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Study of Correlations between Particle Size Analysis and Intrinsic Properties of Termite Mound Soils Cubitermes sp

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Abstract Inappropriate use of termite mounds soils Cubitermes sp can have negative effects on ecological processes. The objective of this study is to find correlations between intrinsic soil properties. The correlation selected is the one with the highest coefficient of determination and the smallest chi-sqr. The correlations obtained can help testing laboratories to reduce the amount of material to be transported and the number of tests to be performed when identifying materials in the preliminary study phase. The soils studied are clays (inactive and normal) of low to medium plasticity, containing minerals (kaolinite, illite, montmorillonite). The swelling potential of the soils varies from low, medium and high. The correlation between the blue value of the soil and the plasticity index is linear fit for all soils. The relationships between intrinsic soil properties are linear fits and Hyperbl and InvsPoly models with coefficients of determination of R^2(0.703 - 1) and Chi-sqr X^2 (0.00599 - 0.08941). From the analysis of particle size in relation to activity and clay fraction, ten parameters (LL, LP, PI, BVS, Ac, CEC, SSA, RA, Sc, CECA) can be predicted by the developed relationships.

Keywords: *intrinsic properties, particle size analysis, prediction, termite mound soils Cubitermes Spp*

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1. Introduction

Termites play a major role in modifying soil morphological properties. They are considered ecosystem engineers and have a pronounced effect on many soil properties [1,2]. Termites use clay as a basic material to build termite mounds. Termites make the mortars and micro-concretes for their termite mound construction units [3]. Termite mound soils have an impact on the properties of the surrounding surface soil at different soil horizons. Termite mounds have a granular structure with rounded or sub-rounded particle shape, which makes them different from surrounding areas [1]. The shape of the termite mound depends on the properties of the soil, which have no impact on the size or age of the colony. Termite mounds often last for more than ten years after the termites have left [4,5]. The use of appropriate local materials in construction should help to reduce cost and environmental impact [6,7]. The presence of a large amount of clays (smectites) in termite mound soils can increase the cation exchange capacity. The presence of swelling clays (smectites) gives the soil macroscopic swelling and shrinkage properties depending on the environment [2].

The organic matter content is the most important factor affecting the stability of materials used by termites for termite mound construction [8]. Soil texture has an important effect on the ecological process and soil quality [2]. Overexploitation of termite mound soils (in agriculture, construction and pottery) leads to the destruction of the ecosystem [10]. This situation leads to the search for ecological solutions in the use of local materials without compromising environmental safety [11]. Several studies have been conducted to understand the impact of termite mounds on their environment. Inconsistencies reported in the literature may be due to variations in site characteristics, species, genus of termites, land use on site and sampling location [3,5,9,12,13]. The mineralogy and geotechnical history of sediments are related to the activity of a soil [14]. The properties and behaviour of soils are strongly influenced by the physic-chemical characteristics of the minerals that constitute them, depending on their relative proportions [15].

From the termite mound soils Cubitermes sp, two clayey fractions (active and inert) with different behaviour can be distinguished. The difference in the behaviour of the minerals (clayey and non-clayey) can be linked to their plasticity and grain size. Indeed, grain size and Atterberg limits are two widely used methods for characterizing, classifying and predicting the behaviour of fine cohesive soils [15]. The amount and type of the clayey fraction is described by the plasticity index. The behaviour of fine-grained soils is dominated by the specific surface area and the cation exchange capacity. The specific surface in combination with the clayey fraction gives an insight into the mineralogy [16]. The particle size distribution of a soil is used to classify the soil and to define standards for geotechnical use [14,17]. Despite the diversity of studies on the termite mound soils Cubitermes sp, they have not exhausted the subject. To our knowledge, correlations between grain distribution and intrinsic properties of the termite mound soils Cubitermes sp have not yet been reported. The objective of this study is to find mathematical models that best simulate the correlations between intrinsic soil properties. In other words, to find a fundamental relationship and on the basis of the clayey fraction obtained from the particle size analysis, to predict other intrinsic soil properties with developed relationships.

2. Materials and Methods

2.1. Materials

The location of the sample collection sites is shown in Table 1. At each site, approximately two of the termite mound soil Cubitermes sp was collected from an area of up to 100 m^2. The color of the termite mound soils Cubitermes sp ranged from grey to yellow (Figure 1).

Table 1. Location and soil sampling of termite mound soils Cubitermes sp

Localities	Sampling	Collection site
Bara	Bara	15°54'E; 1°04'S
Bokosongo	Boko	13°35'E; 4°25'S
Brazzaville	Braz	15°17'E; 4°16'S
Gamboma	Gamb	15°51'E; 1°52'S
Louigui	Loui	14°45′ E; 4°28′ S
Loutété	Lout	13°50'E; 4°17'S
Mbé - Ngabé	MbéN	for the northern area
Mpouya	Mpou	16°11'E; 2°37'S
Ngo - Centre	NgoC	15°45'E; 2°29'S
Ngo - Nord	NgoN	15°45'E; 2°29'S
Ntombo M.	NtoM	-4.86 S ;14.40 E
Odziba-Mbé	OdzM	for the northern area
Ollombo	Ollo	15°55'E; 1°15'S
Yengola	Yeng	4°20'25"S; 13°52'25"E

Figure 1. The termite mound soils Cubitermes sp

2.2. Methods

On the basis of the physic-chemical properties of the grains, the soils are classified according to the standard [NF P11-300] and the Casagrande diagram. The Origin Pro 2019b software was used in the process of implementing the relationships between the intrinsic properties of the termite mound soils Cubitermes sp. The mathematical model selected is the one with the highest coefficient of determination R^2 and the lowest Chi sqr (χ^2). Chi sqr (χ^2) - it allows to test the independence between two random variables.

The granulometry represents the percentage distribution of solid grains according to their dimensions. For particle separation, two types of tests were performed by: sieving for grains of the size ϕ > 80µm according to the standard [19] and the sedimentation for the grains of diameter $\phi \leq$ 80µm according to the standard [20]. The grain size fraction is deduced from the recommendations of grain size nomograms, considering clays as particles < (0.002 mm), silts (0.002-0.06 mm) and sands (0.06-2 mm).

The Atterberg limits are determined by the Casagrande method, in accordance with the standard [21]. The plasticity index characterizes the extent of the water content range in which soils behave plastically. The limits of liquidity (LL) and plasticity (PL) are determined on the fraction of soil (mortar) passing a 0.40 mm sieve. The plasticity index (PI) is expressed by the following relationship:

$$PI = L_L - P_L \quad (1)$$

The measurement of methylene blue adsorption capacity of a soil consists of measuring the quantity of methylene blue adsorbed by the 0/5 mm fraction of material suspended in water. This test makes it possible to characterize the clay content (or cleanliness) of a soil. It is a quantity that is directly linked to the specific surface of soil and reflects the overall quantity and quality (activity) of the clay fraction. The methylene blue value of a soil (BVS) is determined by the standard [22]. Specific surface area (SSA) refers to the actual surface area of a soil particle as opposed to its apparent surface area. It is of great importance for phenomena involving surfaces, such as water adsorption and absorption. This parameter allows the interpretation of physical characteristics such as shrink-swell potentials. Depending on the geotechnical properties, the specific surface is determined by the following formula:

$$SSA = 20.93*SBV \quad (2)$$

SSA (m^2/g) – specific surface, BVS (g/100 g) – Blue value of a soil.

The cation exchange capacity is the number of cations in the double layer that can be easily replaced or exchanged by other cations per 100 grams of soil. It is determined by the formula:

$$CEC = \frac{BVS*1000}{374} \quad (3)$$

CEC (meq/100) – cation exchange capacity; BVS (g/100g) - blue value of a soil.

The "Ac" activity characterizes the mineral constituting the fine particles. When the clay content is sufficiently high, grains larger than two micrometers are embedded in the clay and barely touch each other. The activity can be related to the mineralogy and geology of the soil and defined as the ratio between the plasticity index PI and the clayey fraction CF [14]:

$$AC = \frac{PI}{CF(\%) < 0{,}002mm} \quad (4)$$

Ac – activity, PI - plasticity index, CF – clayey fraction.

The relative activity is the ratio of the plasticity index to the specific surface area, which defines the role of the specific surface area on the plasticity of soil [19]:

$$RA = \frac{PI}{SSA} \quad (5)$$

RA – relative activity, PI (%) – plasticity index, SSA (m^2/g) – specific surface area.

Kaolinite and Illite minerals are defined according to the surface area activity Sc which is the ratio of the specific surface area to the clayey fraction CF, defined by the following formula:

$$Sc = \frac{SSA}{CF} \quad (6)$$

Sc ($m^2/g*10^2$) – surface area activity, SSA (m^2/g) – specific surface area, CF (%) – clayey fraction.

The minerals Illite and Montmorillonite are defined according to the Cation Exchange Capacity Activity CECA which is the ratio of the cation exchange capacity to the clayey fraction is defined by the following formula:

$$CECA = \frac{CEC}{CF} \quad (7)$$

CECA - cation exchange capacity activity, CEC (meq/100) – cation exchange capacity, CF (%) – clayey fraction. The minerals (Kaolinite and Illite) are defined according to the surface area activity (Sc) which is the ratio between the specific surface area and the clayey fraction (Sc = SSA/CF). The minerals (Illite and Montmorillonite) are defined according to Cation exchange capacity activity (CECA) which is the ratio between the cation exchange capacity and the clayey fraction (CEC/CF).

3. Results and Discussion

3.1. Properties of the Termite Mounds Soils Cutermes Spp

Figure 1, shows the distribution of termite mounds soils Cubitermes Spp.

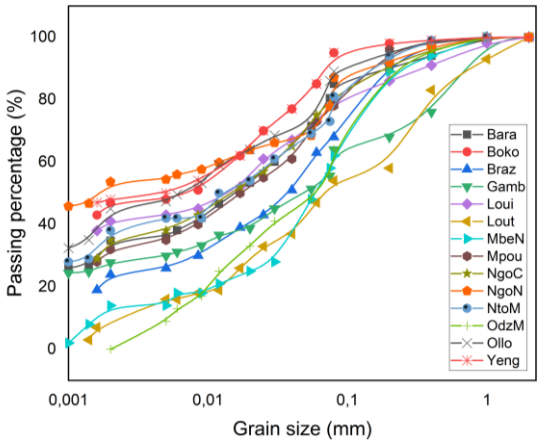

Figure 2. Grain size distribution of the termite mound soils *Cubitermes sp*

Figure 2, shows the grain size distribution of the different termite mound soils *Cubitermes sp*. The contents of the clayey fraction deduced from these curves are reported in Table 1.

Table 2. Proprieties of the termite mounds soils Cubitermes sp.

Soil	CF (%)	LL (%)	PL (%)	PI (%)	SBV (%)	Ac	RA	Ac/Sc	Sc	SSA (m^2/g)	CEC (meq/100g)
Bara	29	30.5	17	13.4	0.41	0.462	1.56	1.56	0.296	8.58	1.096
Boko	43	50.8	23.6	27.2	0.80	0.630	1.62	1.62	0.389	16.74	2.139
Braz	19	32.9	19.9	12.6	0.35	0.664	1.72	1.72	0.386	7.33	0.936
Gamb	25	11.6	2.1	9.5	0.25	0.38	1.82	1.82	0.209	5.23	0.668
Loui	23	26.4	14.8	11.6	0.30	0.504	1.85	1.85	0.273	6.28	0.802
Lout	36	48.2	23.1	25.1	0.70	0.697	1.71	1.71	0.407	14.65	1.872
MbéN	27	27.1	19.6	7.5	0.21	0.278	1.70	1.70	0.163	4.40	0.561
Mpou	28	41.4	18.7	22.7	0.66	0.81	1.64	1.64	0.493	13.81	1.765
NgoC	30	40.7	19.8	20.9	0.60	0.697	1.66	1.66	0.419	12.56	1.604
NgoN	48	45	12	33	0.95	0.688	1.66	1.66	0.414	19.88	2.54
NtoM	33	32.2	16.1	18.6	0.53	0.564	1.68	1.68	0.336	11.09	1.417
OdzM	23	41.4	20.7	12.1	0.33	0.526	1.75	1.75	0.30	6.91	0.882
Ollo	37	40	20	18	0.52	0.486	1.65	1.65	0.294	10.88	1.390
Yeng	46	45.4	22.7	26.2	0.72	0.570	1.74	1.74	0.327	15.07	1.925

CF - Clayey fraction, LL - Liquidity limit, PI - Plasticity index, BVS - Blue value of a soil, Ac - Activity, RA – relative activity, Sc – Surface area activity, SSA - Specific surface area, CEC - Cation exchange capacity.

In Figure 3, of the termite mounds soils Cubitermes sp are classified according to their plasticity.

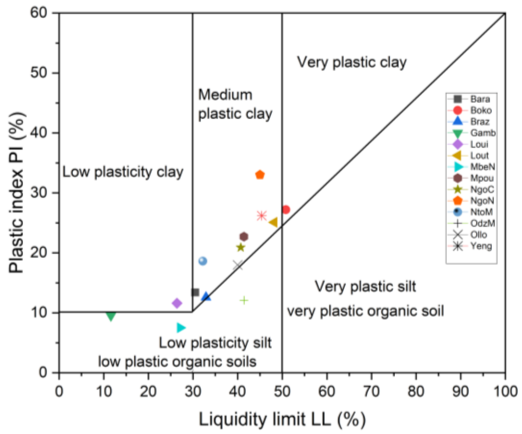

Figure 3. Classification of the soils according to soil plasticity

According to the Taylor diagram, the soils (MbéN, OdzM, Gamb) are low plasticity silts, the soils (Bara, Boko, Braz, Lout, MbéN, Mpou, NgoC, NgoN, Ollo, Yeng, NtoM) are medium plasticity clays and the soil (Loui) is a low plasticity clay. In Figure 4, the soils are classified according to the swelling of the termite mound Cubitermes sp.

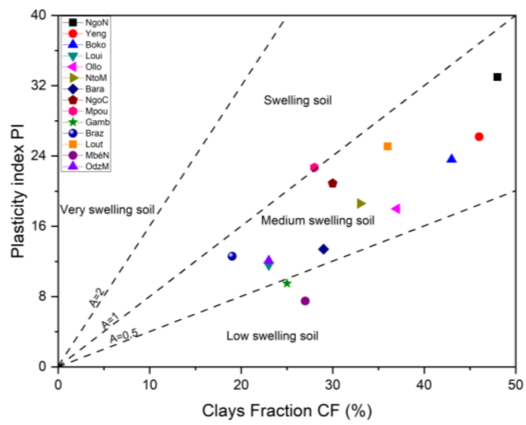

Figure 4. Swelling potential of termite mound soils Cubitermes sp.

A - directing coefficients of the straight lines delimiting the areas of weakly swelling, moderately swelling, swelling and very swelling soils. Swelling potential is the linear variation in soil volume due to water absorption. For this purpose, soils (Gamb, MbéN) are low swelling, soil (Mpou) are swelling and soils (Bara, Boko, Braz, Lout, NgoC, NgoN, Ollo, Yeng, NtoM, OdzM, Loui) are medium swelling. Figure 5, shows the activity of the clayey fractions and the minerals contained in the soils.

The soils (Bara, Boko, Braz, Gamb, Loui, MbéN, NgoC, NgoN, NtoM, OdzM, Ollo, Yeng) are inactive clays containing the minerals (Kaolinite, Illite) and the soil (Mpou) has normal activity, contains the mineral (Kaolinite). The soil (Mpou) is a swelling soil (see Figure 4).

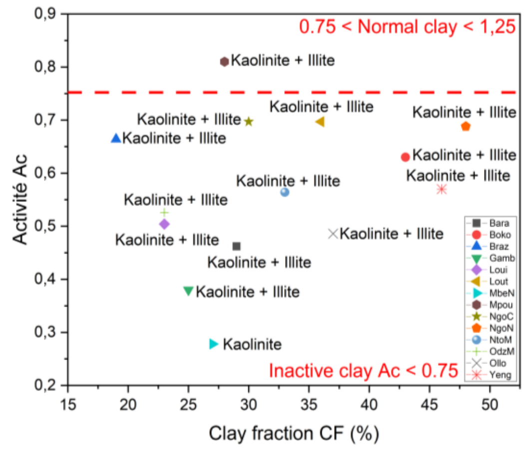

Figure 5. Soil activity of termite mounds soils Cubitermes sp

3.2. Correlations between Intrinsic Properties of the Termite Mound Soils Cubitermes sp

Figure 6 shows the correlation between blue value of a soil and the liquidity limit.

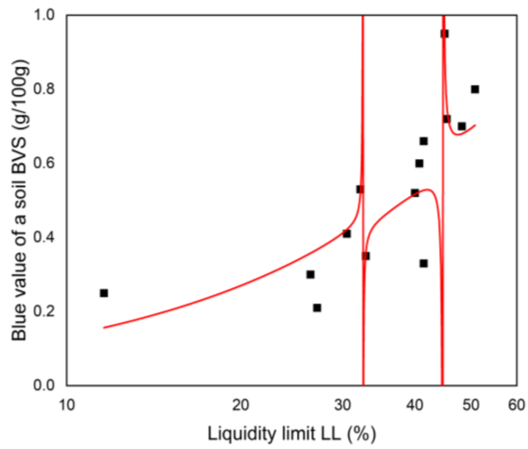

Figure 6. Relationship between blue value a soil and liquidity limit.

The relationship between blue value of a soil and liquidity limit is a nonlinear curve fit of the dHyperbl model:

$$\mathbf{BVS} = \frac{\mathbf{P_1 * LL}}{(\mathbf{P_2 + LL})} + \frac{\mathbf{P_3 * LL}}{(\mathbf{P_4 + LL})} + \mathbf{P_5 * LL} \quad (8)$$

$$\mathbf{P_1} = -9.23516\mathbf{E} - 4 \pm 8.55438\mathbf{E} - 4$$

$$\mathbf{P_2} = -32.51871 \pm 0.34265$$

$$\mathbf{P_3} = -0.00225 \pm 0.0024$$

$$\mathbf{P_4} = -44.701 \pm 0.34721$$

$$\mathbf{P_5} = 0.01352 \pm 9.04369\mathbf{E} - 4$$

$$\mathbf{Chi - sqr}\left(\mathbf{X}^2\right) = 0.01232$$

$$\mathbf{R}^2 = 0.75598$$

R^2 - coefficient of determination, LL – liquidity limit, BVS – blue value of a soil, $\boldsymbol{X^2}$- statistic is a measure of the difference between the observed and expected frequencies of the outcomes of a set of variables.

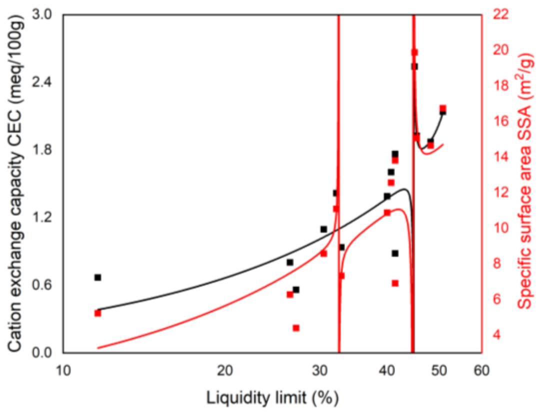

Figure 7. Correlation between cation exchange capacity, specific surface area and liquidity limit

The relationship between cation exchange capacity, specific surface area of a soils and liquidity limit is a nonlinear curve fit of the d'Hyperbl model:

For specific surface area SSA:

$$SSA = \frac{P_1 * LL}{(P_2 + LL)} + \frac{P_3 * LL}{(P_4 + LL)} + P_5 * LL \quad (9)$$

$$P_1 = -0.01929 \pm 0.0179$$

$$P_2 = -32.51832 \pm 0.34298$$

$$P_3 = 0.04708 \pm 0.034298$$

$$P_4 = -44.70079 \pm 0.34713$$

$$P_5 = 0.28298 \pm 0.01891$$

$$Chi - sqr\left(X^2\right) = 5.38346$$

$$R^2 = 0.75632$$

For cation exchange capacity CEC:

$$CEC = \frac{P_1 * LL}{(P_2 + LL)} + \frac{P_3 * LL}{(P_4 + LL)} + P_5 * LL \quad (10)$$

$$P_1 = 0.00339 \pm 0.00553$$

$$P_2 = -44.83234 \pm 0.27243$$

$$P_3 = -0.04114 \pm 0.20594$$

$$P_4 = -55.2516 \pm 18.26085$$

$$P_5 = 0.03224 \pm 0.01049$$

$$Chi - sqr\left(X^2\right) = 0.08941$$

$$R^2 = 0.82853$$

R^2 - coefficient of determination, LL – liquidity limit, CEC – cation exchage capacity, SSA – specific surface area, $\boldsymbol{X^2}$- statistic is a measure of the difference between the observed and expected frequencies of the outcomes of a set of variables.

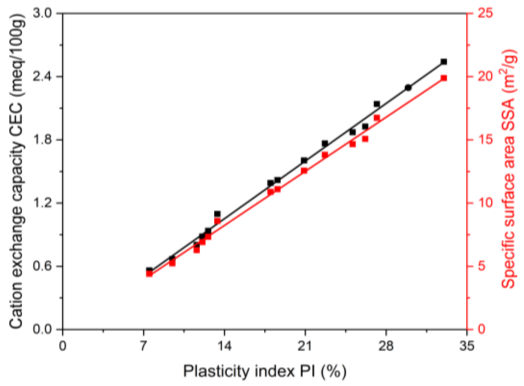

Figure 8. Correlation between cation exchange capacity, specific surface area and plasticity index

The relationship between cation exchange capacity, specific surface area of a soils and plasticity index is a linear fit:

For the specific surface area SSA:

$$SSA = a + b * PI \quad (11)$$

$$a = -0.32659 \pm 0.27016$$

$$b = 0.61139 \pm 0.01359$$

$$R^2 = 0.99362$$

For the cation exchange capacity CEC:

$$CEC = a + b * PI \quad (12)$$

$$a = -0.04265 \pm 0.03458$$

$$b = 0.07815 \pm 0.00174$$

$$R^2 = 0.9936$$

R^2 - coefficient of determination, PI – plasticity index, CEC – cation exchage capacity, SSA – specific surface area.

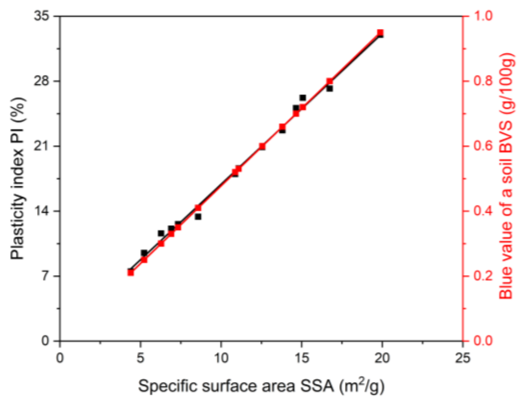

Figure 9. Correlation between plasticity index, blue value of a soil and specific surface area

The relationship between cation exchange capacity, specific surface area of a soils and plasticity index is a linear fit:

For the blue value of a soil BVS:

$$BVS = a + b * SSA \quad (13)$$

$$a = -1.78985E - 4 \pm 8.83003E - 5$$

$$b = 0.0478 \pm 7.44709E - 6$$

$$R^2 = 1$$

For the plasticity index PI:

$$PI = a + b * SSA \tag{14}$$

$$a = 0.63981 \pm 0.42853$$

$$b = 1.62599 \pm 0.03614$$

$$R^2 = 0.9936$$

R^2 - coefficient de détermination, PI – plasticity index, BVS – blue value of a soil.

Figure 10 shows the correlations between blue value of a soil and the plasticity index.

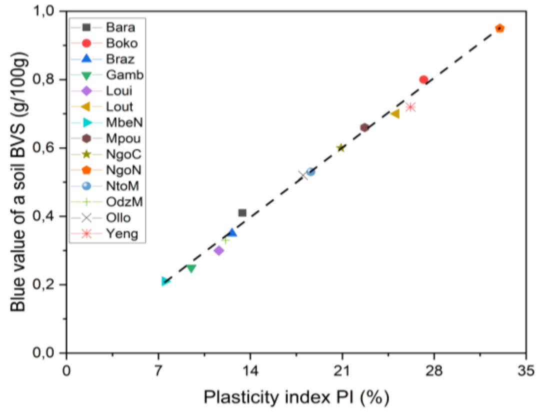

Figure 10. Relationship between the blue value of a soil and the plasticity index

The relationship between blue value of a soil and plasticity index is a linear fit:

$$BVS = a + b * PI \tag{15}$$

$$a = -0.01578 \pm 0.01294$$

$$b = 0.02922 \pm 6.50905E - 4$$

$$R^2 = 0.99359$$

R^2 - coefficient of determination, BVS – blue value of a soil, PI – plasticity index.

Figure 11 shows the correlations between activity and surface area activity.

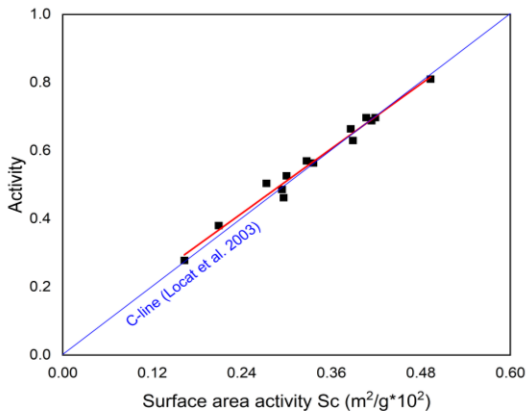

Figure 11. Relationship between activity and surface area activity

The relationship between activity and surface area activity is a linear fit:

$$Ac = a + b * Sc \tag{16}$$

$$a = -0.03642 \pm 0.0229$$

$$b = 1.358226 \pm 0.06602$$

$$R^2 = 0.97783$$

R^2 - coefficient of determination, Ac – activity, Sc – surface area activity.

Figure 12 shows the correlations between activity and clayey fraction.

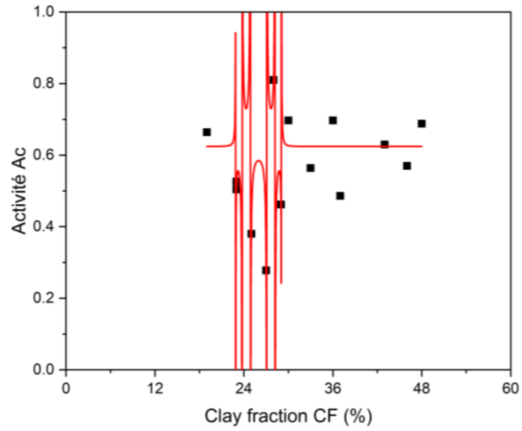

Figure 12. Relationship between activity and clayey fraction

The relationship between activity and clayey fraction is a single peak fit of the InvsPoly model:

$$A_C = Y_0 + \frac{A}{\left(1 + \frac{A_1 * (2 * (CF - X_c))}{W}\right)^2} + A_2 * \left(\frac{2 * (CF - X_C)}{W}\right)^4 + A_3 * \left(2 * \left(\frac{CF - X_C}{W}\right)^6\right) \tag{17}$$

$$\mathbf{Y}_0 = 0.62444 \pm 0.02729$$

$$X_C = 25.98003 \pm 0.04988$$

$$W = 6.17446$$

$$A = -0.03981 \pm 0.06446$$

$$A_1 = -10.61595$$

$$A_2 = 24.56775$$

$$A_3 = -14.93739$$

$$Reduced\ Chi - S = 0.00599$$

$$R^2 = 0.70349$$

R^2 - coefficient of determination, Ac – activity, CF – clayey fraction, $\boldsymbol{X^2}$- statistic is a measure of the difference between the observed and expected frequencies of the outcomes of a set of variables.

4. Discussion

From Table 1, the activity of the inactive termite mound soils varied from Ac (0.278-0.697) and their surface area activity Sc (0.163-0.493). The normal clay of (Mpou) has an activity of Ac (0.81) and a surface area activity of Sc (0.493). The relative activity RA determines the role that the specific surface area plays on the plasticity of the clayey fines, it is none other than the ratio between the activity and the surface area activity [24].

From Table 1, the plasticity index represents the range of water content over which a soil exhibits plastic behaviour. In other words, for two soils (OdzM, Loui) with the same clayey fraction CF (31%) and the same minerals (kaolinite, illite) fig. 5, the soil (OdzM) is more active, with an activity Ac (0.526) Table 1 and a plasticity index PI (12.1%), which is the higher [5,16,23].

From Figure 5, the soils (Yeng, OdzM, NgoN, NgoS, Boko) are inactive clays [14], with low to medium plasticity Figure 3 and low to medium swelling Figure 4. The soils (Léka, Mpou, NgoC, Gamb, Bara) are normally active clays [14], they have low plasticity Figure 3, but swell Figure 4.

The inactive soil clays (Bara, Boko, Braz, Gamb, Loui, Lout, MbéN, NgoC, NgoN, NtoM, OdzM, Ollo, Yeng) contain the minerals (kaolinite, illite) Figure 5 and their specific surface area of SSA (8.16 -15.07 m2/g) (Table 1).

The normal soil clay (Mpou) contains the minerals (kaolinite, illite) Figure 5, with specific surface area of SSA (5.23-19.88 m2/g) Table 1. The soil (Mpou) is swelling, composed of the minerals (kaolinite, illite) and a specific surface area of SSA (13.81 m2/g). Swelling soils containing kaolinite generally have specific surface areas ranging from 10 to 40 m^2/g [16,25].

From Figure 7, the correlation (8) between the specific surface area and the liquidity limit, will not be retained, independently of the coefficient of determination of R^2 (0.75632). Indeed, the Chi-sqr of X^2 (5.38346) of the relation (8) is very high. The relationship (9) between cation exchange capacity and liquidity limit has a very low Chi-sqr of X^2 (0.08941) and will be retained for the prediction of one of the two parameters.

From Figure 8 and Figure 9, the plot of plasticity index versus specific surface area is a linear fit, because the specific surface area controls the range of water content from the liquidity limit to the plastic limit [26]. The plasticity index is closely related to the specific surface area [24] and the liquidity limit is related to the specific surface area by the relation LL=PI+LP [21].

From Figure 9, the blue value of a soil characterizes the activity of the clays and accounts for the surface activity which is defined as the ratio between the specific surface area and the clayey fraction. There is a linear relationship between the plasticity index and the clayey fraction called activity [14] and between the plasticity index and the specific surface area [26]. In other words, the relationship between blue value of a soil and plasticity index is a linear fit (Figure 5) for all soils [5,17,23].

From Figure 10, the relationship between the blue value of a soil (characterizes the activity of clays and accounts for surface activity) [22] and the plasticity index (is the range of water content over which a soil exhibits 'plastic' behaviour) [21] is a linear fit for all soils [5,17,23].

From Figure 11, the relationship defined by Locat et al. 2003 [26], does not appear to be a constant for all clays [18]. From Figures 11 and 13, the relationship between activity and surface area activity is a linear fit with a determination coefficient of R^2 (0.97783) for termite mounds soils Cubitermes Spp. According to Figure 12, the relationship between activity and clayey fraction is fundamental for the prediction of the intrinsic properties of the termite mound soils Cubitermes Spp. Indeed, knowing only the clayey fraction from the particle size analysis, with the relation (17), one can predict the other intrinsic properties of the soils.

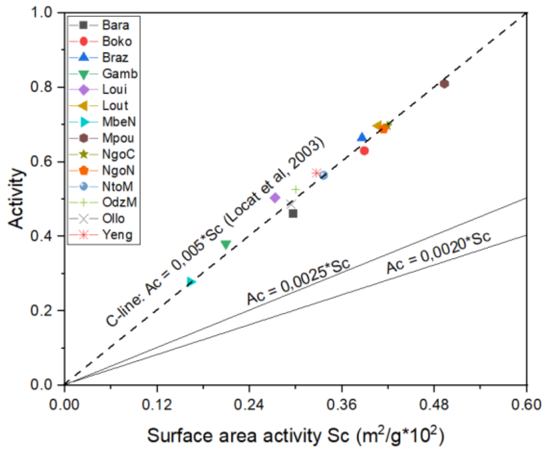

Figure 13. Activity as a function of surface area activity (Locat et al. 2003)

From Figure 13, the soils (NtoM, NgoN, NgoC) are three clays of medium plasticity (Figure 3), medium swelling (Figure 4), containing the minerals (kaolinite, illite) Figure 5. The soil (MbeN) is a low plasticity (Figure 3) and low swelling silt (Figure 4) containing the minerals (kaolinite, illite) Figure 5. The soils (NtoM, NgoN, NgoC, MbéN) are located on the line-C [26], these soils may have the same characteristics as the soils studied by Locat et al. 2003 [26]. Line-C [26], suggests that marine clays, which have an illitic mineralogy, show an lenear relationship between plasticity index and specific surface area (Figure 7) [5,17,26].

Kaolinite in termite mound soils containing clay is of great necessity especially for the making of solid mud bricks. Indeed, clay is known for its crystallising properties, i.e. acting as a mortar especially when the soil contains organic matter [27]. This can improve the mechanical strength of the soil. Illite is one of the important minerals in the composition of soils especially for the firing of earthenware (bricks, tiles and pottery), as it promotes sintering at a relatively low temperature [28].

5. Conclusion

In geotechnical engineering, swelling potential and soil classification are used to determine soil use standards. The correlation between the blue value of a soil and the liquidity limit is a nonlinear curve fit of the dHyperbl model, with R^2 (0.75598) and $\chi2$ (0.01232). The relationship between the cation exchange capacity (CEC) and the liquidity limit (LL) is a nonlinear curve fit of the dHyperbl model, with R^2 (0.82853) and $\chi2$ (0.08941). The relationship between the specific surface area SSA and the liquidity limit LL is to be discarded because of its very high Chi-sqr of $\chi2$ (5.38346). Blue value of a soil VBS and plasticity index PI as a function of the specific surface are linear fits, with R^2 (0.99359 - 1). The correlations between CEC and SSA as a function of the plasticity index PI are linear fits, with R^2(0.9936 - 0.99362). The relationship between activity and surface area activity is a linear fit, with R^2(0.9778). The relationship between activity and clayey fraction is fundamental for the prediction of other soil parameters, with R^2 (0.70349) and $\chi 2$ (0.00599). Four soils located on the line-C of Locat et al. 2003 are low plasticity soils with medium swelling potential and consisting of the minerals (kaolinite, illite).

The relationship between activity and clayey fraction is fundamental in predicting the intrinsic properties of termite mounds soils Cubitermes Spp. The soils (NtoM, NgoN, NgoC) are medium plasticity, medium swelling clays and the soil (MbeN) is a low plasticity, low swelling silt (Figure 3), containing the minerals (kaolinite, illite) Figure 5.

The soils (NtoM, NgoN, NgoC, MbéN) located on line-C, may have the same characteristics as the soils studied by Locat et al. 2003. Line-C suggests that marine clays, which have an illitic mineralogy, show a linear relationship between plasticity index and specific surface area. The MbeN soil contains the mineral (kaolinite) and the other soils the minerals (kaolinite, illite).

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