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The geology

From the coast to the southern border, Surinam can roughly be divided into:

	Demerara formation
Young sediments	Coropina formation
	Zanderij formation

Old cristalline basement

The young (fluvio-marine) sediments stretch from east to west and are deposited on the cristalline basement. In eastern Surinam they have a width of only 35 km ; in western Surinam the width is about 150 km. The Demerara formation includes the latest (Holocene) sea and river deposits.
The Coropina formation is presumably of young Pleistocene, while the Zanderij formation includes the oldest non-consolidated sediments of Miocene age.

The cristalline basement which constitutes the interior of Surinam is part of the large Guianese shield and is considered to be of Pre-cambrain age. The rocks of the old basement are of very complex composition and structure and consist mainly of acidic, metamorphous rocks with igneous instrusions.

The soils

1. *The young sediments*
1.1 *The Demerara formation*

In the Demerara formation two main landscapes can be distinguished :

a. the young sea clay landscape, covering 14,600 sq. km.
b. the ridge lanscape, covering 1,300 sq. km.

The young sea clay landscape has a flat topography and consists of very heavy textured soils (clay 60—70%) with strong swelling and shrinkage capacities.

The clay-mineral association is roughly composed of :
40% kaolonite,
20% montmorillonite,
20% illite and
20% quartz.

The material originates from the Amazon estuary and was transported by the sea current. Under natural conditions the clay landscape is characterized by the occurrence of swamps. The dominating soil colour is gray ; after empoldering brown, yellow and red colours become more pronounced. Oxidation not only involves changes in colours but also changes in chemical, physical and biological properties. Organic material (pegasse) can be destroyed by fire or can be slowly incorporated with the clay.

Other soil forming factors e.g. vegetation, toopgraphy and climate strongly influence soil genesis. The original vegetation is particularly important in case of the salt tolerant *Avicennia* and *Rhizophora* trees. Under certain environmental conditions the first produces iron tubes, which influence the internal drainage favourably. Upon oxidation Rhizophora clays become very acid sulphate (cat) clay soils.

Self-mulching is very active on the more elevated river levee clay soils. This results in the formation of a compact B2t horizon with a very poor internal drainage. Extreme dry periods also stimulate this self-mulching process. Besides reclamation practices e.g. drainage and burning, man also influences the genesis of the clay soil by management. Ploughing and puddling for example have detrimental effects upon heavy soils with initially good physical properties.
The chemical composition of the clay soils can vary tremendously (table 1), but generally the soils are well supplied with elements. Magnesium strongly dominates the clay complex ; the Ca-Mg relation is generally 1 : 2 or 1 :3.
The pH (H_2O) varies from less than 4.0 to more than 7.0 ; this depends on the amount of salts, acidifying forces and the oxidation period. The differences between the physical properties can also vary strongly. Clay soils can have an internal drainage of more than 10 m or less than 8 cm in 24 hours. Contrary to the elevated river levee soils, the more acid clays have generally a good internal drainage.

The ridge landscape consists of long, by the rivers sedimented sand bodies separated by more or less parallel swamps filled with heavier material. They form the higest points in a practically flat landscape. The coarseness of the sand ranges from 53 to 840 mikron. The majority of the ridge soils is strongly influenced by fluctuating groundwater From the top of the ridge to the ridge foot, soil units of hydrosequence occur, each with specific morphological and physical properties. Particularly in the lower parts podzolisation is very active, which results in a decrease in the physical and chemical fertility level. The subsoil of each drainage phase has a higher chemical status than its top-layer. The ridge foot has poor physical conditions, but a relatively high chemical fertility compared to the crest and the flank. The texture is also heavier (sandy loam). Soil water is the dominating soil forming factor in the sandy ridges. Eluviation of finer material increases with moisture and water fluctuations. Generally it can be stated that the chemical level of the sandy ridges is low (table 1), while drainage conditions decrease from ridge crest to ridge foot.

In the Demerara formation shell ridges can occur locally. These ridges have a better chemical level than the sandy ridges and are excessively drained.

1.2 *The Coropina formation*

Two main landscapes are distinguished :

a. the old offshore bar landscape, covering 1,500 sq. km.
b. the old sea clay landscape, covering 2,800 sq. km.

The old offshore bar landscape is mainly constituted by the remains of former offshore bars and is built up of very fine sand (53—105 mu). The remains are dry land dissected by gullies (swamp). The topography is very gently rolling. The soils of the barrier form a hydrosequence; soil characteristics are strongly controlled by the groundwater. Podzolized sands are typical for this landscape. The deepest parts of the gully swamp soils consist of clay with a very strong dominance of kaolonite.

The chemical status of the sandy soils is also very low (table 2), while water forms another limiting factor in the strongly podzolized sands. During a dry-spell they dry out excessively and during a wet period these sands are strongly saturated with water.

The old sea clay landscape is constituted by the remains of a vast plain built up of clay and silt. These nearly level terrains belong partly to dry land, partly to marshland. On the dry lands, soil units of a hydromorphic sequence occur. A characteristic of this landscape is the (often) silty texture of the topsoil. In the swamps, clay soils and peat soils similar to the gully swamp soils of the old offshore bar landscape occur.

The soils are chemically poor and have as a result of the clay mineral (mainly kaolonite), very low adsorbtion capacities (table 2).

1.3 *The Zanderij formation*

The north-south dimensions of this landscape range from 60 to 70 km, in the western part of the country to only 5 to 10 km in the eastern part. The landscape comprises level to undulating plains, which are very vast, especially in the west. Largely it is dry land, but parts of marshlands can occur locally. The material of which this landscape is built up consits of moderately coarse sand (300 to 500 mu) with less than 5% silt and up to 50% clay.

Two main soil associations can be distinguished:

a. the bleached cover soils

b. the non-bleached soils

The bleached cover soils consits of strongly podzolized, coarse, white sand with less than 2% clay and an extremely low chemical status. A hardpan can occur at a depth of 2 to 3 meter.

The drainage of the non-bleached soils is closely related to their texture which can vary from sandy clay to sand. However, generally the drainage is good. In most profiles the amount of clay increases downwards but the clay is relatively inactive and has low adsorbtion capacities. Consequently these soils too must be considered chemically poor (table 3). The dominating soil colour is yellowish brown or brownish yellow.

2. *The old cristalline basement*

The soils of the old cristalline basement are mainly deep weathered products of rocks in situ. Based upon the nature of the rock different landscapes can be distinguished. The topography is hilly. red-brown and yellow, well drained podzols or latosols occur on the summits and the slopes of schist hills. Typical is the occurrence of iron concretions at different depths in the profile. Generally, the texture is coarse sandy loam. The hill soils are well drained but chemically poor (table 4).

The hills are seperated by small valleys with variable soils. Sometimes the texture is sandy, other times more silty in nature. Drainage conditions control soil colour ; this ranges from yellowish brown to grayish white.

Summary

Some general information of soils in Surinam is presented. Geomorphology, soil morphological, chemical and physical properties are disdussed, while the genesis of the different soils is presented extensively.

Reference reading

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Table 2 Chemical data of soils of the Coropina formation

Soil	Depth (cm)	Moisture % air. dr	Ca CO 3%	Org.M.%	N %	mg/100 g dr. Cl	mg/100 g dr. SO 4	pH (H_2O)	pH (KCl)	m.aeq/100 g dr. HZ	m.aeq/100 g dr. S	m.aeq/100 g dr. T	V (%)	mg/100 g dr. K_2O 0.1 N. HCl	mg/100 g dr. P_2O_5 2% ci.ac	mg/100 g dr. (25% HCl) K_2O	mg/100 g dr. (25% HCl) Na_2O	mg/100 g dr. (25% HCl) CaO	mg/100 g dr. (25% HCl) MgO	mg/100 g dr. (25% HCl) P_2O_5
	Very fine sand (well drained)																			
F	0—20	0.8		1.9	0.09	0	5	4.6	3.7	6	2	14		2	1	4	4	7	2	10
	20—35	1.0		1.4	0.06	0	4	4.7	3.7	5	2	12		2	1	4	2	0	0	6
	35—52	0.9		0.8	0.05	0	4	4.8	3.8	4	2	10		2	1	4	5	6	8	5
	52—100	1.6		0.4	0.05	0	5	4.8	3.7	4	2	10		2	1	4	4	7	4	5
	Silty loam (poorly drained)																			
G	0—25	2.8		6.1				6.6	3.8	11	3			6	3	6	42	0	44	16
	25—65	2.3						4.9	4.7	7	1			2	2	5	23	0	25	5
	65—100	1.6						5.9	3.7	6	1			2	2	4	9	0	18	3

Table 3 Chemical data of soils of the Zanderij formation

Soil	Depth (cm)	Moisture % air. dr	Ca CO 3%	Org.M.%	N %	Cl	SO 4	pH (H_2O)	pH (KCl)	HZ	S	T	V (%)	K_2O 0.1 N. HCl	P_2O_5 2% ci.ac	K_2O	Na_2O	CaO	MgO	P_2O_5
	Coarse sandy loam (non bleached)																			
H	0—18	0.7		1.8				4.6	3.9	4				2		3	0	0	10	4
	18—60	0.9		1.7				5.0	4.1	4				2		3	0	0	7	3
	60—127	0.7		1.7				5.1	4.2					1						
	Coarse sand (bleached)																			
I	0—110	0.1		0.6				5.0	3.7											
	110—192	0.1		0.1				5.6	4.9											

Table 4 Chemical data of soils of the Old Basement

Soil	Depth (cm)	Moisture % air. dr	Ca CO 3%	Org.M.%	N %	Cl	SO 4	pH (H_2O)	pH (KCl)	HZ	S	T	V (%)	K_2O 0.1 N. HCl	P_2O_5 2% ci.ac	K_2O	Na_2O	CaO	MgO	P_2O_5
	Hilltop Red-yellow podzol (very well drained)																			
J	0—10	1.7	0	2.2	0.11			4.5	3.8	4	2	9		4	1	5	13	19	7	5
	50—70	0.9	0	0.5	0.02			5.0	4.4	2	2	3		2	2	2	20	13	10	5
	Valley sandy loam (well drained)																			
K	0—10	2.2	0	4.4	0.18			4.3	3.6	7	2	14		7	1	10	20	19	6	7
	20—40	1.8	0	1.0	0.06			4.8	4.1	3	2	8		3	1	7	13	13	3	4

Demerara formation

Soil A : **clay** soil (between 60 and 70% smaller than 2 mu and less than 1% sand); 500 m from the coast; 6 months after empoldering

Soil B and C: plantation clay soils between 60 and 70% smaller than 2 mu and less than 1% sand); 10—25 km from the coast; 2 centuries after empoldering

Soil D : Very fine sand (75—150 mu); grey mottles occur at 20 cm depth; at 40 cm depth: sandy loam

Soil E : Very fine sand (75—105 mu); at 20 cm depth: loam

Coropina formation

Soil F : well drained very fine sand; at 100 cm depth: sandy loam

Soil G : poorly drained silty loam soil

Zanderij formation

Soil H : non-bleached "dek" soil; coarse sandy loam

Soil I : bleached "dek" soil; coarse sand

Old basement

Soil J : very well drained red-yellow podzol on top of a hill

Soil K : well drained coarse sandy loam in valley

Laboratory methods

Organic matter determination		: method of Kurmies
N	„	: Kjeldahl
Cl	„	: titration method of Mohr or Volhardt
SO_4	„	: treatment with Ba Cl_2
pH	„	: glass electrode pH meter
HZ (hydrolitic acidity)	„	: treatment with salts of weak acids
S-value (exchangeable bases)	„	: shaking with O.I N HCI
T-value (exchange capacity)	„	: treatment with Ca Co_3
V	„	: $\frac{100\,S}{T} = V\,\%$

K_2O (O.I N HCI) : K_2O, Na_2O, CaO, (25% HCI) determination : Kipp flame photometer

P_2O_5 determination : in 25% HCI soil extracts and in 2% citric acid extracts (Lorenz)

MgO determination : colorimetric (titan yellow)