



## Characterization of the SEHOUE – MASSI clay used for chemical purification: case of GBAGO ponds (Porto-Novo, Republic of Benin)

Arthur Romuald CAKPO<sup>1\*</sup>, Lyde A S TOMETIN<sup>2</sup>, Narcisse FANOUE<sup>1</sup>, Ferdinand GOUDJO<sup>1</sup>, Igor B AKODEDJROHOUN<sup>1</sup>, Etienne SAGBO<sup>1</sup> and Mohamed M SOUMANOU<sup>3</sup>

<sup>1</sup>Laboratoire de Chimie Physique-Matériaux et Modélisation Moléculaire (LCP3M), Unité de recherche de Chimie Inorganique, Ingénierie des Matériaux et Environnement (URCIIME), Faculté des Sciences et Techniques (FAST), Université d'Abomey - Calavi, République du Bénin

<sup>2</sup>Laboratoire Kabba de Recherche en Chimie et Applications (LaKReCa), Ecole Normale Supérieure de Natitingou de l'Université Nationale des Sciences, Technologies, Ingénierie et Mathématiques (UNSTIM), République du Bénin

<sup>3</sup>Laboratoire d'Etude et de Recherche en Chimie Appliquée (LERCA), Ecole polytechnique d'Abomey-Calavi (EPAC), Université d'Abomey-Calavi, République du Bénin  
arthurac22@gmail.com

Available online at: [www.isca.in](http://www.isca.in), [www.isca.me](http://www.isca.me)

Received 5<sup>th</sup> December 2022, revised 29<sup>th</sup> June 2023, accepted 26<sup>th</sup> July 2023

### Abstract

*The principal objective of this research is to develop the local fisheries with the aim of increasing the productivity of local halieutics resources. The depollution of the studied ponds was made with the clay of SEHOUE-MASSI which is a locality located at 98 km of the town of Cotonou. The site of SEHOUE-MASSI is located between 213°E and 216°E then between 657' and 659'N in LAMA depression with generally flat relief. Ten wells with the mesh of 100m and maximum depth 5m for the majority and sometimes 7m were explored. The clays obtained are plastic, of bank gray color in general. The samples are taken according to the colors observed according to depths and are put in sachets from 5 to 10kg. The clay reserve on the site of SEHOUE-MASSI is estimated at 15,30,000 tonnes according to work's of the Beninese Office of Geological and Mining Research (BOGMR). The purpose of the depollution of the studied ponds is to increase the productivity on a scale of the local fisheries by treating the ponds with lower cost than to booster local consumption and the marketing of the halieutics products in order to reduce the importation of the imported frozen products. The results obtained showed that clays used can cleanse the water samples of GBAGO ponds.*

**Keywords:** Depollution, species halieutics, decontamination, ponds, clay.

### Introduction

Clays are rocks of geological origin. The phenomenon of erosion accentuated by chemical reactions entrains the degradation of the rocks<sup>1</sup>. The study area is within the Pan-African range zone of Dahomeyids<sup>2</sup>. The rocks are metamorphic and magmatic. The climatic conditions having caused their formation and the nature of the bed rock determine the nature of formed clay. The plasticity and adsorption of the clays are the properties due to the presence of the fine particles of size lower than 2µm were noted during levitating of the components of clays according to their sizes.

SEHOUE - MASSI clay was used as adsorbents for chemical purification of the water samples pollutants of GBAGO ponds.

The mineralogical characterization of the crystallized substances was made by Diffraction with x-rays technique. It arises from work of Wiewiora<sup>3</sup>, Brewster<sup>4</sup> and Robert<sup>5</sup>, that the reticular plans of more or less crystallized minerals are obtained by diffraction of incident rays.

The diffraction of x-rays remains the first method for the mineralogical characterization of argillaceous minerals. It is

often used identify the type of clays and for their semi quantitative evaluation<sup>5</sup>

### Material and methods

**Material:** The diffraction of X-rays on powder was carried for mineralogical study of the total or raw rock, finely crushed. A diffractometric study was also made on the fine fraction (< 2µm) purified or normal. The normal fraction obtained was used to prepare directed pastes to undergo the specific treatments.

A Philips brand diffractometer provided with a generator PW 1800 and graphite monochromator was used for recording the diffractograms. The machine used the cobalt radiation and functioning under 40Kv, 40my. X' PERT High Score and the software X' PERT & IDENTIFY were used for treating the spectra.

**Material of the test of cytotoxicity of the water samples of the ponds:** We bought the Onions at kpétoukpinmèdé market in Porto-Novo and dried with the laboratory and some samples of water of the studied sites<sup>6</sup>

Clays of SEHOUE-MASSI were used to treat the water samples of the three sites.

The water samples are those of three ponds of the locality of GBAGO

**Method: Method of treatment of clays:** The samples of clay were crushed in an agate mortar and sometimes filtered with 2 mm before the preliminary analyses. These are brute clays. The diffraction of X-rays on powder of the finely crushed raw rock and on the fine fraction (< 2µm) purified or normal was used for the mineralogical study.

The analyzed sample must be rich in argillaceous minerals. The sample subjected to the beams of x-rays must present the greatest possible number of plans of maximum atomic density from where orientation of the preparations according to a direction parallel with that of the leaflets; these are directed preparations. The sample must be subjected if one needs it for treatments specific to highlight the variability of the interfoliaceous equidistant to knowing: saturation by a polyalcohol, saturation by hydrazine, the heating with 490°C during 4H<sup>7</sup>. In this case the angular sector ranging between 3 and 35 Å is completely satisfactory.

**Method of cytotoxicity test of water:** Various concentrations: 0%, 25%, 50%, 75% and 100% were used for the cytotoxicity test.

We placed onions in the darkness and we changed their culture medium every 24 hours.

After 96 hours of culture (4 days) we measured the lengths of the onions roots for the cytotoxicity test<sup>8</sup>

## Results and Discussion

**Toxicity of ponds water: Parameters based on the length of the roots of onions:** According to the parameters based on the lengths of the onions roots<sup>9</sup>, the roots are growing more on the level of the water samples<sup>10</sup> of the three sites treated by clay B of SEHOUE-MASSI (Figure-1) that when they are not treated (Figure-2). On Figures-3, 4 and 5; we noted on each studied site that the roots have grown more quickly on the site treated by clay B than on the untreated sites. We therefore deduce that the clay used makes it possible to reduce the toxicity of the studied sites.

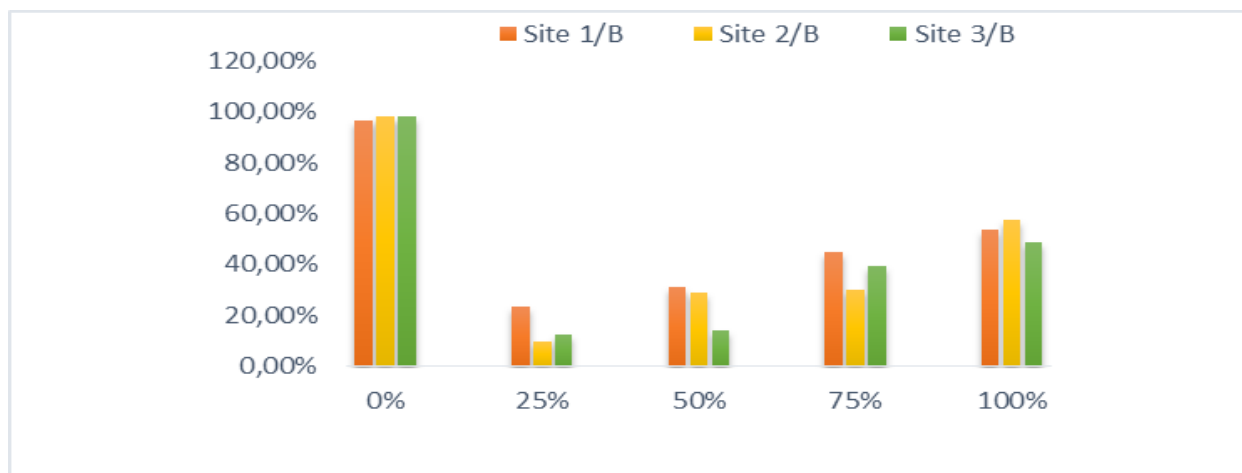


Figure-1: Average lengths of the onions roots of the three sites treated by clay B (Clay of SEHOUE-MASSI).

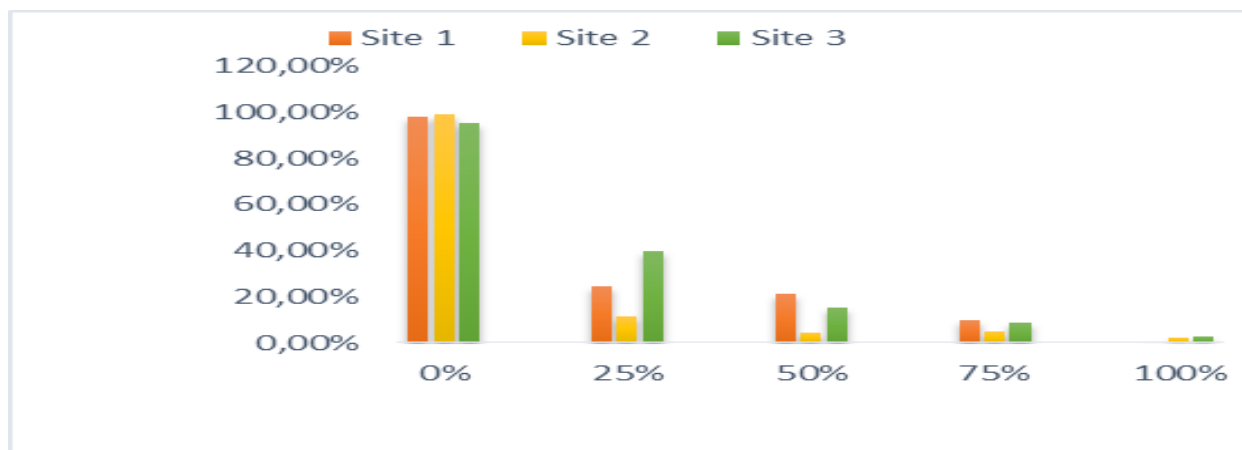


Figure-2: Average lengths of the onions roots of the three sites untreated by clays.

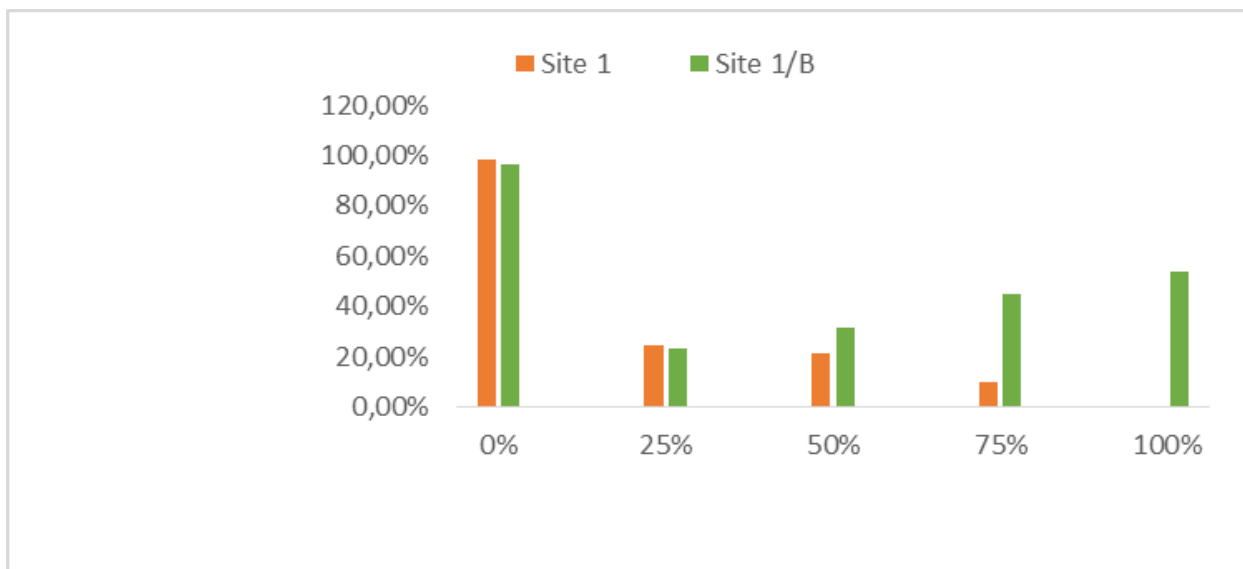


Figure-3: Average lengths of the onions roots of site 1 untreated and treated by clay B.



Figure-4: Average lengths of the onions roots of site 2 untreated and treated by clay B.

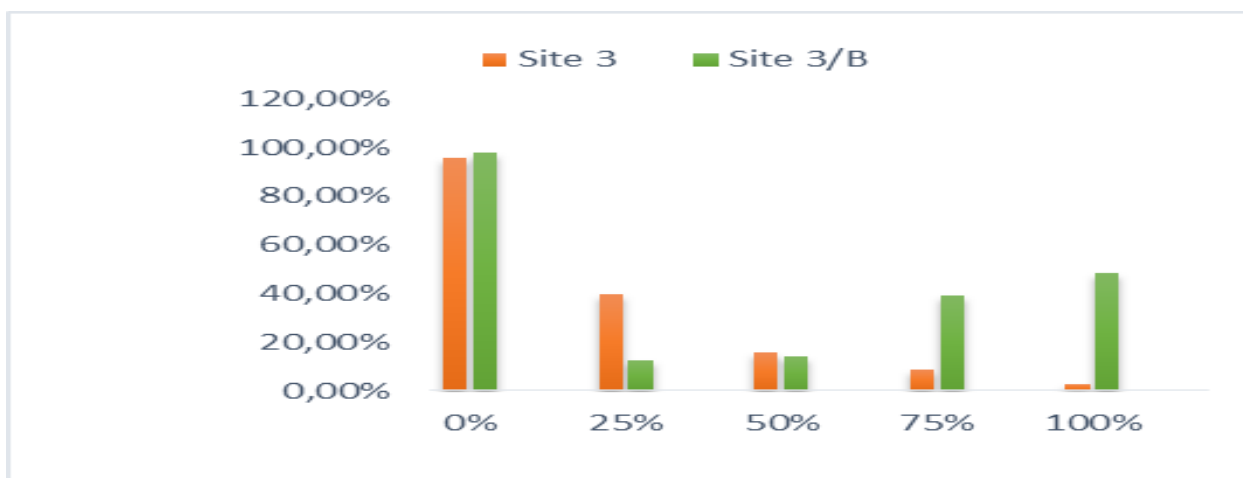


Figure-5: Average lengths of the onions roots of site 3 untreated and treated by clay B.

**Results of mineralogical analyses:** The chemical analyses showed magnesium and calcium abundance in clays of SEHOUE-MASSI compared to those of the other sectors whereas the contents of iron and titanium appear less low<sup>11</sup>. The samples of clay contain quantitatively SiO<sub>2</sub> (45.4-63.8%) and Al<sub>2</sub>O<sub>3</sub> (13.9-23.1%) as mains oxides. Follow-up of Fe<sub>2</sub>O<sub>3</sub> or and FeO (6-11%), and of TiO<sub>2</sub> (0.9-1.5%) and according to each site we have K<sub>2</sub>O, MgO, P<sub>2</sub>O<sub>5</sub>, CaO and Na<sub>2</sub>O in variable quantity. Barium, lead, zinc, copper and nickel are the other components which also appear with the state of traces. The results of the analysis by diffraction of the X-ray are conforming with

chemical analyses. Indeed, the samples of clay contain (SiO<sub>2</sub> + Al<sub>2</sub>O<sub>3</sub>) between 67 and 81%. Thus silico-aluminous minerals with dominance of SiO<sub>2</sub> are the mains components.

The diffractograms of x-rays obtained on the total rocks are presented on figure 7. The major crystalline phases contained in all the clay samples minerals such as: Kaolinite (K): Al<sub>2</sub>Si<sub>2</sub>O<sub>5</sub>(OH)<sub>4</sub> (7.14Å;3.56Å). Quartz (Q): SiO<sub>2</sub> (3.33Å;1.81Å;4.26Å)<sup>12</sup>. Smectite (S): (Ca,Mg)(Al,Fe)<sub>2</sub>(Si,Al)O<sub>10</sub>(OH)<sub>2</sub> (14-15Å)<sup>7</sup> and like trace phase the Anatase (A): TiO<sub>2</sub> (3.52Å;1.89Å).

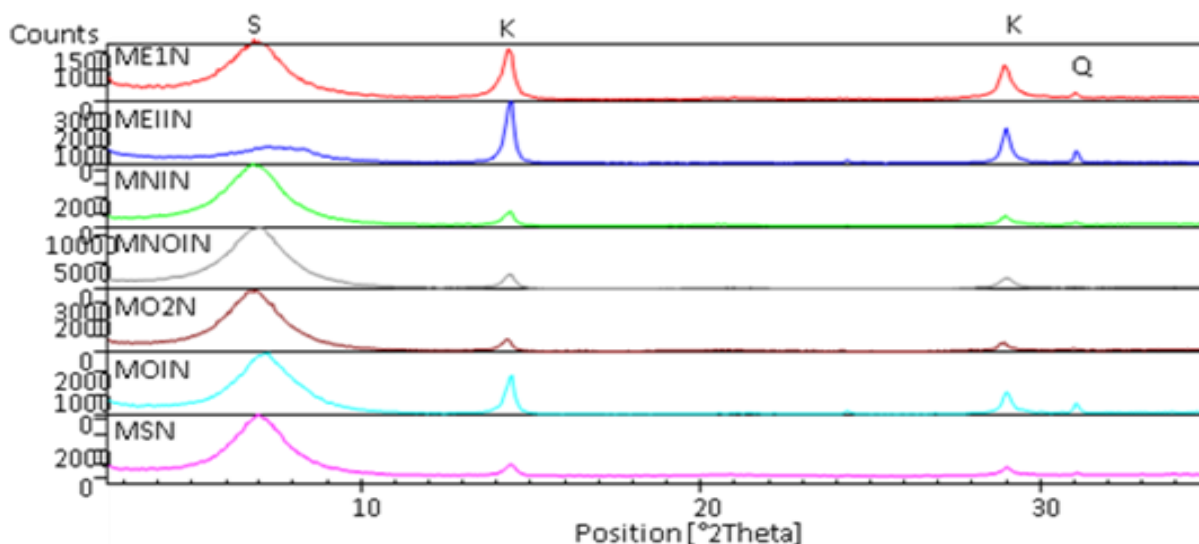


Figure-6: Diffractograms of normal fractions of SEHOUE-MASSI.

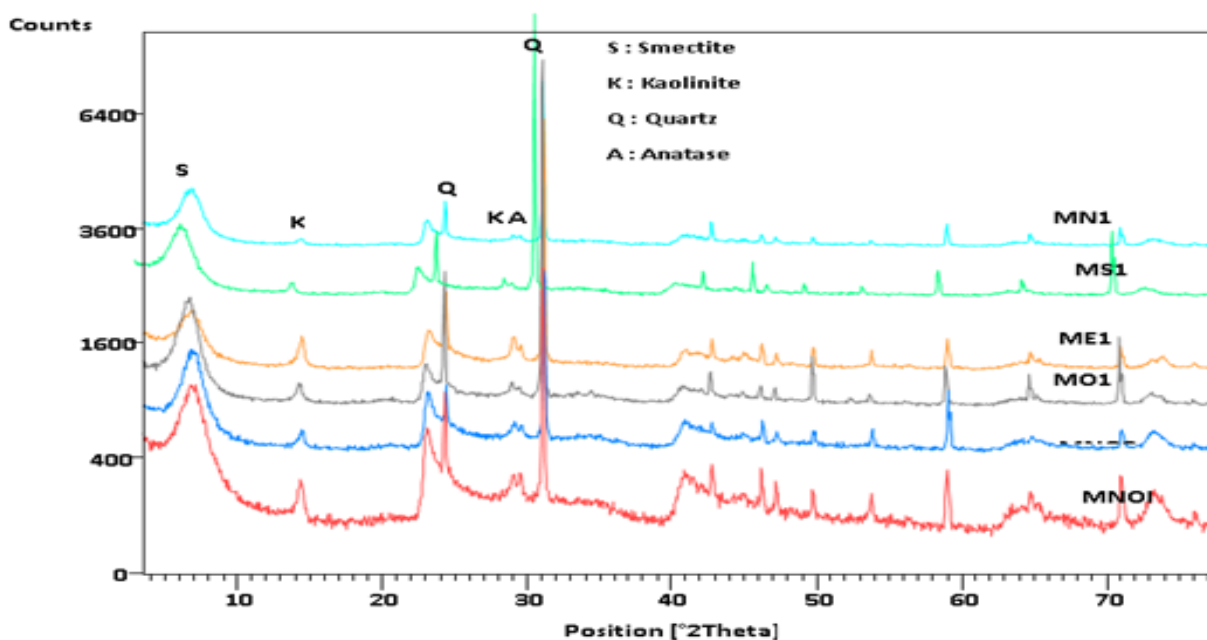


Figure-7: Diffractograms of the total rock samples of SEHOUE-MASSI.

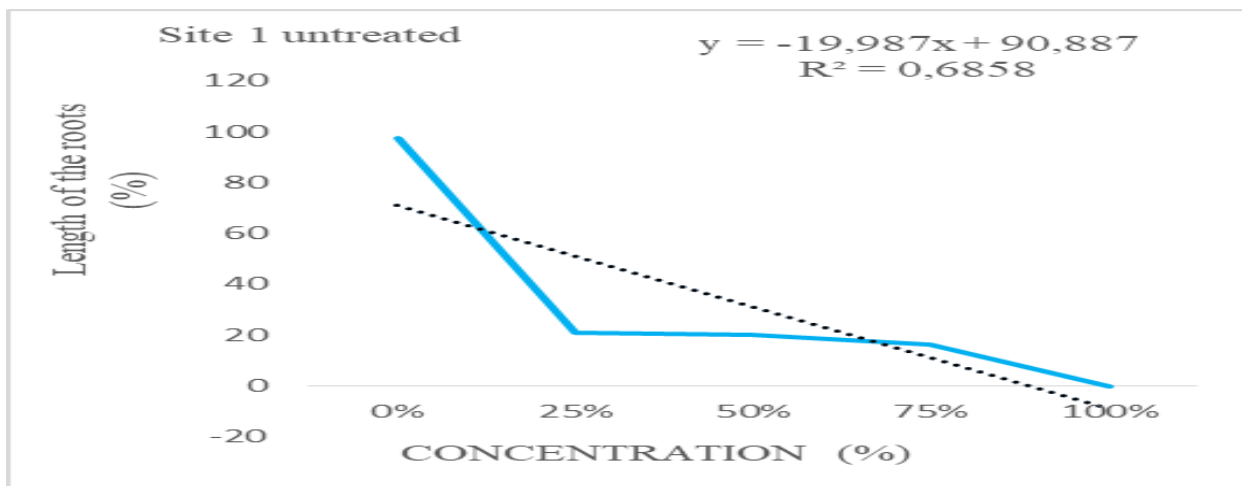


Figure-8: EC50 of site 1 untreated.

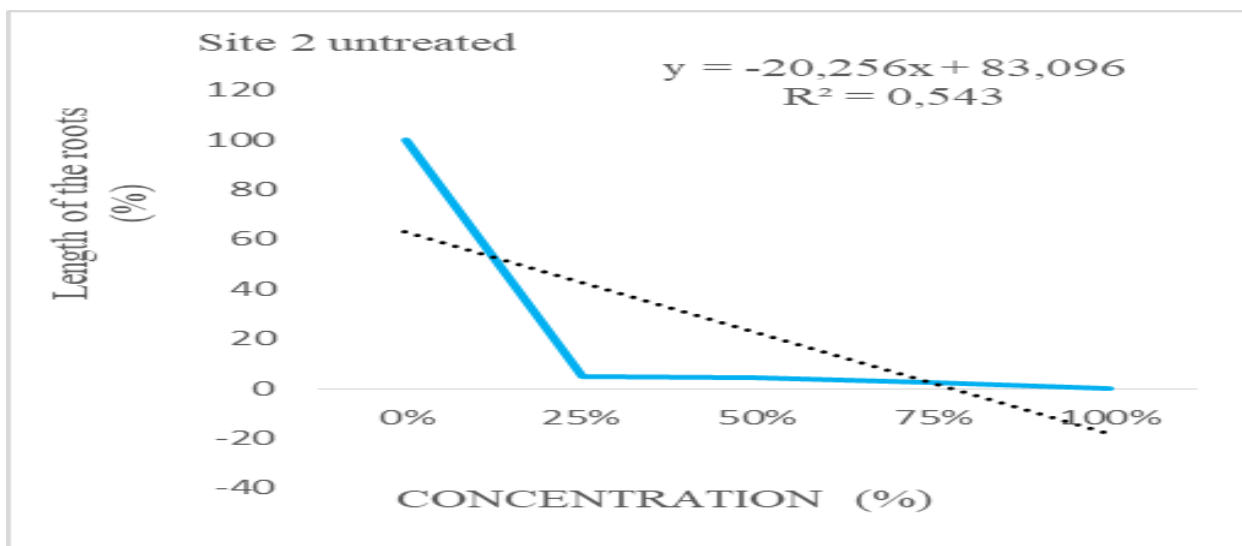


Figure-9: EC50 of site 2 untreated.

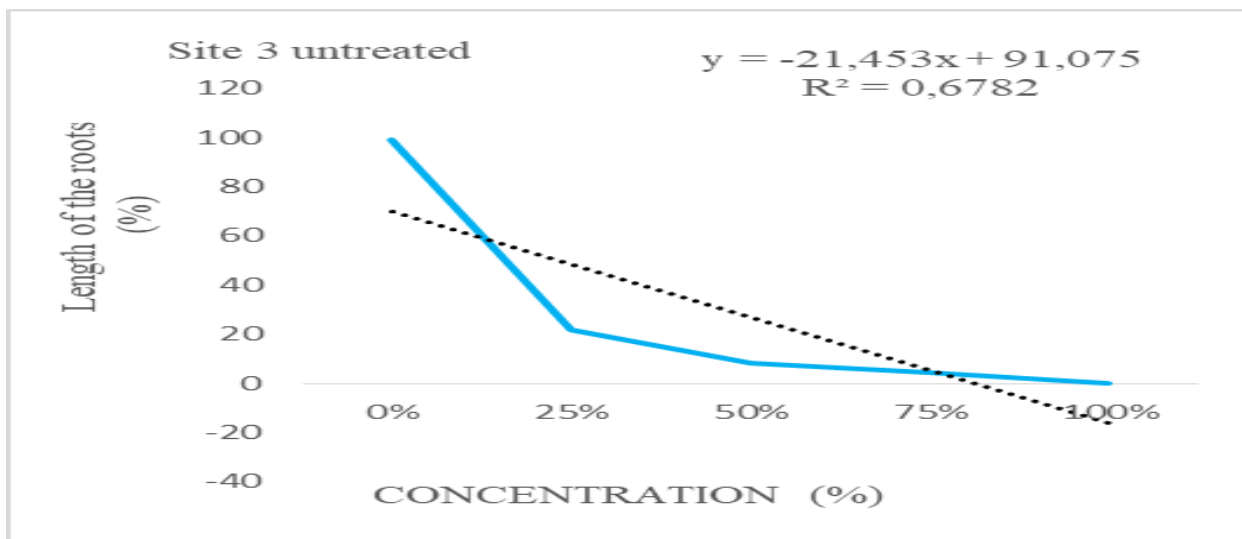


Figure-10: EC50 of site 3 untreated.

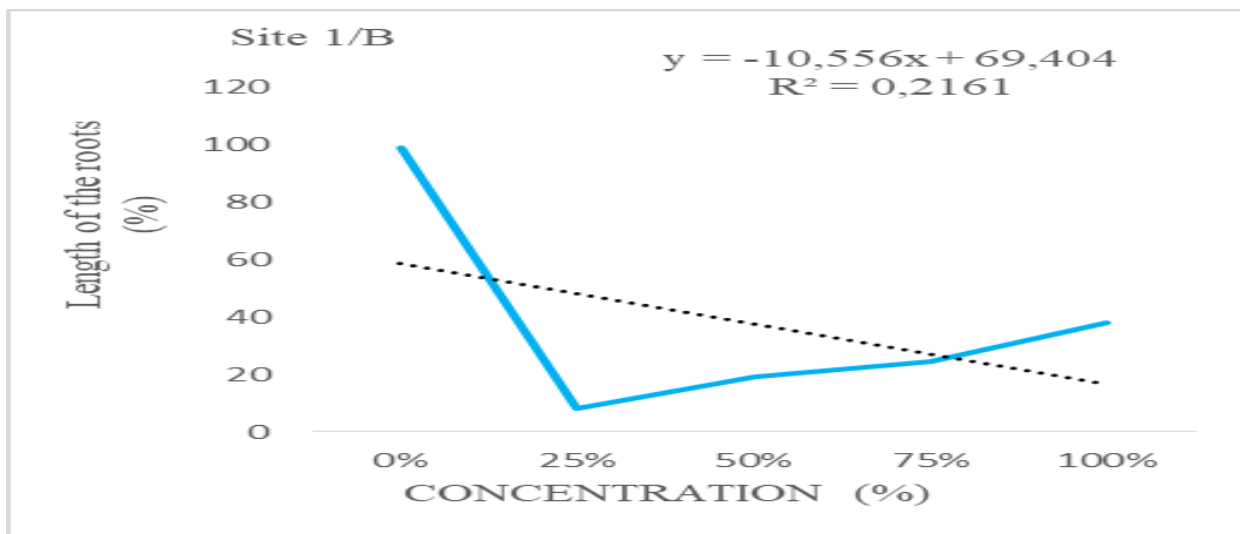


Figure-11: EC50 of site 1 treated by clay B.

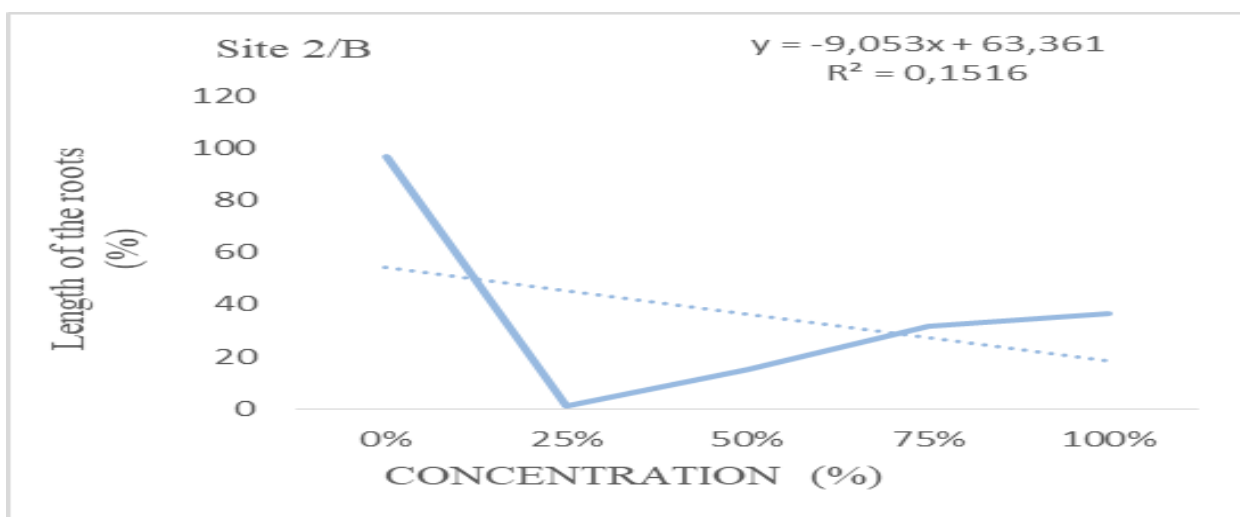


Figure-12: EC50 of site 2 treated by clay B.

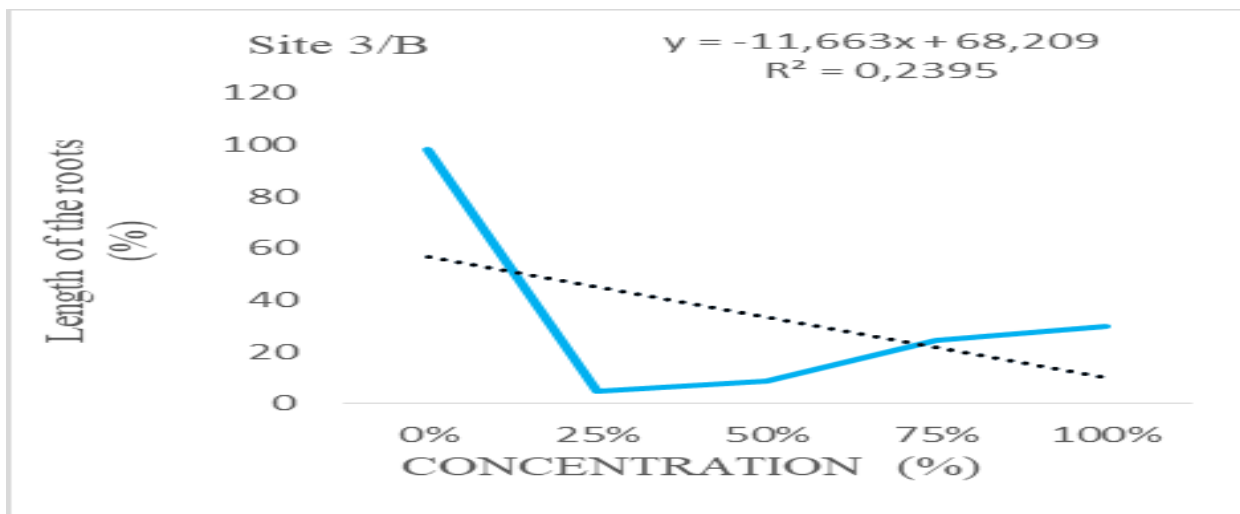


Figure-13: EC50 of site 3 treated by clay B.

The diffractograms of the normal fractions are represented on Figure-6. They highlight the argillaceous phases contained in the total samples of the sites according to various proportions at knowing: Smectite detected by the line d(001) which is presented between 14Å and 15Å, Kaolinite which is presented at 7.2Å and 3.56Å. The width of the peak of the Smectite could easily include a line towards 10Å which would be due to the illite. The quartz is almost eliminated by sedimentation. All this confirms the homogeneity of the sites.

**Parameters based on growth inhibitions of onions roots:**

According to the parameters based on growth inhibition of onion roots, the effective concentrations (EC<sub>50</sub>) varied from 20 % to 28 % (Figures-8, 9, 10, 11, 12, 13). The values obtained in Table-1 show that the EC<sub>50</sub> (the effective concentration of the chemical producing 50% of the total effect) of the three untreated sites are lower than those of the sites treated by clay B. We therefore deduce that the clay used made it possible to decontaminate the three sites studied. These results of the cytotoxic study<sup>13</sup> confirm those of toxicity obtained previously.

**Table-1:** Concentrations EC<sub>50</sub> of three sites.

Site	EC <sub>50</sub> (Site untreated)	EC <sub>50</sub> (Site treated by clay B)
Site 1	25%	28%
Site 2	20%	24%
Site 3	22%	26%

**Conclusion**

The physicochemical parameters varied slightly according to the three sites. Total toxicity on the three (3) sites varies according to parameters' based over the length of the roots of onions<sup>14</sup>. Acute toxicity (EC<sub>50</sub>: Effective Concentration 50) on the three (3) sites varies according to parameters based on inhibition of onion root growth.

According to results obtained, site 2 is the most polluted of the three sites followed more by site 3. The acute toxicities (EC<sub>50</sub>) obtained on the three sites make it possible to note that clays of SEHOUE- MASSI decontaminate the water samples of the treated ponds

**References**

1. Sagbo, E. (2015). Characterization and valorization of some clays of the coastal sedimentary basin of the Benin. Thesis, Formation Doctorale Chimie et Applications (FAST), UAC, Bénin
2. Bessoles, B., & Trompette, R. (1980). Geologie de l'Afrique, la chaîne panafricaine" zone mobile d'Afrique centrale (partie sud) et zone mobile soudanaise".

3. Wiewióra, A., & Weiss, Z. (1985). X-ray powder transmission diffractometry determination of mica polytypes: method and application to natural samples. *Clay Minerals*, 20(2), 231-248.
4. Brewster, G. R. (1980). Effect of chemical pretreatment on X-ray powder diffraction characteristics of clay minerals derived from volcanic ash. *Clays and Clay Minerals*, 28, 303-310.
5. Robert, M., Hardy, M., & Elsass, F. (1991). Crystallochemistry, properties and organization of soil clays derived from major sedimentary rocks in France. *Clay Minerals*, 26(3), 409-420.
6. Samuel, O. B., Osuala, F. I., & Odeigah, P. G. (2010). Cytogenotoxicity evaluation of two industrial effluents using *Allium cepa* assay. *African Journal of Environmental Science and Technology*, 4(1).
7. Holtzappel, T. (1985). Les minéraux argileux, préparation, analyse diffractométrique et détermination. *Société géologique du Nord*, 12, 1-36.
8. Cakpo, A. R. (2012). Etude de la toxicité des eaux d'une lagune tropicale et contamination du poisson par le plomb: Cas du tilapia (*Sarotherodon melanotheron*) de la lagune de Porto-Novo (Sud Bénin). DEA, FAST, Université d'Abomey-Calavi.
9. Cakpo, R. A. (2015). Study of chemical pollution, the toxicity of the sediments and fishes and the cytogenotoxicity of waters and fishes of a tropical lagoon: case of the lagoon of Porto-Novo (South of Benin). Thesis, Formation Doctorale Chimie et Applications (FAST), UAC, Bénin ; 151p
10. Samuel, O. B., Osuala, F., Odeigah, P. G. (2010). Cytogenotoxicity evaluation of two industrial effluents using *Allium cepa* assay. *African Journal of Environmental Science and Technology*, vol 4(1): 021-027
11. Itheta, B. (1982). Rapport sur les recherches géologiques d'argiles dans la zone du Bassin Sédimentaire côtier du Bénin. Programme des Nations Unies pour le Développement.
12. Caillière, S., & Hénin, S. (1982). *Minéralogie des argiles*. (No Title).
13. Bakare, A. A., Mosuro, A. A., & Osibanjo, O. (1999). Cytotoxic effects of landfill leachate on *Allium cepa* L. *Biosci. Res. Com*, 11(1), 1-13.
14. Chauhan, L. K. S., Saxena, P. N., & Gupta, S. K. (1999). Cytogenetic effects of cypermethrin and fenvalerate on the root meristem cells of *Allium cepa*. *Environmental and experimental botany*, 42(3), 181-189.

