLINITE GI=GIBBSITE QZ=QUARTZ FD=FELDSPAR CA=CALCITE
T=TRACE *=0-10% **=10-50% ***=GREATER THAN 50%

SOIL CHARACTERIZATION LABORATORY
SOIL AND CROP SCIENCES DEPT., THE TEXAS AGRICULTURAL EXPERIMENT STATION

SOIL SERIES: TERMITE MOUND
SOIL FAMILY:
LOCATION: ICRICAT SEHELIAN CENTER

PEDON NUMBER: S82TX-004-07

LAB NO	PARTICLE SIZE DISTRIBUTION (CLAY-FREE BASIS)												
	SAND						SILT			RATIOS			
	VCS	C	M	F	VF	TOTAL	C	F	TOTAL	S/SI	FSI/CSI	VFS/FS	CEC/C
	%												
1518	0.0	3.8	19.2	36.4	20.2	79.6	10.3	10.1	20.4	3.9	1.0	0.6	0.10
1519	0.0	3.6	17.0	32.8	18.4	71.7	9.4	18.9	28.3	2.5	2.0	0.6	0.12
1520	0.3	5.2	23.5	38.3	18.7	85.9	5.9	8.2	14.1	6.1	1.4	0.5	0.14
1521	0.1	6.4	26.2	43.5	18.8	95.0	2.6	2.4	5.0	19.0	0.9	0.4	0.18
1522	0.1	6.3	27.4	41.4	18.4	93.6	4.7	1.7	6.4	14.6	0.4	0.4	0.18
1523	0.1	6.8	24.9	43.7	20.0	95.5	3.4	1.1	4.5	21.2	0.3	0.5	0.16

GLOSSARY

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Backslope. The slope component that is the steepest, straight then concave or merely concave middle portion of a erosional slope.

Base Saturation. The degree to which material having cation exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation exchange capacity.

Bedding planes. Fine stratifications, less than 5 millimeters thick, in unconsolidated alluvial, eolian, lacustrine, or marine sediments.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay bridges. The preferential orientation of translocated clay between skeleton grains yielding optical birefrigence.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15.2 to 38.1 centimeters (6 to 15 inches) long.

Coarse-textured soil. Sandy or loamy sand.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—*Loose*—Noncoherent when dry or moist; does not hold together in a mass. *Friable*—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump. *Firm*—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable. *Plastic*—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger. *Sticky*—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material. *Hard*—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger. *Soft*—When dry, breaks into powder or individual grains under very slight pressure. *Cemented*—Hard; little affected by moistening.

Constructional surface. A land surface retaining the form or forms developed by depositional processes.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 25 cm and 100 cm.

Cummulative water retention difference. The amount of water, in cm, that a soil can hold between 0.1 and 15 bars of tension to a depth of two meters or the base of the solum whichever is shallower.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized: *Excessively drained*—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness. *Somewhat excessively drained*—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness. *Well drained*—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly previous layer within or directly below the solum, or periodically receive high rainfall, or both.

Delineation. A portion of the landscape shown by a closed boundary on a soil map that defines the area, shape, and location of one or more soils plus inclusions.

Drainage, surface. Runoff, or surface flow of water, from an area.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as the gravitational creep. *Erosion (geologic).* Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion. *Erosion (accelerated).* Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Footslope. The relatively gently sloping, slightly concave to straight slope component of an erosional slope that is at the base of the backslope component.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Geomorphic surface. A portion of the landscape specifically defined in space and time that has determinable boundaries and is formed by one or more agencies during a given time period.

Geomorphology. The science that studies the evolution of the earth's surface. The systematic examination of landforms and their interpretation as records of geologic history

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is pebble.

Gravelly soil material. Material that is 15 to 35 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.5 centimeters) in diameter.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil forming processes. In identification of soil horizons, an upper case letter represents the major horizons, a lower case letter is used as a suffix to indicate specific characteristics of the major horizons, and Arabic numerals are used to indicate vertical subdivisions. An explanation of the subdivisions is given in the *Soil Survey Manual.* The major horizons of mineral soil are as follows. *A horizon*—Mineral horizons that formed at the surface and (1) are characterized by an accumulation of humified organic matter intimately mixed with the mineral fraction and are not dominated by properties characteristic of E or B horizons, or (2) have properties resulting from cultivation, pasturing, or similar kinds of disturbance. *E horizons*—Mineral horizons in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these, leaving a concentration of sand and silt particles of quartz or other resistant minerals. *B horizons*—Horizons that formed below an A or E horizon and are dominated by obliteration of all or much of the original rock structure and by (1) illuvial concentration of silicate clay, iron, aluminum, humus, carbonates, gypsum, or silica, alone or in combination; (2) evidence of removal of carbonates; (3) concentration of sesquioxides; (4) coatings of sesquioxides that make the horizon conspicuously lower in value, higher in chroma, or redder in hue than overlying and underlying horizons without apparent illuvation of iron; (5) alteration that forms silicate clay or liberates oxides or both and that forms granular, blocky, or prismatic structure if volume changes accompany changes in moisture content; or (6) any combination of those. *C horizons*—Horizons or layers, excluding hard bedrock, that are little affected by pedogenic processes and lack properties of A, E, or B horizons. The lithology of C layers may be either like or unlike that from which the solum presumably formed. A C horizon may have been modified even if there is no evidence of pedogenesis. *R layers*—Hard bedrock.

Hydraulic conductivity. The rate of movement of water within the soil as related to hydraulic gradient.

Inclusion. A soil within a delineation of a map unit that is not identified by the map unit name. Such soils are either too small to be delineated separately without creating excessive map detail, occur too erratically to be considered a component, or are not identified by practical mapping methods.

Laterite. An indurated, pedogenic accumulation of sesquioxides of Fe and Al. It may occur as sheets, blocks, or cemented ironstone gravels. Commonly red in color.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Map unit. A conceptual group of one to many delineations identified by the same name in a soil survey that represent similar landscape areas comprised of the same kind of soil, plus inclusions.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Moderately coarse textured soil. Sandy loam and fine sandy loam.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—few, common, and many; size—fine, medim, and coarse; and contrast—faint, distinct, and prominent. The size measurements are of the diameter along the greatest dimension. Fine indicates less than 5 millimeters; medium, from 5 to 15 millimeters and coarse, more than 15 millimeters.

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Overburden. Material recently deposited by a transportation mode, that occurs immediately superjacent to the surface horizon of a contemporaneous soil.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Ponding. Standing water on soils in closed depressions. The water can be removed only by percolation or evapotranspiration.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0

Rill. A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called groundwater runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Soil. A natural, three-dimension body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 mm in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 1.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—platy (laminated), prismatic (vertical axis of aggregates longer than horizontal), columnar (prisms with rounded tops), blocky (angular or subangular), and granular. Structureless soils are either single grained (each grain by itself, as in dune sand) or massive (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer", or the "Ap horizon."

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse", "fine," or "very fine."

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Water retention difference. The amount of water in g per cm^3 soil, held between 0.1 and 15 bars of tension.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintergration and decomposition of the material.

LITERATURE CITED

Allen, B. L. and D. S. Fanning. 1983. Composition and soil genesis. PP. 141-192. *In* Wilding, L. P., N. E. Smeck, and G. F. Hall (eds.). Pedogenesis and Soil Taxonomy: I. Concepts and Interactions. Elsevier Scientific Publ. Co., Amsterdam.

Batiano, Andre. 1982. ICRISAT Centre Sahelien Annual Report, Section: Soil Chemistry, pp. D1-D31. ICRISAT, Niamey, Niger.

Brasher, B. R., D. P. Franzmeier, V. T. Valassis, and S. E. Davidson. 1966. Use of saran resin to coat natural soil clods for bulk density and water retention measurements. Soil Sci. 101:108.

Daniels, R. D. and L. P. Wilding. 1983. Report of soil/geomorphical relationships in area surrounding ICRISAT Sahelian Center. Dept. of Soil and Crop Sciences, Texas A&M University, College Station.

Gavaud, M. 1966. Etude pedologique du Niger occidentale. ORSTOM, Dakar-Hann, 3 Vol.

Greigert, J. 1966. Descriptions des formations cretacees et tertiares du bassin des Illummeden. Carte geologique "Le Bassin des Illuemmeden." 1:1,000,000 Publ. Dir. Mines et Geol. no. 2 Rep. du Niger

Holmgren, G. S., R. L. Juve, and R. C. Geschwender. 1977. A mechanically controlled variable rate leaching device. Soil Sci. Soc. Am. J. 41:1207-1208.

ICRISAT. undated. Carte de la Vegetation de la Station Experimentale de Tiaguirire. ICRISAT, Niamey, Niger.

Kilmer, V. J. and L. T. Alexander. 1949. Methods of making mechanical analysis of soils. Soil Sci. 68:15-24.

Sanchez, P. A., W. Couto, and S. W. Buol. 1982. The fertility capability soil classification system: interpretation applicability and modification. Goederma. 27:283.

Sivakumar, M. V. K. undated. Climate of Niamey. ICRISAT, Andhra Pradesh, India.

Sivakumar, M. V. K., S. M. Virmani, and S. J. Reddy. undated. Rainfall climatology of West Africa: Niger. ICRISAT Bull. No. 5, Andhra Pradesh, India.

Soil Survey Staff. 1972. Soil survey laboratory methods and procedures for collecting soil samples. SSIR No. 1, SCS, USDA. U.S. Government Printing Office, Washington, D.C.

Soil Survey Staff. 1975. Soil Taxonomy: A basic system for making and interpreting soil surveys. Agric. Handbook no. 436, SCS, USDA. U.S. Government Printing Office, Washington, D.C.

Soil Survey Staff. 1982. Soil Survey Manual. SCS, USDA. U.S. Government Printing Office, Washington, D.C.

Sombroek, W. G. and I. S. Zonneveld. 1971. Ancient Dune Fields and Fluviatile Deposits in the Rima-Sokoto River Basin (N.W. Nigeria). Soil Survey Papers No. 5, Netherlands Soil Survey Institute, Wageningen.

United Nations Program for Development and ICRISAT. Undated. Avant Project pour l' Etablissement au Niger d'un Centree ICRISAT de Recherches pour le Zone Sud-Sahelienne. UNPD and ICRISAT.

Van Wambeke, A. 1982. Calculated Soil Moisture and Temperature Regimes of Africa. Technical Monograph #3, Soil Management Support Services, Ithaca, NY.

Watson, J. P. 1974. Termites in relation to soil formation, ground water, and geochemical prospecting. Soil Fert. 37:111-114.

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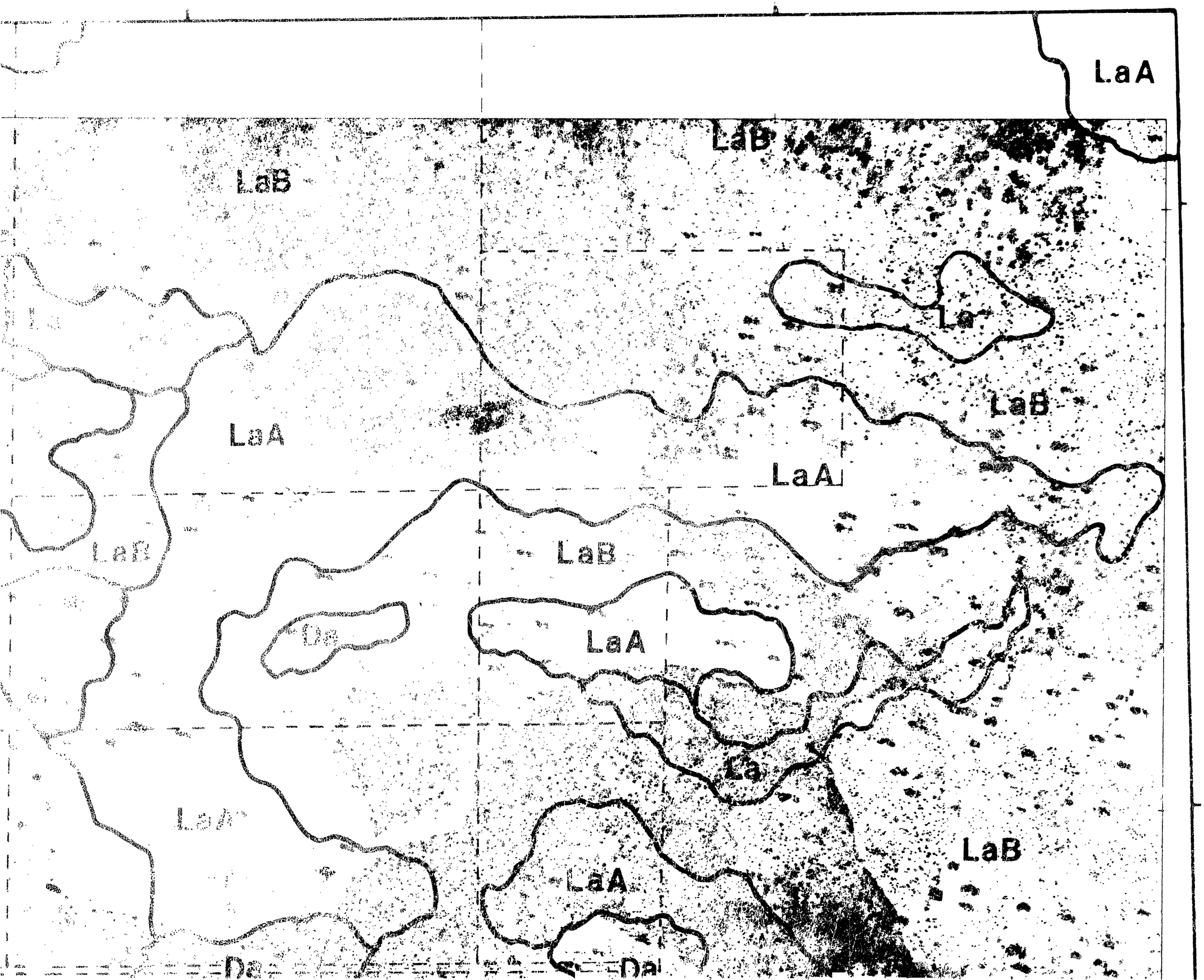
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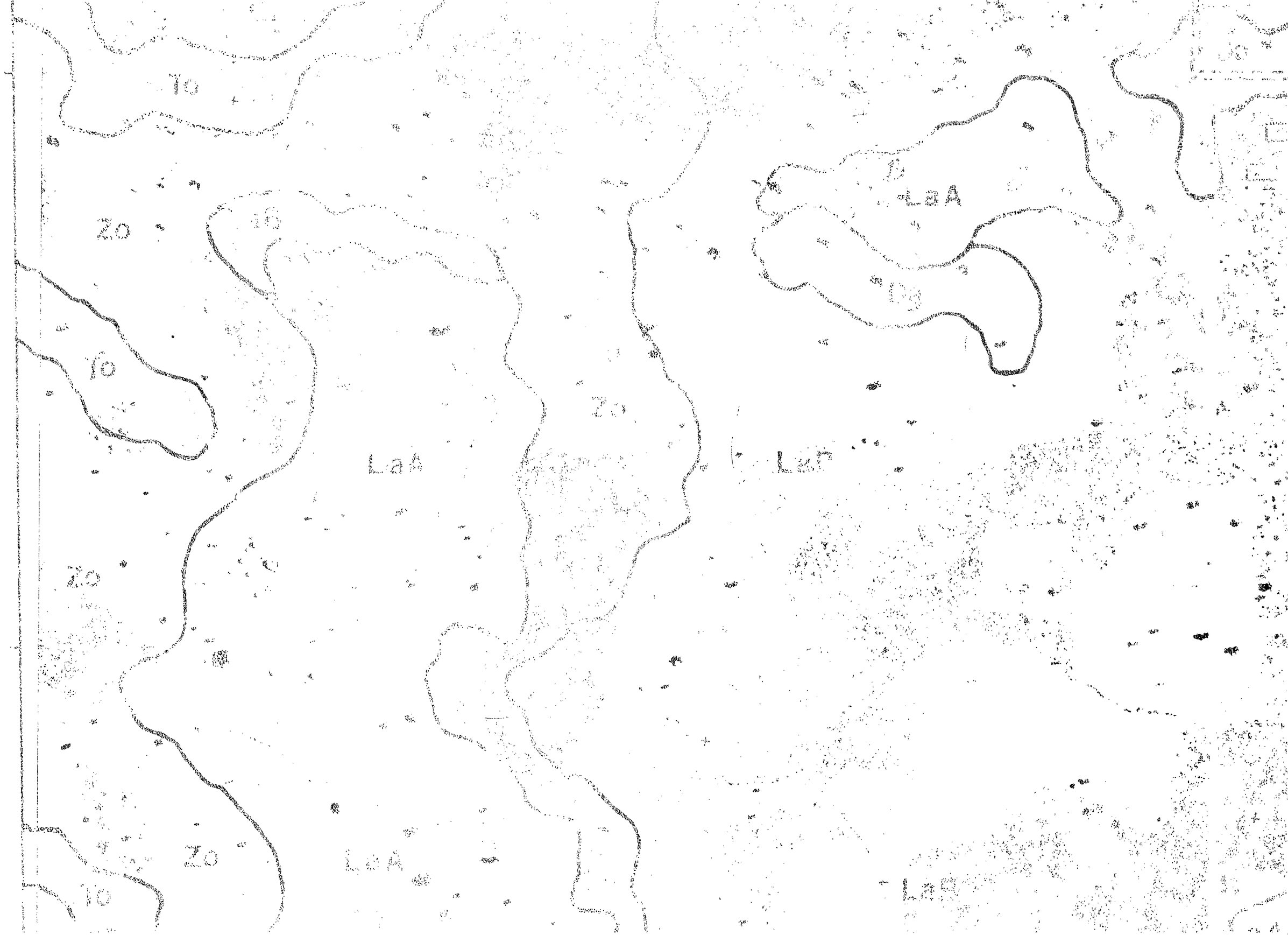

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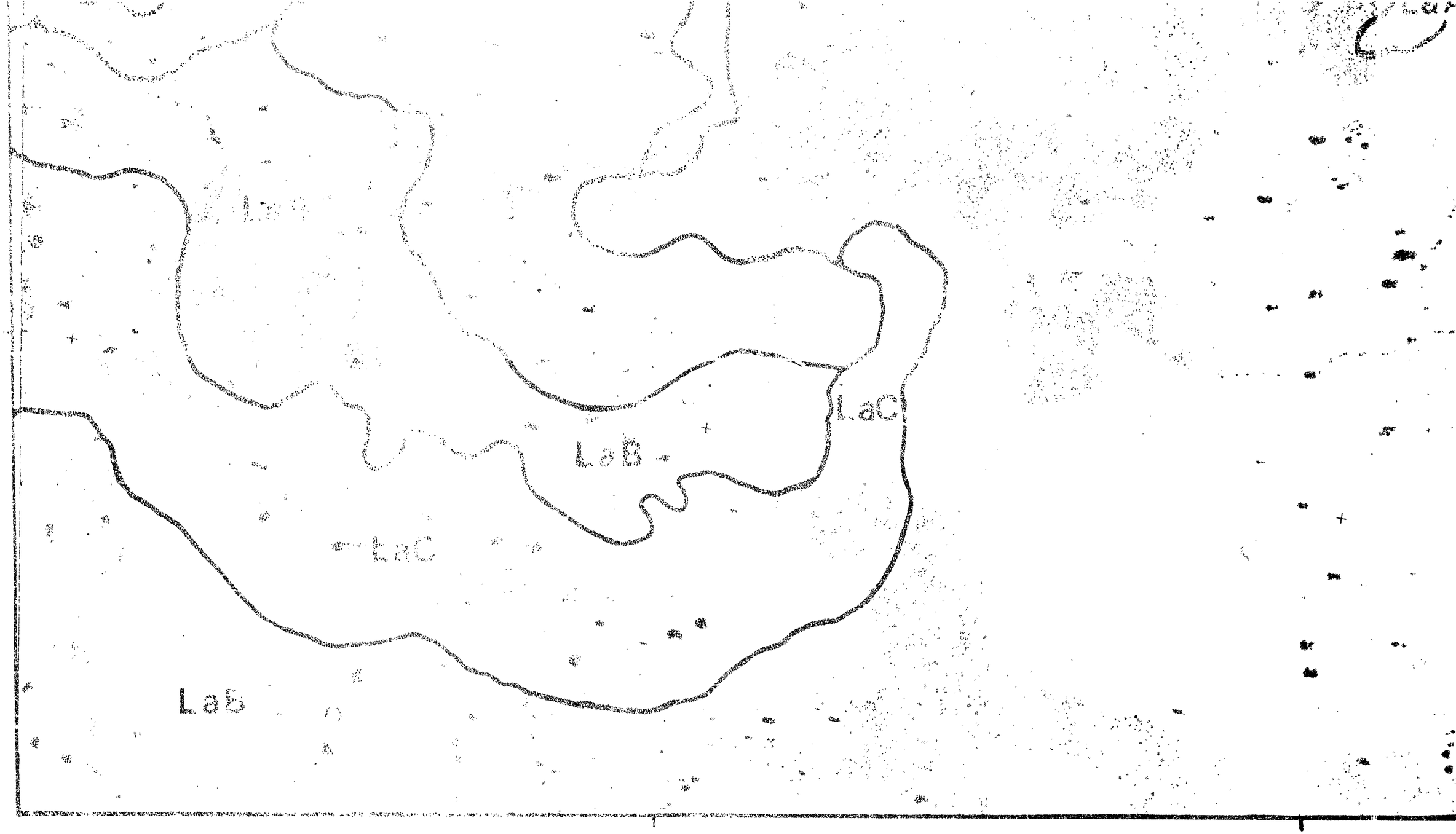

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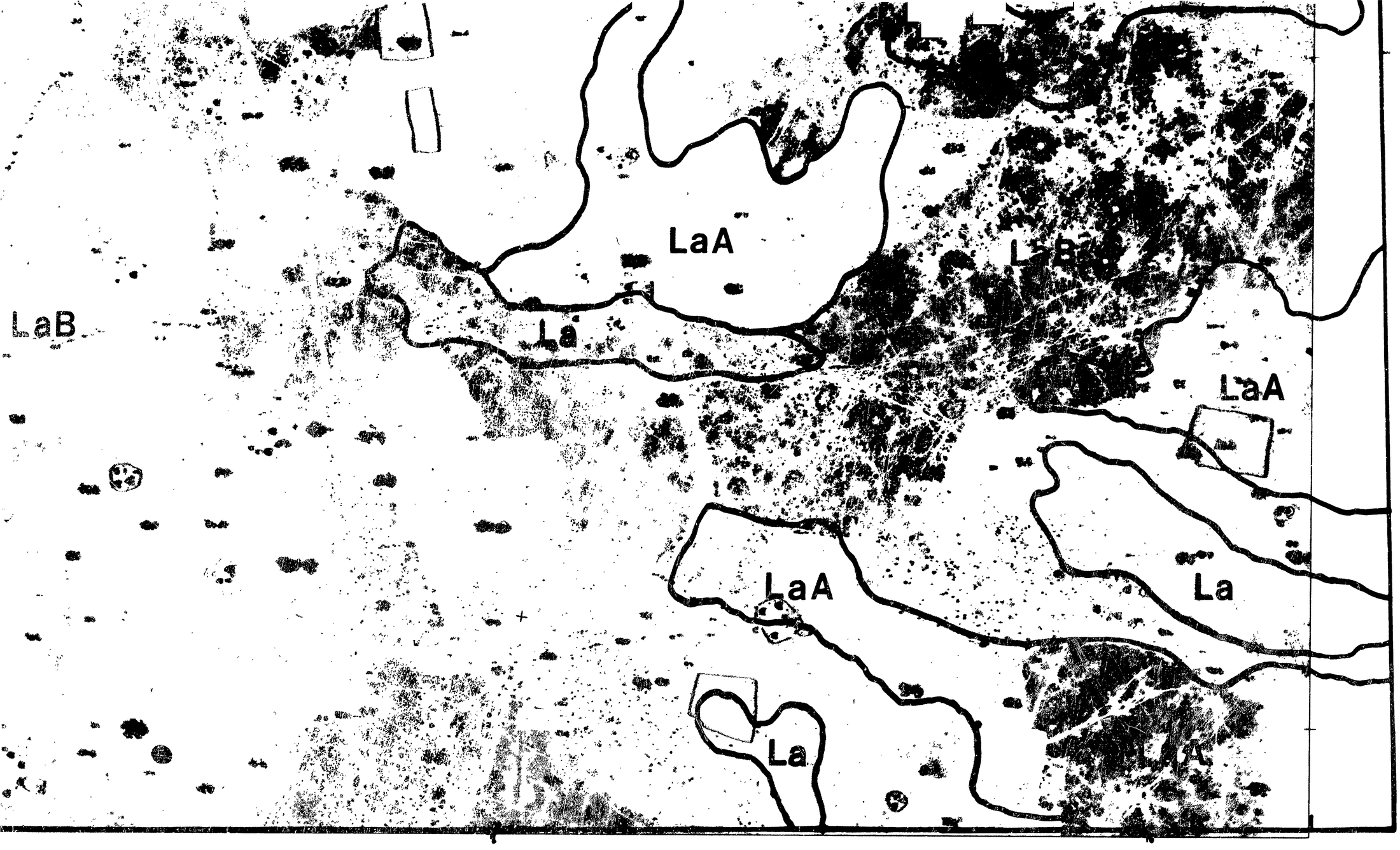

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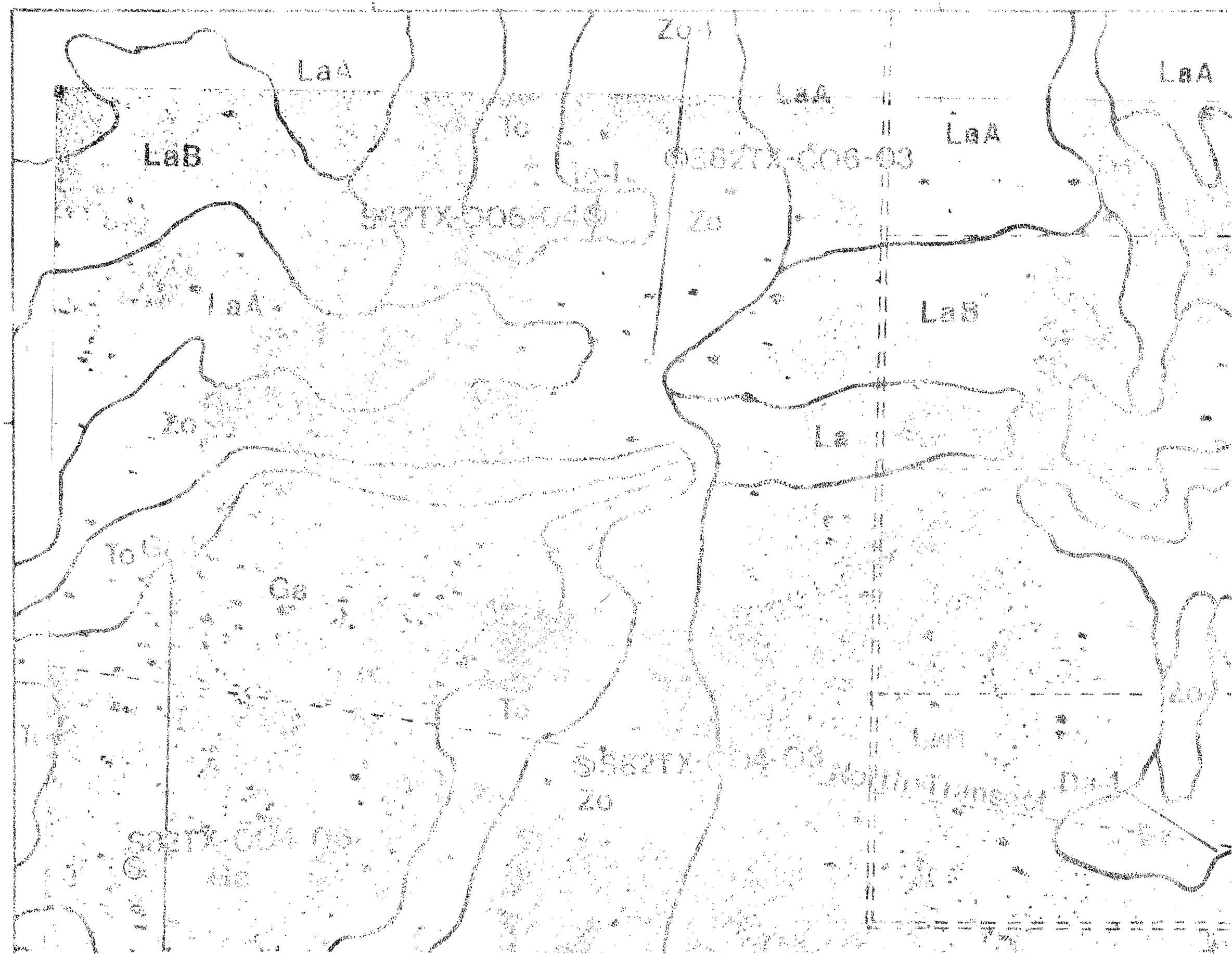

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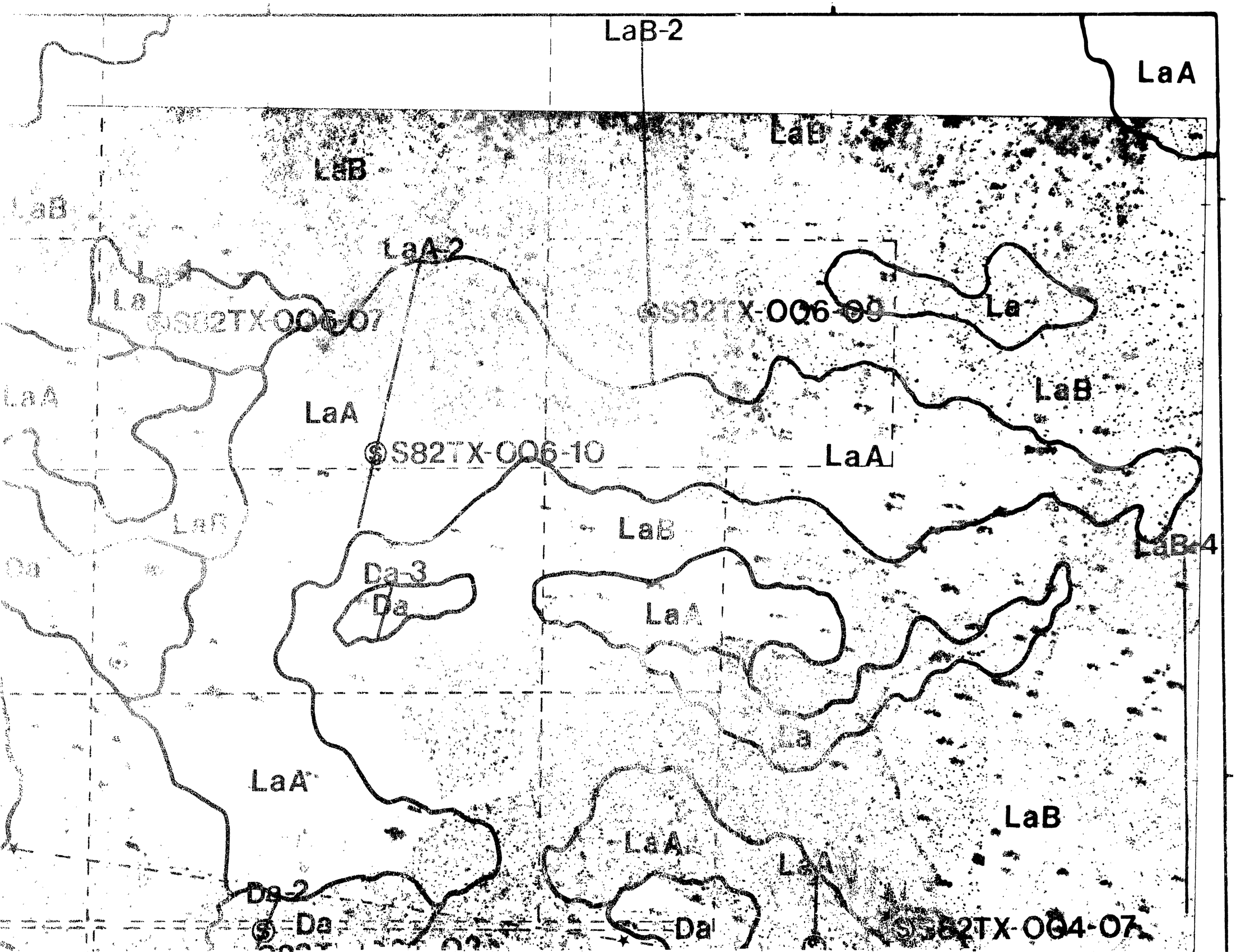
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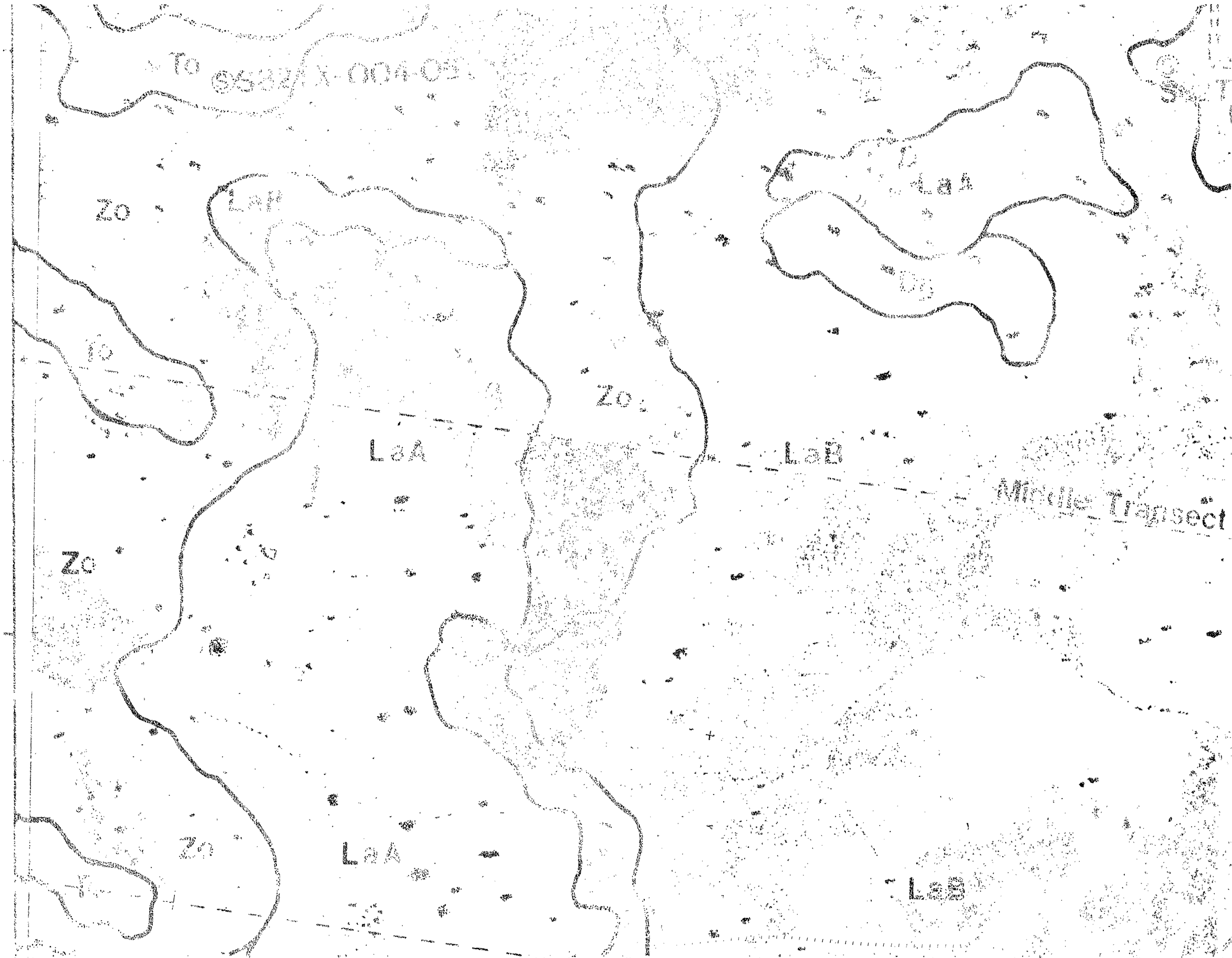
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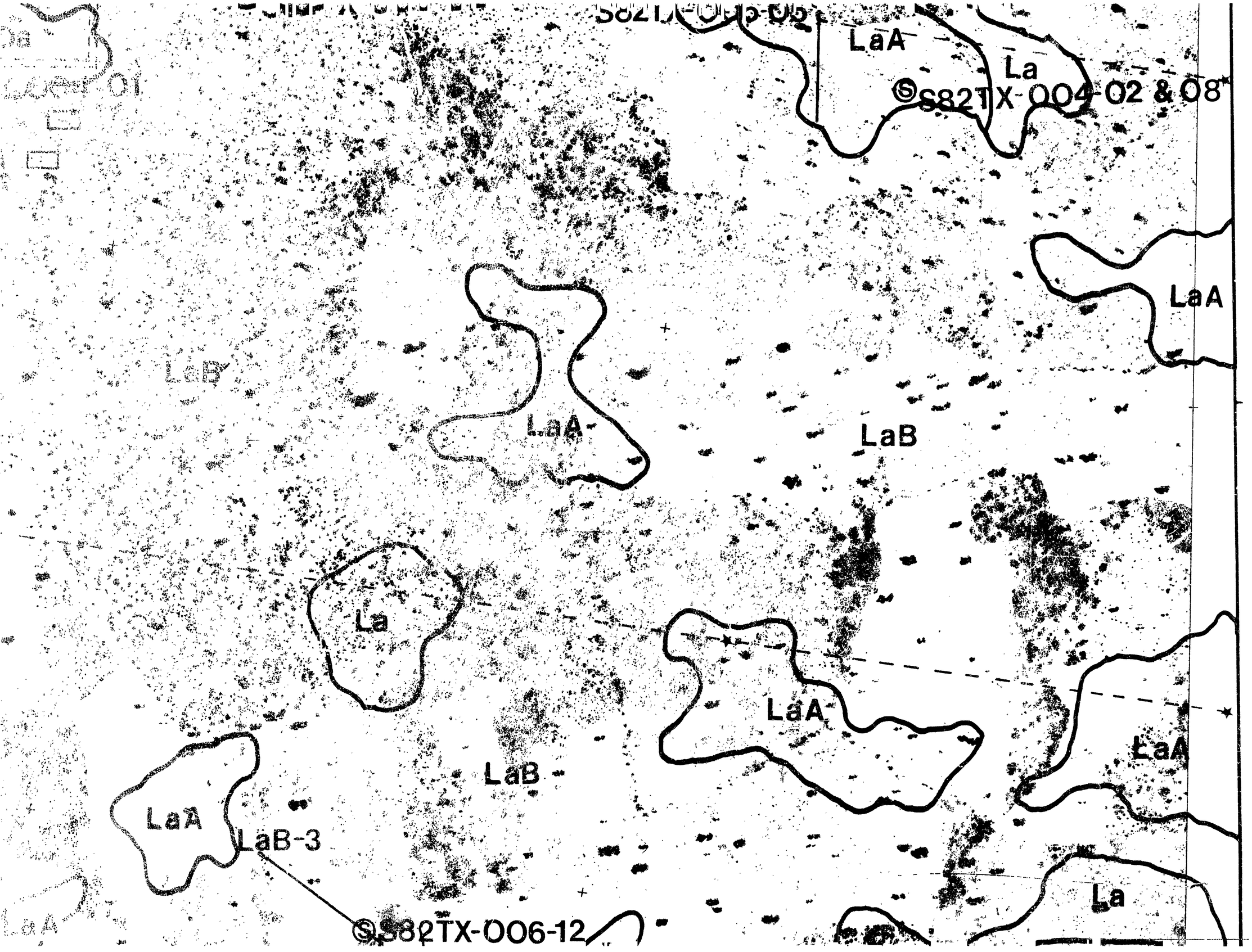
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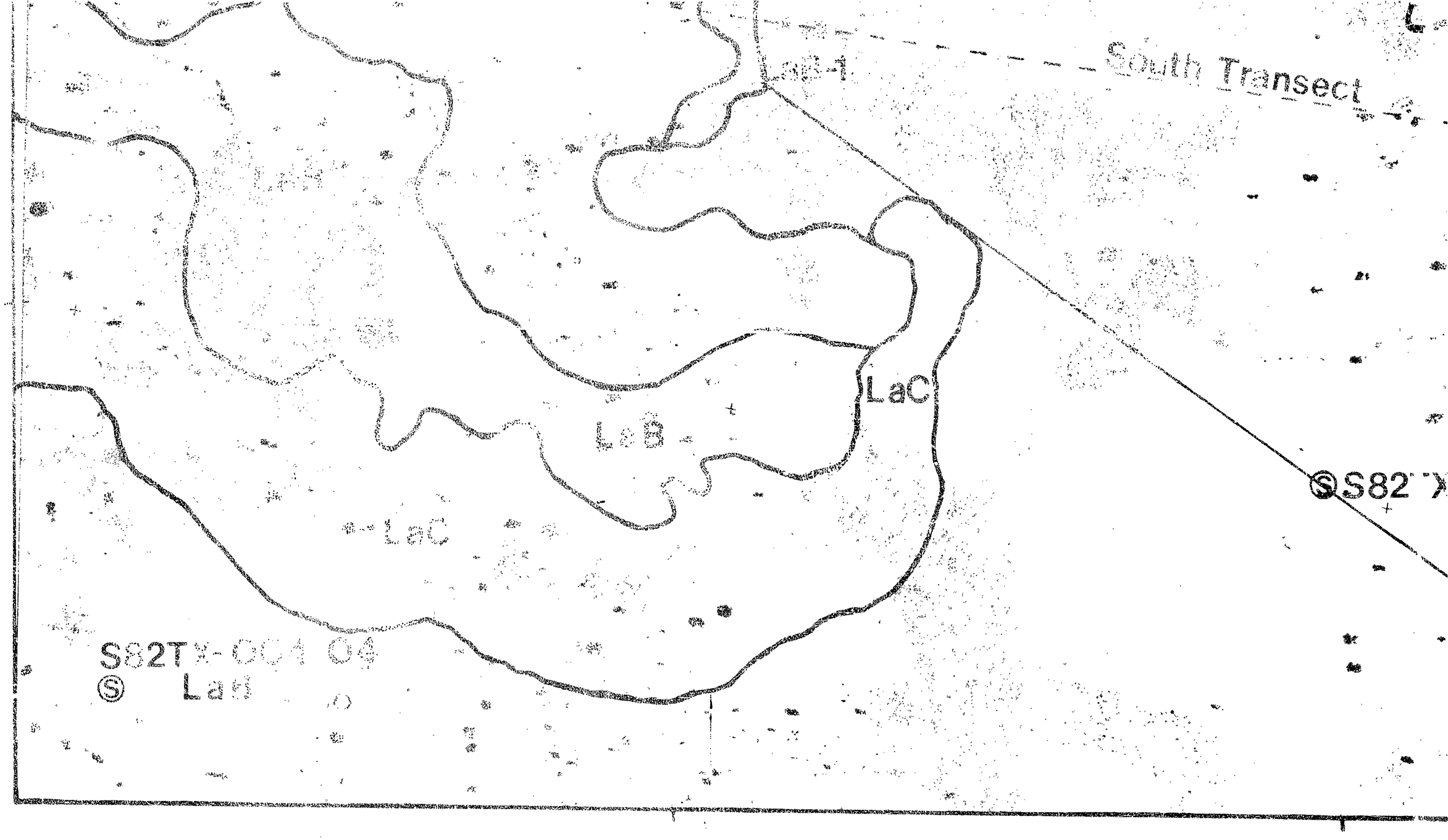

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MISSION PHOTO 1981

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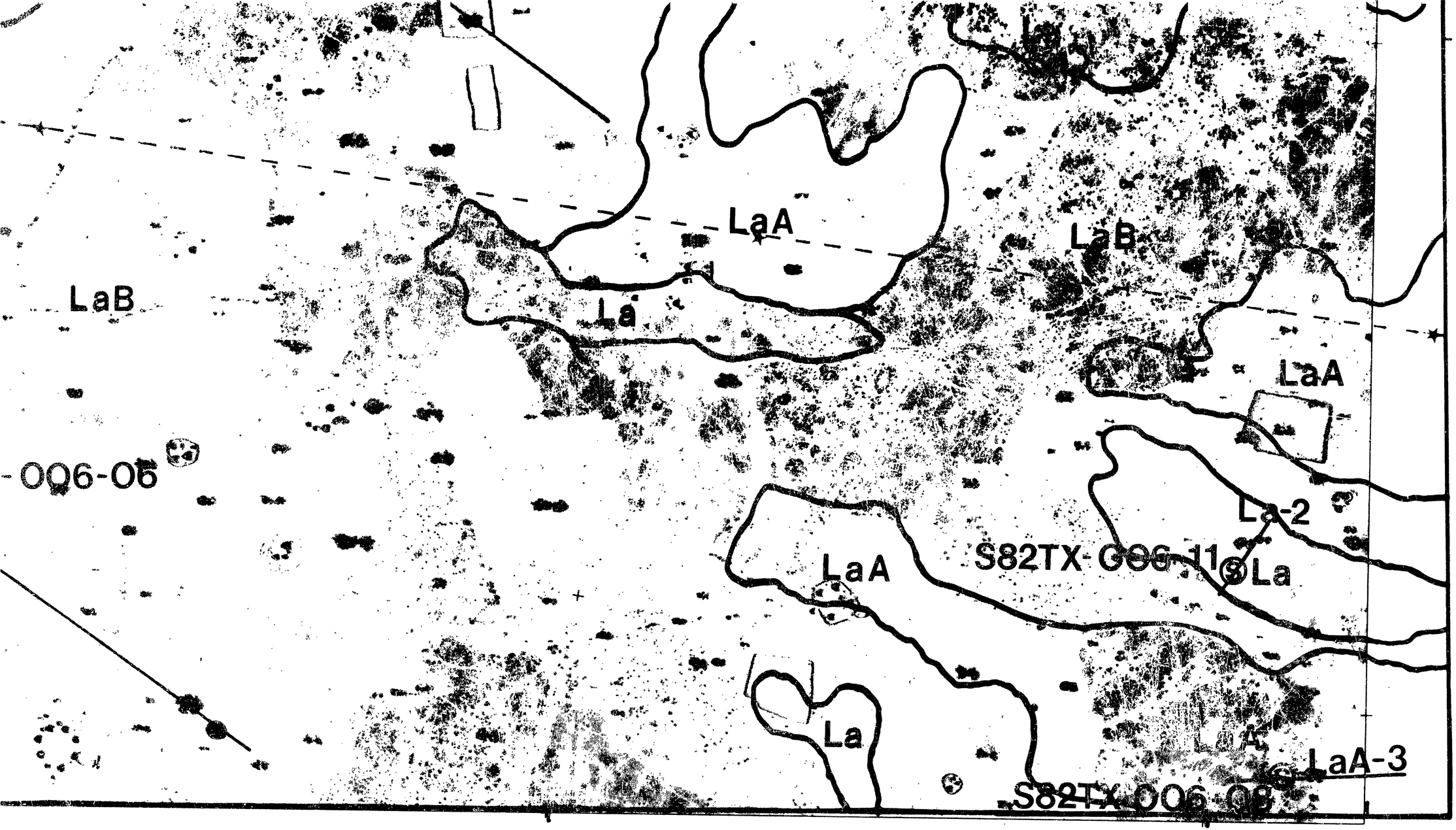

1 : 5000

Sample Site

ELLIPSOIDE DE CLARKE

PROJECTION U.T.M.

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