Chapter 17
"Rock – Stone" and "Soil – Earth": Indigenous Views of Soil Formation and Soil Fertility in the West Indies

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17.1 Introduction

Scientific investigations are conducted without blinders on. While the goals of our investigations tend to lead us from point A to point B in targeted data collection, sometimes information that is tangential, yet undeniably fascinating, falls into our laps. Such was the case for us during the course of botanical, agronomic and pedological investigations conducted in the West Indies during 1981-1986. This paper is based on information collected during informal interviews with local, family farmers from the islands of Martinique and Saint Lucia.

Two sorts of farming system coexist all over the Lesser Antilles (see Peeters 1976):

- large (private or public) plantations represented by intensive monocultures (sugarcane, bananas, pineapple, coconut or fruit orchards), close to the food processing industry, and characterized by agricultural practices defined by scientific knowledge;
- small family farms, "the Creole garden", where subsistence and cash crops are closely interlinked. The level of chemical inputs is still low despite efforts aimed at introducing modern technology. Farm management practices focus on rotation with traditional (bush) fallow crops, and recycling of organic residues (burying of fallow vegetation, use of crop residues and manures). The rationalization for crop rotations as well as other agricultural practices is based on a traditional view, but also integrating some technical elements, such as mineral fertilization provided by rural extension services.

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The small farmers working on the hilly terrains caught our interest. The most interesting interview was with a farmer designated "X", living in the region of Saint-Marie, in the northeastern part of Martinique. This interview was used in the present work as a comparative reference, particularly with regard to interview data gathered during a meeting with a group of six farmers (called the SL group) from Choiseul on Saint Lucia Island. Our discussions focused on the origin of soils and rocks, and what emerged was a remarkable contrasting view from these tillers of the soil as compared to the general scientific view of the rock weathering cycle.

17.2 Relationships between soils and rocks

17.2.1 The Scientific View of Soil Formation

The collision of the Caribbean and Atlantic tectonic plates contributed to the emergence of the West Indies arc, with its string of volcanic islands such as Martinique and Saint Lucia (Westercamp and Tazieff 1980). These islands are mainly made-up of volcanic rocks ranging from dacite to basalt, and appearing as different lava flows or aerial fallouts. Volcanic activity continues to recent times, and the 1902 and 1929 Mountain Pelée eruptions, with emission of ash and pumice, are still relevant events in minds of Martinique inhabitants.

Through alteration, these volcanic rocks give rise to soils whose characteristics (Fig. 17.1) depend largely on the age of the deposits and the amount of rainfall (Cabidoche et al. 2004; Feller et al. 2006). Following the terrain along a path of increasing rainfall, one can distinguish:

- soils that are more and more clayey when increasing age (older than 10,000 years), with a dominance of kaolinitic clays under high rainfall (Ferrallitic soils and tropical Brown-red soils with red, grey, yellow and multicoloured horizons) and with dominance of smectitic (swelling) clays in lower rainfall regions (Vertisols with black horizons);
- on very recent deposits of ash and pumice (between 50 and 10,000 years) and under high rainfall, sandy-silty and sandy-clayey soils (young Andosols) with a dominance of allophanic minerals (amorphous, non crystallized clay) develop.

The regions, with an average rainfall above 2.5 metre, of "X" and of the SL group show similarities in soil distribution due to the existence of a stacking of young materials (pumice or tuff) on old weathered one (dacite or andesite lava): Ferrallitic paleosols or paleo-weathered horizons are often covered by younger soils, such as Andosol or Brown soils.Variations can be observed at the scale of the farm (Fig. 17.2). Colluvial or alluvial soils occupy only very small parts of these areas.

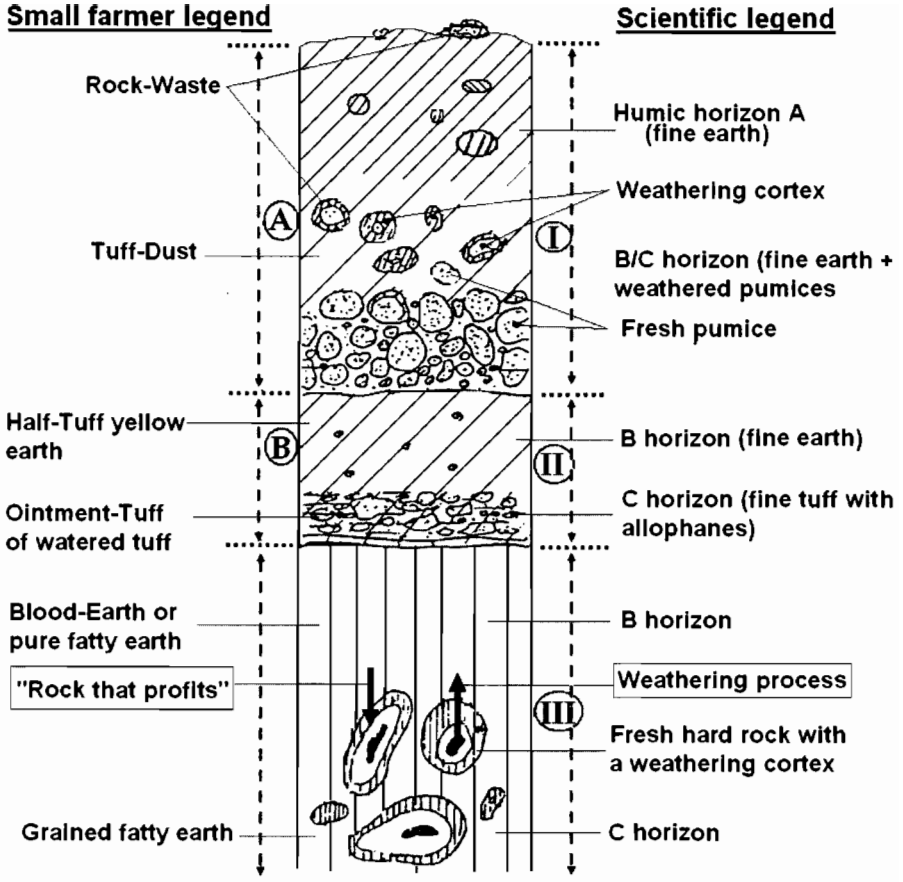

Fig. 17.1 Example of horizon profile likely to be found in Northern Martinique or Choiseul region of Saint Lucia with farmer nomenclature on the left and scientific legend on the right. Note the succession of present soil (A and I) and paleosols (B, II and III)

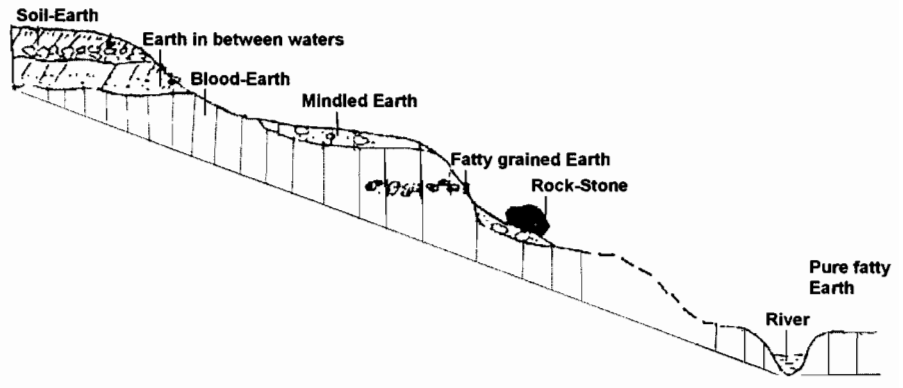

Fig. 17.2 Schematic soil distribution in the farm of X. Note in particular that the "pure fatty earth" (ferrallitic weathered B horizon) close or not to a river and devoid of rocks (because completely weathered) is said to be a "substance-free soil", inappropriate for the growth of "rocks-stones"

17.2.2 The Local Farmer's View of Soil Formation

Below is a synthesis of the view of soil formation uncovered by our interviews. Words or terms in quotation marks are from the interviewed people and translated from Creole (given in bold); the French equivalent term is given in parentheses and quotation marks.

In the beginning, God created the Sky, the Earth (planet), seas, rivers, mountains, rocks and "earth" (soil materials in the pedologic sense), humans, animals, and plants. X and the SL group agree that the "earth" has always existed, but their views diverge concerning soil-rocks relationship. Some (X and the SL1 subgroup) developed a theory attributing the formation and growth of rocks from "earth" (**woch ka profité, laté ka nouri wôchla**), while others (SL2 subgroup) rejected this theory. None of them related the presence of rocks to volcanic phenomena, and none subscribed to the scientific view of soil formation, that is "earth" from rocks (alteration and pedogenesis).

The concept of the "benefiting rock" (noted below) seems to be well anchored in the West Indian farmers' perception of soil and rock, though some of them reject it. The same Creole term is used both in Martinique and Saint-Lucia, suggesting its appearance many years ago. We focus below on the statements of X whose father was a "quimboiseur" (local French word for a traditional medicine-man; a kind of shaman) and whose views demonstrated a synthesis of field observations and traditional knowledge.

17.2.2.1 Views of X

The "earth" which has always existed (established soil), and which was neither recovered nor mixed with recent inputs, is the "soil-earth." Additionally, "earth" can also be brought by rivers or landslides. Different deposits are then observed: "earth in between waters" or a mixture of materials ("many-coloured earth"). Although rocks can be deposited by rivers, they generally can "grow in/from the earth and benefit of it". This assumption is confirmed by:

- the nature of some rocks—the "waste-rocks"—whose external covering (the altered layer according to scientific view) is formed by moist soft materials having an earth aspect but already acquiring the structure of rocks (Fig. 1). In some cases, the origin of the "waste-rocks" would be the **filibo-la-rivière** (filibo of the river). The filibo-la-rivière is described as "an earth rolled by rivers and transformed into pebbles". In fact, it is a fragment of highly weathered rocks (the example of a filibo waste-rock shown to us was a totally altered, brown andesite fragment). The Creole term "filibo" (or "pilibo") when used alone refers to a multicolored, pyramid-shaped candy. It is a specific traditional candy from Martinique that does not exist in other Caribbean islands. The small pebble **filibo-la-rivière** looks like a filibo candy;
- the fact that some "earths," though they are set close to a river, do not contain any rock (all "earths" are not capable of rock growth), and conversely, other "earths" distant from the river contain hard and large rocks, the "stone-rocks" (Fig. 2);

Many factors regulate the growth of rocks:

- "earths" contain some "substance" that is needed for rock formation. This substance is found in the water of the earth and moves from earth towards the rock's heart (Fig. 1). A rock grows at its periphery, the outer cortex being always moister than its heart and still looking like "earth" (rock in formation). Thus all "earths" do not have the same capacity for rock growth;
- "earth" or "earth substance" works all the better when the moon rises or a river is nearer; like some plants, "earth and rocks swell as the moon rises". Although opinions differ between X, SL1 and SL2 groups about the "swelling of rocks", a unanimous agreement is however reached about the "swelling of earth". A small farmer from Saint Lucia describes the following observation: the amount of earth extracted from a hole would not be enough to refill it when the moon withdraws, but would spill over when the moon rises;
- "all pebbles don't change to rocks". Pebbles must first reach a certain "maturity." An example of a well-matured pebble is the "waste-rock" [slightly altered dacite or andesite gravel (Fig. 1) which could develop into "stone-rock" (hard large rock, like a non-altered andesite). Consequently, the bigger the "stone-rock", the older it is. Some strongly altered, blackish gravels will never form rocks. Moderately altered "tuff" (coarse pumice stone) fragments (these are "soft rocks") will only form "small tuff gravels" instead of "stone-rocks". Finally, "male rocks" (hard rock, see below) seem also to be incapable of growing;
- rocks can be "wounded" (broken). This term "wounded rock" was also used by the SL2 subgroup. These rocks lose their "vitamin", "their substance" through the wound. Consequently, they give back "earth". Only the healthy part of them will be able to grow;
- wet seasons facilitate the growth of rocks, unlike dry seasons. Indeed during the dry season, the typical pattern can reverse, and the transformation of a rock into "earth" can occur (X described this process on a slightly altered pumice with a dusty, crumbly outer rind).

In summary "rock grows from earth", but growth capability depends on the kind of earth, gravel or rock, on the climate, on the moon position, and on the history of the rock (a wound, for example). Thus, growth regulation is possible. "Pebbles are like seeds" and have a life history: birth, life and death. The "substance" (sometimes called "the rock genius") is the active principle and comes from the "earth." Each "earth" has its own "substance" but can also lack it. What is then this "substance"?

This substance seems to be the growing factor for everything related to the "earth" such as rocks and plants as well. Effectively, the more "creamed" (containing some humus and/or fertilizer) is an "earth", the more "substance" it has to nourish plants: the "cream feeds plants" (**la krem ka nouri plant**) [this fundamental notion of "cream" is very common in the Lesser Antilles]. It is still difficult for us to understand the relationship between "cream" and "substance", but probably it must be strong, since X described interactions between plants and rocks. Thus, bad plant growth is attributable, in some cases, to a competition between plants and rocks (to the advantage of the latter) in the use of the "earth substance".

This justifies why gravels should be removed from arable land, and why uncultivated fields will be soon loaded with rocks. In other cases, a "wounded" rock can throw out in the "earth" some "substances" that can be either toxic for plants, or can inhibit the effects of fertilizers or manure.

Each "earth" has its own properties, its own "powers" towards rocks, plants, animals or humans. "Each country has its own earth". The earth "emits vapours", especially at night; at dawn, there is dew, evidence that "the earth sweats". These vapours may poison some plants (essentially "foreign plants"); hence, the non-adaptation of some exotic plants. Those vapours may also be harmful to humans. "Earth should not be worked before 7 or 8 in the morning, for it is bad for the lungs" unless "some rum or absinth liquor has been drunk in the morning" to act as an antidote. "A cemetery earth" poisons any other "earth".

Some "earths" or gravels are used as a component of some medicine, or required for a given "work" done by the "quimboiseur" (shaman). X refused to speak about this last subject "avoiding evil to come to us"; nevertheless, he quoted some traditional pharmacopoeias as examples:

- the **filibo-la-rivière** (a weathered stone, see explanation above 17.2.2.1.) "crushed and mixed with vinegar and bicarbonate taken at 2- and 8-day intervals when the moon withdraws, followed with a purge, is a good medicine against cancer;
- "violent pleurisies" can be cured with "firm earth" preparation;
- a powder made of "female tuff" can fight against acne.

17.2.2.2 Nomenclature of Rocks and Earths

Statements of X are richer than those of the SL group; nevertheless no major contradiction has been noticed between them. Terms only used by X will be emphasized below.

The classifications of "rocks" and "earths" as presented hereafter come from us.

Different kind of rocks

a) The "male" and "female" rocks

X and the SL group agree that in nature, everything is either male or female—rocks, plants, animals, and humans. While the SL group can not distinguish between these two kind of rocks, X stated that "male" rocks are very hard and can be scarcely broken, such as "apricot-rocks", "stone-rocks", and some "tuffs", while "female" rocks can easily be broken; they are either a weakened hard rock due to their flat shape ("porcelain-rocks"), or soft rocks known as "female tuffs" [With some humour, one member of the SL group seems convinced of this sex difference between rocks, as it is not rare (he says) to observe rocks atop one another... No comment!].

b) Rock classification according to their hardness, structure, or alteration level

"Apricot-rock": small to medium-sized hard rock (dacite and andesite);

- "Iron-rock": very hard rock;
- "Stone-rock": hard rock. "They smell of sulphur when rubbed against each other". They can reach a large size;
- "Waste-rock": hard and slightly altered rock;
- "Tuff": coarse pumice stone;
- "Grained rock": slightly altered tuff with coarse grains;
- "Ointment-tuff": fine textured tuff, often with allophane;
- "Female tuff": fine and altered tuff spreading "dust in sunlight". It gives back to "earth";
- "Ordinary sand": fragments of sandy pumice stone;
- "Cement sand" or "sand-earth" or "hollow earth": volcanic-ash derived sand, rich in magnetite, and currently used in earthquake-resistant building materials;
- Finally, for a particular case, the filibo-la-rivière which is "an earth rolled by rivers and transformed into pebbles" (see section 17.2.2.1.).

Different kind of earths

Many criteria are considered when characterizing earths:

a) Coarse element content

- "Dust for tuff": a soil with allophane (showing little development), rich in pumice fragments, developed on slightly altered pumice stone;
- "Half-tuff yellow earth": a soil with allophane in which the proportion of fine elements increases;
- " Mixed-earth" or "mingled-earth" (**tè mélé**): a mixture of fine and coarse elements;
- "Grained fatty earth": Clayey ferrallitic (rich in iron oxides) horizon (B or C) commonly red or multi-coloured, still containing highly altered clayey lithorelics (rock debris with important mineralogical transformations);
- "Fatty-earth", "firm earth", "blood earth", "Carafe-earth": clay materials, commonly red and without particles larger than 2 mm.

b) Fine element content and degree of moisture

According to all the farmers interviewed, "earths" are distinguished as:

- "light earths" (**tè légé**), "firm earths" (**tè fim**), "half-fatty earths", "fatty earths", and "heavy earths" according to sand or clay content;
- "Cold earths", "warm earths", or "hot earths" according to moisture, colour and period of sunshine. "Cold earths" correspond to the wettest Andosols (with allophane), characterized by a yellow colour; "hot earths" correspond to halloysite-rich soils (Nitisols) or smectitic soils (Vertisols), characterized by a dark reddish or black colour respectively.

Some other typical West Indies terms can also be used:

- "the mangrove tree earth" ("terres mangle-coulisse"): an unconsolidated clay mud located near edges of rivers and ponds. "Mangrove tree earths" ("terres-mangles") or "mango tree earths" ("terres-mangues") (**tè mang**). It is difficult for us to distinguish between those two terms although the Creole term refers to wet, peaty, muddy soils found in the mangrove zones (with mangrove trees such as *Rhizophora mangle*). In old books (Anonyme ATB 1841; Descourtilz 1835, vol. 1, plate 10, p. 45) mangrove trees are also called "mangliers" (in French). Descourtilz (1835, vol. 6, p. 72) indicated also that the Indian mangrove trees *Rhizophora* or *Bruguiera* can also be called *Mangium celsum* and **Mangé-mangi**. To conclude, let us say that the Creole pronunciation would be "terres-mangue" in Martinique and "terres-mangle" in Saint Lucia;
- "dried mangrove tree earth": when cultivated;
- "Yellow ointment earths": soil with hydrated allophane with thixotropic effect (soapy touch; sliding of material when pressed between fingers). This diagnostic field test used by X is the same as that used by professional soil surveyors. These "earths" are generally localized above a "watered-tuff" (a sedimentary volcanic layer below the water table).

c) Stackings of clay horizons or material mixtures

These are "earths in between waters" or "many-coloured earths" (see section 17.2.2.1).

d) The richness of "earth"

The richness of an "earth" depends on the "substance" or the "cream". "Creamed earths" are good soils and "have much power". "Earths" can be "creamed" with organic inputs, manures, animal dungs, etc. X also described a "double fatty earth"—a clayey earth not having abundant organic matter but not requiring the use of fertilizers.

In summary, the quality of observation and the language accuracy, often picturesque, from the farmer's statements are noteworthy. Rocks are distinguished according to their hardness, ("iron rock", "apricot-rock", "stone-rock"), structure ("grained" or not), level of transformation ("waste-rock", "mature rock", "stone-rock"), water-holding capacity ("tuff", "ointment tuff", "watered-tuff"). "Earths" are also classified according to their colour, coarse-element content, texture, humus content and fertility.

17.3 Discussion and Conclusions

Differences in the respective views of X, and the SL1- and SL2-subgroups have been specified above; henceforth, the farmers' views discussed will refer mainly to X and the SL1 group.

The farmers' discourse is clearly based on the assumption of the *nourishing Earth*, but in a more extended meaning than its usual consideration, since "earth" provides a source of life, not only for plants (hence for animals and humans), but also for rocks.

Would "earth" then, in that view, be the fundamental matter of reproduction and renewal? It would be very interesting to see if parallels can effectively be drawn up between soil fertility and human fertility across a variety of traditional cultures.

This assumption of parallelism would seem to explain:

- *the genesis of rocks*: its birth with "rolled earth" (as in the case of filibo-la-rivière), growth into "waste-rocks" and "mature rocks", and death with "wounded rocks" and "old rocks" to give back "earth". "Earth" is therefore the owner of the growth factor, since "waste-rock" or "mature-rock" show on their surface a rind which "is not anymore an earth, but not yet a rock". This factor is the "substance" sometimes called "the genius of the rock". Devoid of this "substance", an "earth" contains few or no rocks.

- *plant growth:* essential role of the "substance" and including:
  - Competitive phenomena between rocks and plants based on either the use of the nutrient factor ("the substance"), or toxicity and inhibition;
  - Mechanisms of regulation, particularly by the Moon or the Sun. There is a generalized integration of the Earth's physical milieu with the cosmos. "Swelling" of "earths", rocks, or plants is a moon-regulated process. The Moon is probably the uppermost factor of regulation. The role of the Sun is less clear; it can however change rocks into "earth".

Hence, one can understand through the farmers' discourse, that the local volcanoes, despite recent eruptions, are not perceived as the source of "rock" or "earth". The farmers' statements concerning the earth–plant relationship bring to mind a general agronomic theory of the late 18th century (Thaer 1811)—the Humus theory—giving a major importance to soil organic matter in plant nutrition (Feller et al. 2003).

Beyond local traditional construction, the farmers' perceptions of earth-rock relationships and rock genesis from soil may also come from scientific discourses conveyed by colonizers two or three centuries ago. J. Barrau from the French National Museum of Natural History told us (pers. comm.) that a scientific theory very close to that of farmers was common in the 18th century concerning mines that were "left for rest" so that they will "build up again". Up to the end of the 18th century, scientific discourses are not really clear about the formation and origin of rocks and earth. For instance, at the end of 16th century, Bernard Palissy, one of the founders of modern geology and of the mineral theory of plant nutrition (Feller 2007) clearly attributed the formation of rocks from earth through some special water—the "generative water (Palissy 1880 edition, pp. 357, 405-406, 420). One can find some Palissy-like ideas in the discourse of X: stone formation is easier along the river (pp. 359, 360). One century later, in the book "Nouvelle Maison Rustique" (Liger 1721, p. 483), it is written that "tuff is a dry earth that begins to petrify". This idea was largely accepted up to the end of the 18th century. Where modern soil scientists would see alteration, scientists from the 18th century (in line with the present-day view of X) saw the first steps of rock formation.

In conclusion, let us compare the scientific view [based on pedogenesis (from rock to soil)] with the farmers' view [based on lithogenesis (from "earth" to rock)]:

Scientific view (pedogenesis)	Local farmer's view (lithogenesis)
Rock existed first.	"Earth" existed first.
Rock gives birth to soil.	"Earth" gives birth to rock.
Rock is older than soil.	"Earth" is older than rock.
Soil development depends on time:	Rock development depends on time:
- young, thin soils: little developed	- small pebbles: young
- old and thick soils: highly developed	- large rocks: old
There is alteration.	There is aggregation.
Water is the main alteration factor.	Water is the main growth factor.
Competition (for plant nutrition) exists between soil and plant—*e.g.*, in fertilizer use: immobilization in soil or root absorption.	Competition (for plant nutrition) exists between rock and plant.
Rock (the mineral) means death.	Rock means life.

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