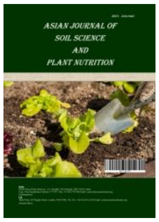

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Granulometric Evolution of Soils in Response to Their Fertilization with Crushed Rocks: Case Study of the Western Highlands Andosols Treated with Trachyte Powder

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Authors' contributions

This work was carried out in collaboration among all authors. This work was conducted by author JCFT. Authors PT and JPN helped in the deepening of the discussions. All the authors read and approved the final manuscript.

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ABSTRACT

The present paper aims to highlight the consequence of the fertilization of soils with rock powder on their granulometric evolution. For that purpose, Andosols developed on trachyte in the upper part of the southern limb of the Bambouto Mountains were fertilized with trachyte powder at different rates, activated with water and incubated during nine months. The different treatments generate the granulometric evolution of soils. The increasing of the amounts of trachyte powder as same as the duration of the incubation process makes the evolution more significant. In the detail, that treatment induces the enrichment of the treated soils in silts particles in the expense of clay and sands. At the end of the process, soils with high amounts of sands and silts in general are engendered. The use of rock powder as fertilizers must be gainfully preceded by the acquisition of informations concerning their amounts in organic matters. In case of low amounts, a supply with organic fertilizers would be necessary.

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Keywords: Sands; silts; clay; activation; incubation; duration.

1. INTRODUCTION

The declining of soils fertility constitutes today a major torment worldwide [1]. That preoccupation is getting greater as far as tropical zones are concerned [2]. In that part of the world in fact, demographic growth largely contrasts with crop yield [3]. This is the consequence of the permanent growth of anthropic pressure on soils, known as their major source of income [4,5]. The resource poor farmers despite their low level of technology have often behaved courageously in response to the problem. First of all rudimentary, their fighting technics got improved with the discovery of synthetic fertilizers. Unfortunately, for most of those peasants, the high cost of those substances [5], their availability [6], the acidification of soils induced in response to their use in long term [7], the eutrophisation of water by nitrates and phosphates from the dissolution of a part of those products [8], as same as the recent medical reports revealing the implication of the consumption of water full of nitrates in some cancer case of digestive tract [9], tend henceforth to discredit those fertilizing matter considered in the beginning as magic. Due to that fact, investigations went deeper, the aim being the finding of more ecological fertilizers, capable to sustainably improve soil fertility. In that purpose, the agri use option of plants such as *Titonia diversifolia* [10], fluids such as human urine [11] and water from cooked beans, single or mixed, [12,13], as same as geological materials [14,12,11] was revealed. Concerning geological fertilizers, if their efficiency was demonstrated as long term nutrients provider (e.g. [15,16,17]), [12] regrets however their poor action in short term. Fopoussi [2] agrees with that point of view by considering them as wonderful long term fertilizers, proposing at the same time their gainful combination in farms with substances with quickly available nutrients such as human urine and water from cooked beans among others. Apart from the enhancement of the chemical aspect of soils due to the supply with geological matters, the other aspects of soils could be beneficially questioned. It is the case of the granulometric evolution which remains unknown up to now. The aim of the present study is then to highlight that particular aspect of the modification of soil characteristics in response to their treatment with geological materials. For that end, Andosols from the Western Highlands of Cameroon were treated with trachyte powder at different rates and followed up during nine month.

2. MATERIALS AND METHODS

2.1 Materials

The present study was carried out in the upper part of the southern limb of the Bambouto Mountains (Fig. 1). This geomorphological unit stretches between 2000 and 2740 m high. Its relief is Mounty and rough, characterized by steep slopes (>13%) [18,19].

The climate is fresh (from 11 to 13°C of mean annual temperature), foggy [20] and rainy (about 2600 mm of mean annual pluviometry) [21].

The flora is made of natural and anthropic species. The natural species are mainly *Sporobolus, Hyparrhenia*, *Hypericum riparium*, *Arundinaria alpina*, *Philippia manii*, *Hypéricacées,* and *Adenocarpus.* In the same way, boarding water courses, there are relics of gallery forests made of knotty trees such as *Maesa lannceolata, Trema guineensis* et *Adenocarpus.* Those trees bear species like Usnee *sp* [22]. Concerning anthropic species, they are essentially carrots, potatoes, cabbages, and leek amongst others [23,24]. The hydrographic network is radiated [20].

The substratum is essentially trachyte. It drowns islets of basalts, rhyolites, phonolytes, and pyroclastites [25]. It outcrops as blocks with variable sizes. It is dark grey, massive, hard, and compact, with saccharoid aspect. It is more or less weathered and traversed by many cracks with tanned borders. On its external part, many phenocryts of sanidine are recognized, conferring to the rock a mangy aspect. Under compound light microscope, sanidine (KAlSi3O8) is the most abundant (95%) mineral; augite $((Si,Al)_2O_6)(Ca,Mg, Fe,Ti,Al)_2$, ilmenite ($FeTiO_3$), magnetite (Fe3O4), and apatite $Ca_5(PO_4)_3$(F, Cl, OH) are also present [25,26,2]. All these minerals are orientated in a preferential direction, responsible for the flow like texture of the rock [2].

The pedological cover is essentially made of strongly desaturated, humic and highly rejuvenated andic ferralitic soils [2]. Many dispersed blocks of trachyte cover its surface. Its tillable part is dark (5YR2.5/1) and silty, with a crumby structure. Under compound light microscope, it reveals an abundant (50%), dark and isotic plasma, many holes (30%), and a

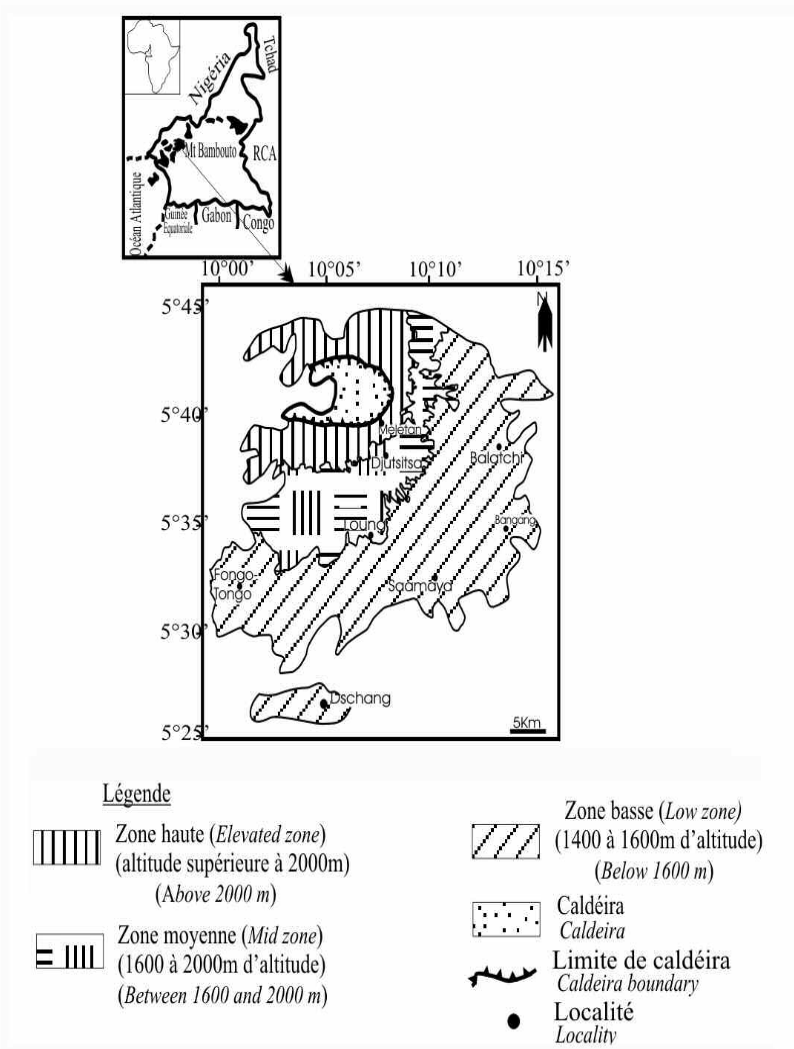

Fig. 1. Localization of the Western Highlands of Cameroon

squeleton made of quartz and more or less weathered fragments of sanidine [27]. Spots of hydromorphic soils are also present in drained valleys [28]. Human activities are intense, represented by farming and husbandry [2].

The study of the landscape has helped to identify natural surfaces disseminated in the upper part of the southern limb of the Bambouto Mounts. It has also helped to localize more or less fresh outcrops of trachyte.

2.2 Methods

To reach the target, studies were held on the field and in the laboratory.

On the field, it consisted of the localization of natural surfaces. This stage was followed by the collection of soil and fresh trachyte samples. Concerning soil samples, they were collected in the tillable part at different positions in the natural surfaces (Table 1).

In the laboratory, representative soil samples were built up by quartering (photograph 1, Fig. 2). 72 identical portions of one kilogram each were constituted and put in non-busted recycled plastic containers for incubation tests. In the detail, those 72 tanks of identical soil samples were grouped into three series of 24 each because of the three different treatments to be done. In each of the three groups, samples were

Photograph 1. Mixing of soil samples

Photograph 2. Blocks and trachyte powder

organized in subgroups of four samples in response to the different period of lab analysis chosen in advance, for a total of 6 subgroups per group (first month, second month, third month, fifth month, seventh month, and nine month from the beginning of the incubation process).

Trachyte was (photograph 2A) finely crushed (photograph 2B) after [29,30], and sieved with a 2 mm mesh. The product of the sieving was used for fertilization tests

After these stages, the treatment of the different subgroups of soils with rock powder took place apart from the control. These different treatments included the use of rock powder at 5% (A5) with regular lab analysis after one (A51), two (A52), three (A53), five (A55), seven (A57) and nine

(A59) months (Treatment 1); the use of rock powder at 15% (B15) with regular lab analysis after one (B151), two (B152), three (B153), five (B155), seven (B157), and nine (B159) months (Treatment 2); the use of rock powder at 25% (C25) with regular lab analysis after one (C251), two (C252), three (C253), five (C255), seven (C257), and nine (C259) months (Treatment 3). In the detail, the treatment at 5% refers to the use of 50 g of rock powder to treat 1 kg of soil; the treatment at 15% for its own refers to the use of 150 g of rock powder to treat 1 kg of soil; concerning the treatment at 25%, it refers to the use of 250g of rock powder to treat 1 kg of soil.

The different mixtures constituted and the control was weekly activated with great quantities of water (250 ml) after [2] since the functioning of Andosols requires pronounced amounts of water [31]. At the end of each selected period, a representative sample was built by the quartering of the four treated samples constituting the subgroup concerned (Fig. 2) for the granulometric analysis.

2.3 Soil Analysis

Particle size distribution was determined by the Robinson pipette method following dispersion with sodium hexametaphosphate.

3. RESULTS AND DISCUSSION

3.1 Results

Two months after the beginning of the incubation of the activated soil-rock powder mixtures with water, a reddish film appears at the surface of the concoction (photograph 3A). A detailed observation reveals the same phenomenon on the walls of the container (photograph 3B).

3.1.1 Granulometric evolution of soil-rock powder mixtures equally treated but incubated at different durations

3.1.1.1 Soil-rock mixtures at 5%

The Fig. 3 shows at the first degree that independently to the duration of the incubation of the activated soil-rock powder mixtures at 5%, the amounts in each granulometric fraction remain proximate. But closer, a slight decrease of the amounts of clay and sands particles in the profit of those of silts compared to the initial situation is detectable. In fact, the amounts of clay size particles are 17.8 in the control (T) and 17.26% in soils treated at 5% with rock powder after nine months of activation and incubation (A59). Those of silts are 36.4 in the control (T) and 38.04% in soils treated at 5% with rock powder after nine months of activation and incubation (A59). Concerning those of sands, they are 45.9 in the control (T) and 44.7% in soils treated at 5% with rock powder after nine months of activation and incubation (A59) (Table 2).

3.1.1.2 Soil-rock mixtures at 15%

After the Fig. 4, the treatment of soils at 15% followed by activation with water and incubation at different durations generate a more sensible changing in the amounts of each granulometric particles compared to the previous situation. So, the amounts of clay and sands respectively sinks as follow from the control (T) to soils treated and incubated during nine month (B159): 17.9% to 16.18% and 45.9 to 44.14%. Concerning the amounts of silts, they rise from 36.4 in the control (T) to 39.68% in soils treated and incubated during nine months (B159) (Table 2).

Table 1. Location of sampling points

Sample Ei	Longitude	Latitude	High (m)
E1	10^{o}04’54.80’’E	5^{o}38’07.03’’N	2731
E2	10^{o}04’56.4’’E	5^{o}37’55.04’’N	2707
E3	10^{o}04’56’’E	5^{o}38’01.94’’N	2722
E4	10^{o}04’58.64’’E	5^{o}38’03.27’’N	2697
E5	10^{o}04’52.87’’E	5^{o}37’54.86’’N	2708
E6	10^{o}04’59.14’’E	5^{o}37’49.64’’N	2684
E7	10^{o}04’56.87’’E	5^{o}37’51.53’’N	2696
E8	10^{o}05’04.30’’E	5^{o}37’32.46’’N	2630
E9	10^{o}05’05.97’’E	5^{o}37’31.99’’N	2626
E10	10^{o}05’02.73’’E	5^{o}37’40.74’’N	2665
E11	10^{o}04’58.01’’E	5^{o}37’44.80’’N	2685

Ei: sample number i

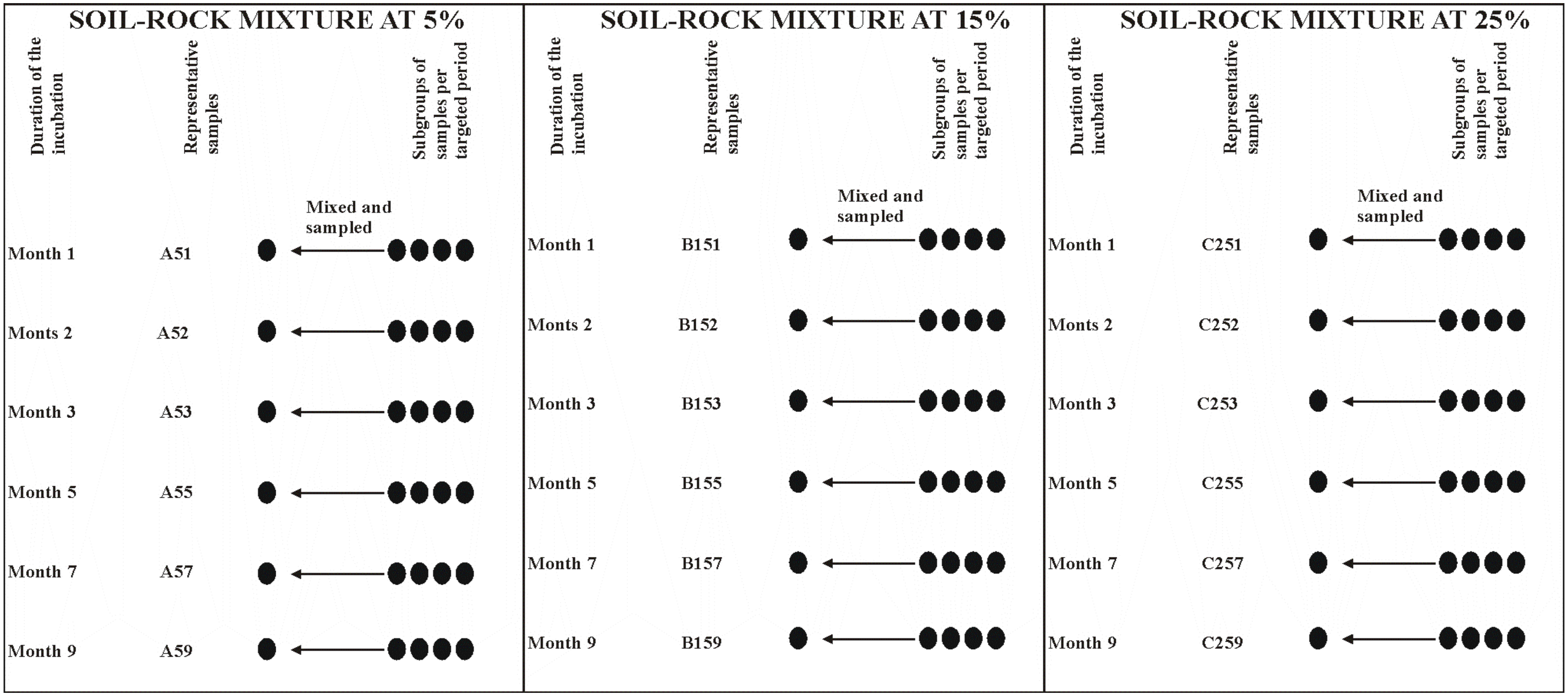

Fig. 2. Sampling design for lab test

3.1.1.3 Soil-rock mixtures at 25%

The graphic of the Fig. 5 shows that the treatment of soils with rock powder at 25% followed by activation and incubation during nine months induces a more pronounced modifications in soils granulometry. So, the amounts of silts increase gradually and significantly, varying from 36.4 in the control (T) to 44.59% at the end of the ninth month (C259) (Table 2). For sands, a significant and gradual decrease of their amounts is detected: from 45.9% in the control (T) to 40.25% at the end of the ninth month (C259). For clay, the following changing is detected: from 17.8 in the control to 15.16% in soils treated and incubated during nine months (Table 2). But here, it is important to highlight the fact that the amounts of silts at the end of the ninth month of incubation is largely greater than the amounts of sands during the same duration.

3.1.2 Granulometric evolution of soil-rock powder mixtures differently treated but incubated at the same duration

3.1.2.1 After one month of incubation

The Fig. 6 reveals quite the constancy of the distribution of soils particles independently to the rate of treatment after one month of activation and incubation. In fact, one can note in all the samples (**T**, A 51, B 151, C 251) that the different soils particles are distributed in the same manner; sands (45.71 to 45.9%) are the most abundant fractions, respectively followed by silts (36.4 to 37.31%) and clay (17.36 to 17.8%) particles (Table 2). But in the detail, one can notice that when soils are treated at 25% (C251) with rock powder, the amounts of clay slightly decrease in the profit of silts compared to the situation in the control (T).

3.1.2.2 After two months of incubation

The study of the Fig. 7 reveals that after two months of permanent activation and incubation, a more sensible modification appears between the granulometry of the control (T) and that of soils treated (A52, B152, C252) in response to the increasing of the amounts of rock powder used in the treatments. In the details, the amounts of silts increase (from 36.4 in the control to 38.22% in soils treated at 25% with rock powder) in the expense of those of sands (45.9 in the control to 44.86% in soils treated at 25% with rock powder) and clays (from 17.8 in the control to 16.92% in soils treated at 25% with rock powder) (Table 2).

3.1.2.3 After three months of incubation

The Fig. 8 shows that quite independently to the amounts of rock powder incorporated in soils followed by activation and incubation during three months, the amounts of sands (from 45.9 in the control to 44.39% in soils treated at 25% with rock powder) and clay (from 17.8 in the control to 16.48% in soils treated at 25% with rock powder) decrease in the profit of silt (36.4 in the control to 39.13% in soils treated at 25% with of rock powder) (Table 2).

Photograph 3. Presence of a reddish film at the surface of the soil-rock mixture and on the walls of the container

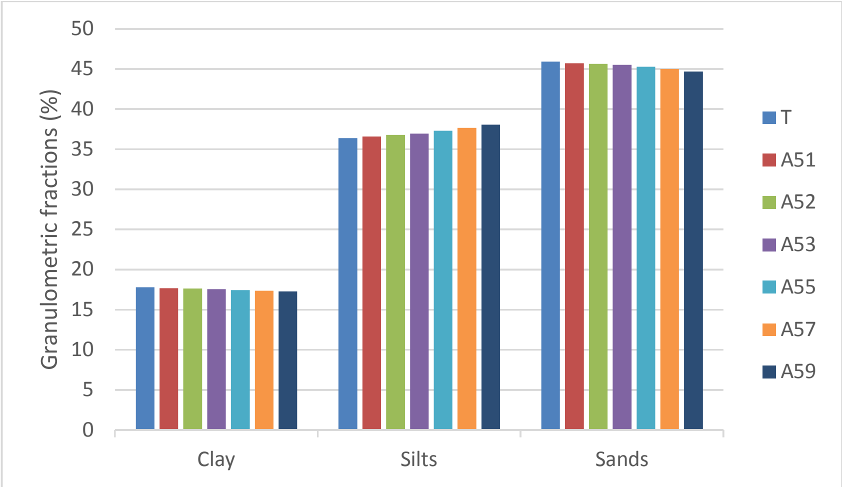

Fig. 3. Grain size particles of the soil-rock powder mixtures at 5% incubated at different durations

Table 2. Grain size particles of the different samples

Samples	**Granulometry (%)**		
	Clay	**Silts**	**Sands**
T	17.8	36.4	45.9
A51	17.71	36.58	45.71
B151	17.53	36.76	45.71
C251	17.36	37.31	45.71
A52	17.62	36.76	45.62
B152	17.26	37.13	45.61
C252	16.92	38.22	44.86
A53	17.53	36.95	45.52
B153	16.99	37.49	45.52
C253	16.48	39.13	44.39
A55	17.44	37.31	45.25
B155	16.72	38.22	45.06
C255	16.04	40.95	43.01
A57	17.35	37.67	44.98
B157	16.45	38.95	44.6
C257	15.6	42.77	41.63
A59	17.26	38.04	44.7
B159	16.18	39.68	44.14
C259	15.16	44.59	40.25

A51 : soils amended at 5% with trachyte powder after 1 month of incubation ; B151 soils amended at 15% with trachyte powder after 1 month of incubation; C251 : soils amended at 25% with trachyte powder after 1 month of incubation; A52 : soils amended at 5% with trachyte powder after 2 months of incubation ; B152 : soils amended at 15% with trachyte powder after 2 months of incubation ; C252 : soils amended at 25% with trachyte powder after 2 months of incubation A53 : soils amended at 5% with trachyte powder after 3 months of incubation; B153 : soils amended at 15% with trachyte powder after 3 months of incubation; C253 : soils amended at 25% with trachyte powder after 3 months of incubation; A55 : soil amended at 5% with trachyte powder after 5 months of incubation; B155 : soils amended at 15% with trachyte powder after 5 months of incubation ; C255 : soils amended at 25% with trachyte powder after 5 months of incubation; A57 : soils amended at 5% with trachyte powder after 7 months of incubation; B157 : soils amended at 15% with trachyte powder after 7 months of incubation ; C257 : soils amended at 25% with trachyte powder after 7 month of incubation; A59 : soils amended at 5% with trachyte powder after 9 months of incubation; B159 soils amended at 15% with trachyte powder after 9 months of incubation; C259 : soils amended at 25% with trachyte powder after 9 months of incubation

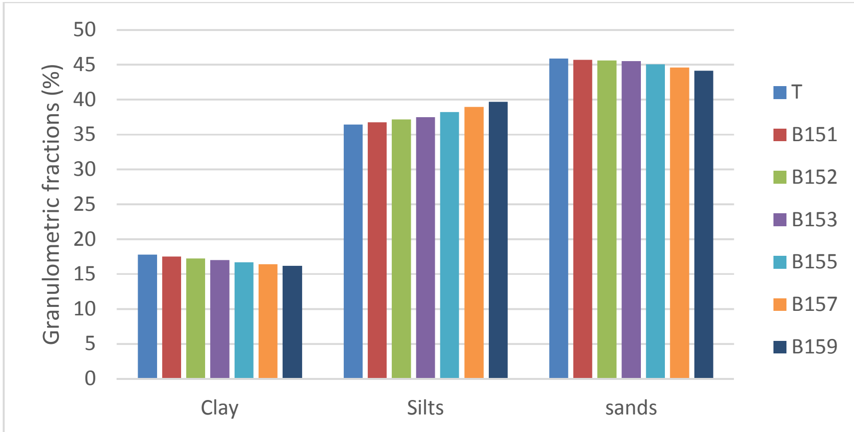

Fig. 4. Grain size particles of the soil-rock powder mixtures at 15% incubated at different durations

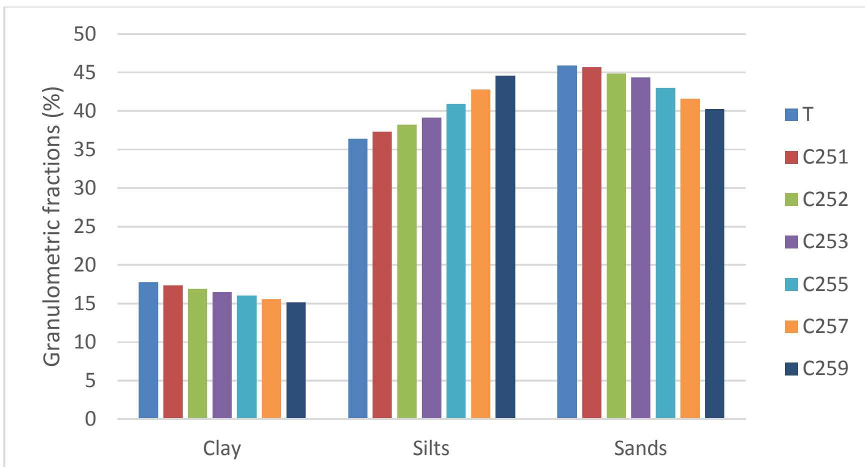

Fig. 5. Grain size particles of the soil-rock powder mixtures at 25% incubated at different durations

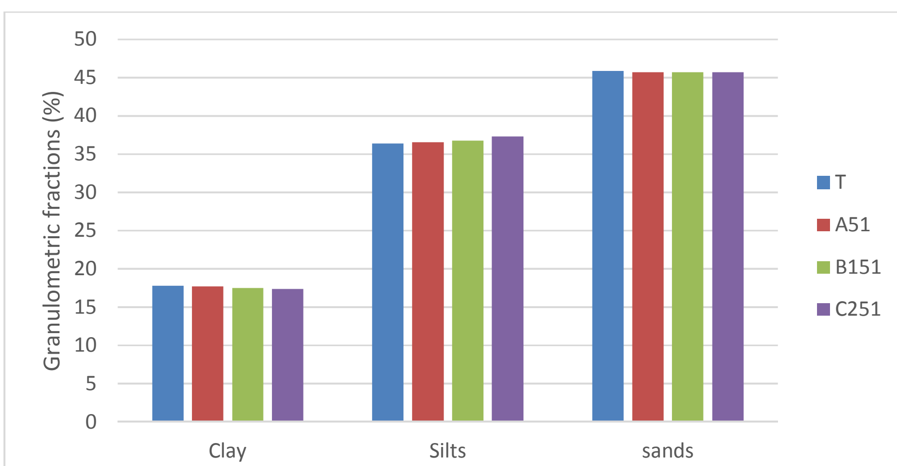

Fig. 6. Grain size particles of the soil-rock powder mixtures at different rate of treatment but incubated during one month

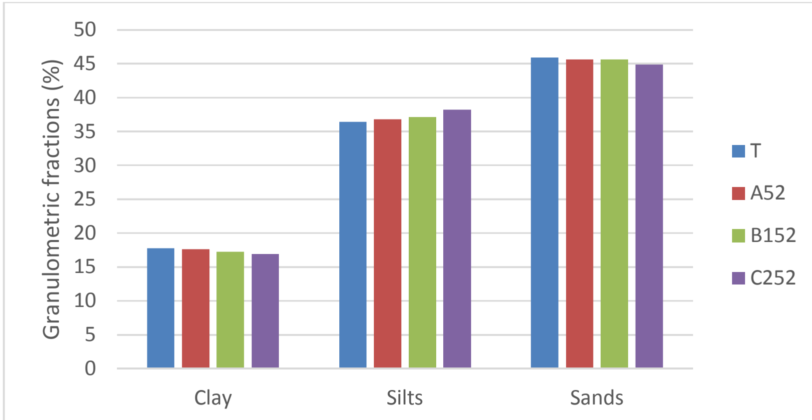

Fig. 7. Grain size particles of the soil-rock powder mixtures at different rate of treatment but incubated during two months

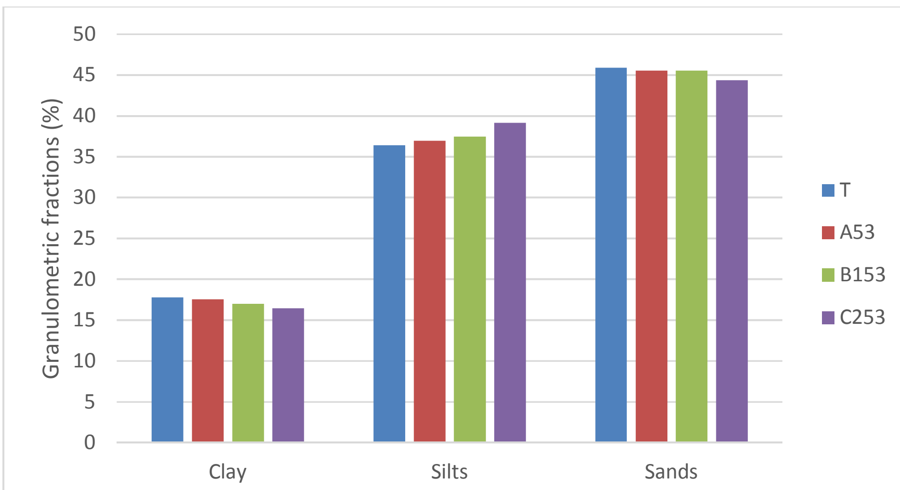

Fig. 8. Grain size particles of the soil-rock powder mixtures at different rate of treatment but incubated during three months

3.1.2.4 After five months of incubation

The graphic of the Fig. 9 reveals that after the activation and incubation processes during five months of soil-rock powder mixtures at different rate, the amounts of sands (from 45.9 in the control to 43.01% in soils treated at 25% with of rock powder) and clays (from 17.8 in the control to 16.04% in soils treated at 25% with of rock powder) decrease in the profit of the amounts of silts (from 36.4 in the control to 40.95% in soils treated at 25% with of rock powder) (Table 2). Moreover, the decreasing in one hand and the increasing in the other hand are more expressed.

3.1.2.5 After seven months of incubation

After seven months of activation and incubation of soils treated with different amounts of rock powder, one can notice as showed on the Fig. 10 that the amounts of clay (from 17.8 in the control to 15.6% in soils treated at 25% with rock powder) and sands (from 45.9 in the control to 41.63% in soils treated at 25% with rock powder) decrease regularly in the profit of silts (from 36.4 in the control to 42.77% in soils treated at 25% with rock powder) (Table 2).

3.1.2.6 After nine months of incubation

After nine months of activation and incubation of soils treated with increasing amounts of rock powder, it is noticeable on the Fig. 11 a significant and gradual reduction in the amounts of sands (from 45.9 in the control to 40.25% in soils treated at 25% with rock powder) and clay (from 17.8 in the control to 15.16% in soils treated at 25% with rock powder) in the profit of the amounts of silts (from 36.4 in the control to 44.59% in soils treated at 25% with rock powder) (Table 2).

3.1.3 Synthesis

Two months after the beginning of the incubation of the activated soil-rock powder mixtures with water, a reddish film appears at the surface of concoctions and on the walls of containers.

The treatment of soils with the same amounts of rock powder followed by activation and incubation at various durations generates the decreasing of the amounts of clay and sands in the profit of the amounts of silts. That fact becomes more sensible with the increasing of the amounts of rock powder in soils. So, in soils treated at 25% with rock powder, the amounts of silts is greater than the amounts of sands at the end of the ninth month of the incubation process.

The treatment of soils with various amounts of rock powder, activated and incubated during the same duration, engenders the increasing of the amounts of silts in the expense of those of clay and sands once more. That increasing is more sensible in soils treated with larger amounts of rock powder. However, during the first months of the activation followed by the incubation of the mixtures, the increasing is the weakest.

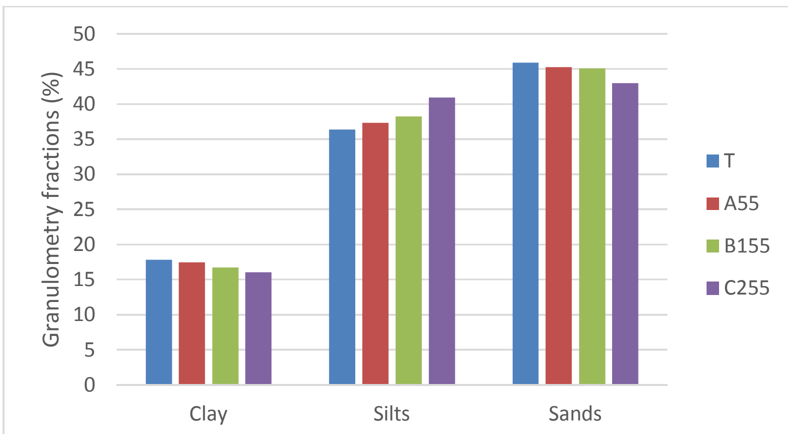

Fig. 9. Grain size particles of the soil-rock powder mixtures at different rate of treatment but incubated during five months

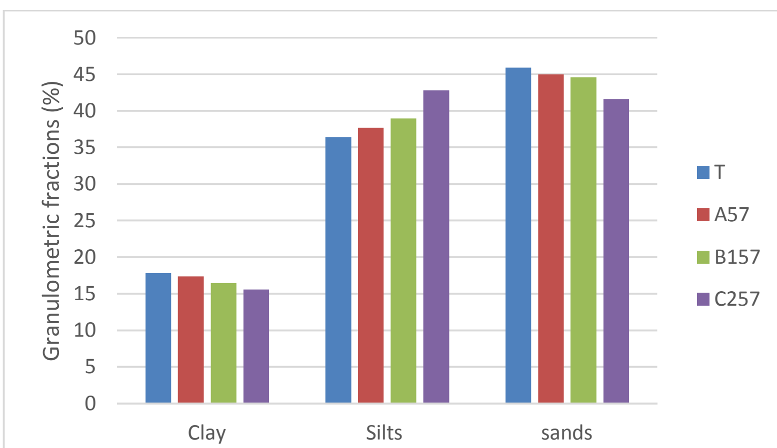

Fig. 10. Grain size particles of the soil-rock powder mixtures at different rate of treatment but incubated during seven months

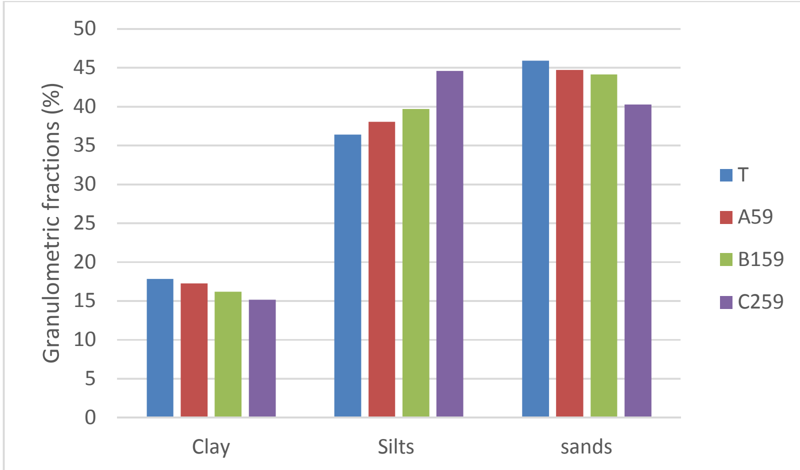

Fig. 11. Grain size particles of the soil-rock powder mixtures at different rate of treatment but incubated during nine months

4. DISCUSSION

Two months after the beginning of the incubation of the activated soil-rock powder mixtures with water, a reddish film appears at the surface of concoctions and on the walls of containers. According to Delvigne [32], this film is made of iron. The release of that element started with the beginning of the weathering process of dense and ferromagnesian minerals present in the trachyte used as fertilizers in the present study; this observation corroborates the results of Edou-Minko et al. [33] and [34]. Such reasoning agrees with the presence of augite, ilmenite, and magnetite in the concerned rocks as showed by [2]. The same author demonstrated that during the alteration process of ilmenite for instance, iron, more mobile than the titanium, is the first one to be released in the solution of the attack, followed by its lixiviation stage. That observation can be also linked to the one made by Trescases [35]. In fact, he highlighted that in the presence of water, hydrolysis takes place, making then iron bear minerals to release that element within the solution of the attack. When the saturation rate is reached, the precipitation process starts, ending by the formation of iron coatings on available surfaces. In that point of view, [36] located in some ferralitic soils in the Central Plateaus of Cameroon the presence of iron-cutanes. He justified their presence by the releasing of iron by ferromagnesian minerals, followed by their transportation and further precipitation downward in the studied sequence.

In the control, the granulometry is dominated by sands and silts in the same order. The abundance of those two granulometic particles can be explained in two ways. First of all, it can be due to the presence of fragments of sanidine with different sizes within the soils, released by the numerous dispersed blocks of trachyte observed at the soils surface and in the tillable part as observed on the field. This corroborates the studies of Fopoussi [37]. In the second hand, that granulometric distribution in soils under natural vegetation can be due to the abundance of organic matters as highlighted by [2]. In that way, [38] demonstrated that organic matter in soils acts as glue between smaller size particles, generating in consequence the larger ones, with sand and silts sizes.

The treatment of soils with the same amounts of rock powder followed by the activation and the incubation at various durations generates the decreasing of the amounts of clay and sands particles in the profit of the amounts of silts. That fact becomes more sensible with the increasing of the amounts of rock powder in soils. So, in soils treated at 25% with rock powder, the amounts of silts is greater than the amounts of sands at the end of the ninth month of the incubation process. Moreover, the treatment of soils with various amounts of rock powder, activated and incubated during the same duration, engenders the increasing of the amounts of silts in the expense of those of clay and sands. That increasing is more sensible in soils treated with larger amounts of rock powder once more. However, during the first months of the activation and the incubation of the mixtures, the increasing is the weakest. From these observations, the increasing of the amounts of rock powder as fertilizers as same as the duration of the incubation of soil-rock powder mixtures contributes to the increasing of the amounts of silts in the expense of the amounts of sands and clay particles in soils. The increasing of the amounts of the silts particles with the duration of the incubation can be due to the fact that it makes longer the contact between the rock powder and the water. Then, the large specific surface generated by the rock crushing eases the alteration process, with in terms of consequence great amounts of cations leached. In its studies dealing with the alteration process of trachyte at the bottom of the Andosolic cover from the Western Highlands of Cameroon, [2] put into relief the releasing of cations such as aluminum, iron, calcium, potassium, magnesium among other, naturally bore in those rocks by sanidine, augite, ilménite, magnetite, and apatite for the most common. Concerning the influence of those listed cations in soils functioning, [39] and [18] in their different studies highlighted their aptitude to establish bonds between clay size particles in other to generate those a little bit larger such as silts. In the same way, [18], insisting particularly on the role played by iron and aluminum in the evolution of soils granulometry of Andic ferralitic soils in the middle part of the southern limb of the Bambouto Mountains, reached to the conclusion that those two elements beside organic matter largely contribute to bond small size particles in silts size ones. This observation can then efficiently explained the increasing of silts in treated soils with trachyte powder independently to the amounts of rock powder brought and to the duration of the incubation. The decreasing of the amounts of clay appears then as the logical consequence of the formation of silts size particles by their grouping according to Fopoussi [18]. Concerning the decreasing of the amounts of sands, this fact can be the consequence of the alteration of fragments of sanidine constituting one part of the sands particles as showed by Fopoussi [2]. To densify this assertion, the reasoning developed by Trescases [35] can be valued. In fact, that author demonstrated that during the process of alteration, some minerals completely disappear in response to the complete leaching of their components. Further, those elements released can then enter the circle of the newly formed minerals in exogenous conditions.

At the end, the treated soils appeared largely dominated by sands and silts in general, even if at certain moments, the amounts of silts surpass those of sands. For [40], such a situation is risky. In fact, it favors at the end a tendency to the development of a cultural sole, harmful for the fluids circulation and roots development in soils. In the same way, De Paul [41] showed that soils with highly expressed sandy and silty characteristics are suggested to an intense erosion process in landscapes with rough relief. But, [2] lightens that fear by showing that in landscapes with rough relief; the use of grooves can be a solution for the reducing of erosive phenomenon. This is in accordance with the observations of [22]. Further, [42] demonstrated that in soils with high amounts of organic matters, sands, silts, and clay particles can be easily bonded by organic matters, generating then light and resistant crumbs as showed by Tematio et al. [43].

5. CONCLUSION

The incorporation of rock powder in soils as fertilizers independently to the amounts brought generates their granulometric evolution. But, this fact is more expressed in response to the increasing of the amounts of the rock powder brought as same as with the increasing of the duration of the incubation process. In the detail, that treatment induces the enrichment of the treated soils in silts particles in the expense of clay and sands. At the end of the process, soils with high amounts of sands and silts in general are engendered. The studies of some authors demonstrate the dangerousness of such a situation when the fluids circulation, roots development, and erosive risk are further of concerned. But, the studies of others researchers reveal the stabilization of soils with high amounts of silts and sands in particular conditions.

6. RECOMMANDATION

The use of rock powder as fertilizers must be gainfully followed by the acquisition of informations concerning their amounts of organic matters. In case of low amount, a supply with organic fertilizers would be necessary.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Boyer J. Ferralitic soils. Fertility factors and land use. Initiations Documentation, Techniques. N52. ORSTOM. 1982;341.

2. Fopoussi Tuebue JC. Petrology of the andosols of the western highlands of cameroon and fertilization test: Case of a toposequence developed on trachyte of the upper zone of the southern slope of the Bambouto Mountains. PhD. Department of Earth Sciences, Faculty of Science, University of Ngaoundere. 2018;233.
3. Isolina Boto. Population growth and its implications for ACP rural development. Resources on population growth in ACP countries1. No. 16. CTA Office Brussels. 2012;55.
4. Sanchez PA, Kwesiga FR, Ndiritu CG, Woomer PL. Soil fertility replenishment in Africa: an investment in natural resource capital. In: Buresh RJ, Sanchez PA, Calhoun F. (Eds), Replenishing soil fertility in Africa. SSSA Spec Publ. 1997;51:1-46.
5. Sanchez PA. Ecology. Soil fertility and hunger in Africa. 2002 ;295(5562):2019-20.
6. Cleaver H. The contradictions of the green revolution. American Economic Review. 1972;62(2):177-86.
7. Clergué B, Amiaud B, Plantureux S. Evaluation of the biodiversity with agro-environmental indicators at the scale of a farming landscape, seminar 2004 of the Doctorate school RP2E *Engineering of resources, proceedings, products and environment*, Nancy; 2004.

   (ISBN: 978-2-9518564-2-4)
8. Dorioz JM, Trevisan D. The diffuse phosphorus transfert in farming basin : Le transfert diffus du phosphore dans les bassins agricoles: Sized, mechanisms, ordres de grandeur, mécanismes, mastery. Water engineering, agriculture, territories, nitrogen special number, phosphorus and pesticides; Strategies and perspectives of flux reduction, 2008;27-47.
9. Fan AM, Steinberg VE. Health implications of nitrate and nitrite in drinking water: An update on methemoglobinemia occurrence and reproductive and developmental toxicity. Regulatory Toxicology and Pharmacology. 1996 ;23 (1):35-43.
10. Kaho F, Yemefack M, Feujio-Teguefouet P, Tchantchouang JC. Combined effect of *Tithonia diversifolia* leaves with synthetic fertilizers on corn yields and properties of a ferralitic soil in the Centre Region of Cameroon. Tropicultura. 2011;29(1):39-45.
11. Richert A, Gensch R, Håkan J, Stenström TA, et Dagerskog L. Practical advises for an efficient urine utilisation in farming. EcoSaRes Ser. 2011-3.
12. Fopoussi Tuebue JC, Basga SD, Tematio P, Nguetnkam JP. Effect of trachyte powder, human urine and reserved water from cooked beans on andosols fertility in Cameroonian Western Highlands. Asian Journal of Soil Science and Plants Nutrition. 2018;3(2):1-17.

    Article no. AJSSPN.41999

    [ISSN: 2456-9682]
13. Fopoussi Tuebue JC, Basga SD, Tematio P, Nguetnkam JP. Impact of the mixture of water from cooked bean and human urine on the growth of some common plants in Cameroon: Case study of *Talinum fruticosum* L. and *Ocimum gratissimum* L. 2019a;5(1):1-15.

    Article no. AJSSPN.51071

    [ISSN: 2456-9682]
14. Van Straaten P. Rocks for crops: Agromine rals of subSaharan Africa. ICRAF, Nairobi, Kenya; 2002.
15. Nkouathio DG, Wandji P, Bardintzeff JM, Tematio P, Kagou Dongmo A, Tchoua F Utilisation of volcanic rocks for the remineralization of ferralitic soils in tropical regions. Case study of basaltic pyroclasts from Tombel graben (Volcanic line of Cameroon). Bull. Soc. Vaud. Sc. Nat. 2008;911:1-14
16. Basga SD, Nguetnkam JP. Fertilizing effect of swelling clay Materials on the growth and Yield of bean "*Phaseolus vulgaris*" on the Sandy Ferruginous Soils from Mafa Tcheboa (North Camerron, Central Africa). International Journal of Plants and Soil Science. 2015;5(1):10-24.
17. Yaya F, Nguetnkam JP, Tchameni R, Basga SD, Penaye J. Assessment of the fertilizing effect of Viviannite on the Growth and Yield of the Bean "*Phaseolus vulgari"* on oxisoils from Ngaoundere (Central North Cameroon). Int. Res. J. Earth Sci. 2015;3(4):18-26.
18. Fopoussi Tuébué JC. Contribution to the study of soils risen on trachyte in the southern limb of the Bambouto Mountains

(Western-Cameroon). Mém. Maîtrise. Fac. Sc., Univ. Dschang. 2001;56.

19. Momo Nouazi M, Yemefack M, Tematio P, Beauvais A, Ambrosi JP. Distribution of duricrusted bauxites and laterites on the bamileke plateau (West Cameroon): Constraints from GIS mapping and geochemestry. 2016;140:15-23.
20. Njiosseu Tanko EL. Hydrological Potentials of the Menoua basin, South-east side of the Bambouto Mountains. Mém. Maîtrise, Fac. Sc., Univ. Dschang; 1998.
21. Tékoudjou E. Study of the pluviometry variability on the southern side of the Bambouto Mountains. Mém. D.E.A.. Univ. Ydé I, Fac. Sci; 2004.
22. Morin S. The fundamental dissymetries of the Western Highlands of Cameroon and their consequences on the human occupation. Case study of the Bambnouto Mountains. Human and tropical Mountain. SEPANRIT éd., Bordeaux. 1988;49-51.
23. Ngoufo R. Bamboouto mountains. Environment and space utilisation. PhD in geophysics. Univ. Yaoundé. 1988;1(2): 374.
24. Tematio P, Olson KR. Impact of industrialized agriculture on land in Bafou-Cameroon. Journal of Soil and water conservation. 1997;403-407.
25. Youmen D. Volcanic, petrologic, and temporal evolution of the Bambouto Mounts caldeira (Cameroon). PhD., Univ. Kiel; 1994
26. Deferne J. In the Hearth of minerals, Museum of Genève. 2014;45.
27. Fopoussi Tuebue JC, Basga SD, Tematio P, Nguetnkam JP. Organisation of soils along the sides of interfluves in the Western Highlands of Cameroon: Case study of an andosolic toposequence on trachyte in the Upper Part of the Southern Limb of Bambouto Mountains 2019b;5(1): 1-19.

    Article no. AJSSPN.51629

    [ISSN: 2456-9682]
28. Tematio P, Kengni L, Bitom D, Hodson M, Fopoussi JC, Leumbe O, Mpakam HG, Tsozue D. Soils and their distribution on Bambouto volcanic mountain, West Cameroon highland, Central Africa. Art., ELSEVIER, J.A.E.S. 2004;447-457.
29. Kühnel RH, Van Der Gast SJ. Formation of clay minerals by mechano-chemical reactions during grinding of basalt under water. Appl Clay Sci. 1989;4:295-305.
30. Lim HH, Gilkes RJ, Mc Cormick P. Beneficiation of rock phosphate fertilizers b y mechano-milling. Nutr. Cycl. Agroecosyst ems. 2003;67:177-186.
31. Clothier BE, Vogeler J, Megasan GN. The breakdown of water repellency and solute transport through a hydrophobic soil. Journal of Hydrology. 2000;307:112-125.
32. Delvigne J. Pedogenesis in tropical zone. The formation of secondary minerals in ferralitic areas. PhD, Mém. O.R.S.T.O.M., Dunod, édit. Paris. 1965;177.
33. Edou-Minko A, Colin F, Trescases JJ. Alterability of titan bearing minerals (Ilmenite and rutile) and mobility of titan in soils profils in the sector of Ovala (Gabon). JAES. 1995;21(2):313-318.
34. De Toni A.F. Paragenesis with magnetite from the alterations associated to the systems of iron oxydes and and alteration into alkaline elements. Magmatic zone of the large lac of bear. Thesis, University of Quebec, National Institute of Scientific Research, Maitrise in Earth Sciences. 2016;549.
35. Trescases JJ. Exogenous geochemical evolution of ultra basic rocks in tropical zone. Formation of Nickel ore deposit of the New Caledonia. ORSTOM; 1975.

    [ISBN: 2-7099-0362-8]
36. Bitom D. Organisation and evolution of a ferralitic cover in humid tropical zone (Cameroon). Genesis and transformation of deeper hardened ferruginous levels. PhD, Univ. Poitiers. 1988;164.
37. Fopoussi Tuebue JC. Petrographic, mineralogical and geochemical studies of Andosols risen on trachyte in the upper part of the southern limb of the Bambouto Mountains (Western-Cameroon). Mém. DEA. Fac. Sc., Uiv. Yaoundé I. 2004; 67.
38. Ruellend A, et Dosso M. View on soils. Francophone University. Ed. Foucher Aupelf. 1993;192.
39. Duchaufour P. Pédologie: 1-Pedogenesis and classification. Doc. 2nd ed. Masson, Paris. 1983;491.
40. De Paul MA, et Bailly M. The compaction of forester soils: Definition and principles of the du phenomenon. Forêt Wallonne. 2005a;38-47.

41. De Paul MA, et Bailly, M. Effects of the forester soils compaction. Forêt Wallonne. 2005b;48-57.
42. Colmet-Daage F, et Lagache P. Characteristics of some groups of volcanic soils from West Indies. Cah. ORSTOM, sér. Pédol. 1965;91-121.
43. Tematio P, Tsafack EI, Kegni L. Effects of tillage, fallow and burning on selected properties and fertility status of Andosols in the Bambouto Mounts, West Cameroon. Agricultural Science. Flight. 2011;2(3):334-340.

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