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Full Length Research Paper

Geophagic clays: Their mineralogy, chemistry and possible human health effects

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Randomly chosen representative geophagic clay samples from Cameroon and Nigeria were mineralogically and chemically analysed. The primary objectives of the study were to qualitatively and quantitatively identify the mineral constituents and to determine selected elemental compositions in the clay samples in order to infer on possible human health effects. Laboratory tests performed on the samples included X-ray powder diffractometry (XRPD), Fourier transform infra red (FTIR) spectrophotometry, and selected trace elemental analysis using inductively coupled plasma-mass spectrometer (ICP-MS). Quartz and kaolinite were conspicuously dominant in the samples. Very significantly, low concentrations of Rb, Ba, Sr, Sc, V, Cr, Co, Ni, Cu, Zn, Y, Zr, Nb and Mo as well as Th and Pb were detected in the samples. Results depict purified and refined clays of sedimentary origin with medicinal and nutritional values beneficial to the geophagic individual though there are possibilities of associated human health risks.

Key words: Kaolinite, quartz, medicinal and nutritional values, health risks.

INTRODUCTION

Geophagia is the custom of involuntarily deliberate ingestion of soil, especially by women and children. The habit is as old as humankind, and is more prevalent in some societies than others. In the 16th to 18th century, geophagia was regarded as magical and superstitious, hence the desire for its prevention and therapy for those indulged in its habit (Halsted, 1968). The link between geophagia, hunger and poverty has been claimed (Von Humboldt, 1985) although there is evidence to suggest that the practice is not limited to poor people but cuts across socio-economic, ethnic, religious and racial divides. The African explorer, David Livingstone reported in detail his observations on geophagia in Africa and refuted poverty as a possible explanation for the practice (Woywodt and Kiss, 2002). He observed that the practice was common amongst the slaves, the contended workers as well as the poor and that the abundance of food did not prevent it (Livingstone, 1870). No single reason for the practice of geophagia by all societies has been advanced. In Peru, lumps of clay were used as pacifiers for little children (von Homboldt, 1985) and in the 19th century Sweden it was not unusual for certain people to mix earth and flour to bake bread (Halsted, 1968) although it is not clear whether such action was necessitated by the shortage of flour or an act to improve quality and/or taste of bread (Olivier, 1997). In the south of USA, geophagia was reported to be so prevalent that clay could be purchased in small bags at bus stations for the convenience of travelers; and migration of African American families to the North in search of jobs, saw large sacks of clay purchased and mailed to them by relatives who stayed behind (Edwards et al., 1994; Lourie et al., 1963).

Geophagic clays have been commonly designated according to the name of community from which they come (Vermeer, 1979). In parts of Nigeria, clay is mined in large quantities and distributed for sale in markets all over West Africa (Hunter, 1973). Geophagic practice is so prevalent that some clay for sale in open markets throughout Cameroon are generally referred to as

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'Calabar chalk'; named after Calabar, a city in the South Eastern part of Nigeria renowned for mining and sale of geophagic clays. Pregnant women in Nigeria and Cameroon believe that the eating of clay is good for their unborn children because it makes the skin of their babies smooth and beautiful. Reports in South Africa reveal that young urban women believe that earth-eating makes them more beautiful (Woywodt and Kiss, 2002). Clays were used against poison, even mercury poisoning (Thompson, 1913) and the success of this treatment has been ascribed to the ion-exchange capacity of the clay (Black, 1956). Pathogens could be introduced to the body through ingestion of geophagic clays (Booth, 1934).

Geophagia has been linked to anaemia as far back as several centuries ago (Avicenna, AD 980 - 1037; Cragin, 1836). More recent researchers and physicians have confirmed the long held observation (McDonalds and Marshall, 1964; Carlander, 1959; Lanzkowsky, 1959; Minnich et al., 1968). Red earth is believed to have properties that might prevent iron deficiency anaemia, although iron bioavailability has been refuted (Harvey et al., 2000; Dreyer et al., 2004). Tateo and Summa (2007) describes the mobility of elements in clay for healing and notes that its usage is widespread but the chemical component of the clay is hardly given any consideration.

Although several mineralogical identification and characterization studies have been carried out on clays, very sparsely documented evidence exist in scientific literature referring to the mineralogical and chemical nature of geophagic clays. In West Africa, and specifically Cameroon and Nigeria where human consumption of geophagic clays is very prevalent, documented laboratory studies of the materials are lacking. Fourier transform infra-red spectrophotometry is one of the reliable techniques in characterizing clays and could be applied to the study of geophagic clays. Its drawback, however, includes absorption peaks in the high frequency stretching and/or low frequency bending modes. When this occurs, the results could be misinterpreted. In overcoming this ambiguity caused by interferences of peaks, X-ray powder diffractometry (XRPD) technique is applied as a complementary tool in the identification and characterization of mineral phases (Ekosse, 2005; 2005a) present in the geophagic clays. Elemental analysis of transition metals could only be carried out with the aid of inductively coupled plasma-mass spectrometer (ICP-MS) because of their assumed very low concentrations in clays.

MATERIALS AND METHODS

In this study, randomly selected representative geophagic clay samples were purchased from vendors in Bamenda (5°56"N, 10° 10'E), Kumba (4°38"N, 9° 26'E), Tiko (4°4"N, 9° 24'E), Limbe (4°00"N, 9° 12'E) and Yaounde (3°52"N, 11° 31'E), in Cameroon; and Ibadan (7°23"N, 3° 53'E) and Lagos (6°27"N, 3° 23'E) in Nigeria. Nine samples (CAM-1, CAM-2, CAM-3, CAM-4, CAM-5, CAM-6, CAM-7, CAM-8 and CAM-9) were obtained from Cameroon and three (NIG-1, NIG-2 and NIG-3) from Nigeria. The purchased samples were in the state in which they are consumed; having mean particle size distribution of 40.96 wt% being $\geq 180 \leq 500$ µm; 34.09 wt% being $\geq 63 \leq 180$ µm; and 24.96 wt% being < 63 µm. Mean concentrations of SiO_2, Al_2O_3 and loss on ignition (LOI) of the samples were 51, 30 and 13 wt%, respectively. The mean concentrations for other major elemental oxides for the samples were as follows: MgO, total Mn oxides, Na_2O, CaO and K_2O = < 1 wt% each; TiO_2 = 1.2 wt% and total Fe oxides = 1.4 wt%, respectively.

The samples for mineralogical and chemical analyses were gently ground with a mortar and pestle prior to analyses. Clay minerals in geophagic clays were identified by X-ray diffractometry, after the samples were mounted on the sample holder with little pressure and then later scanned by Philips XRPD equipment operated at 40 kV and 45 mA, having a Cu-K_α radiation and a graphite monochromator. A PW 1877 Automated Powder Diffraction, X'PERT Data Collector software package was employed to capture raw data and a Philips X'PERT Graphics and Identify software package was used for qualitative identification and semi-quantitative analyses of the minerals from both the data and patterns obtained by scanning at a speed of 1° 2Θ. The results were compared with data from the Mineral Powder Diffraction File, data book (International Center for Diffraction Data (ICDD), 2001). Sample CAM-6 was very small; therefore only XRPD analysis was conducted on it.

Functional group characterization based on fourier transform infra red (FTIR) spectrophotometry was done on a Perkin Elmer spectrum 100 with a universal ATR at 4 cm^{-1} resolution. The procedure employed is that mentioned by Ojima (2003) and Madejova et al. (1997) in Ekosse (2005). The ground powdery geophagic clay samples were homogenized in spectrophotometric grade KBr in an agate mortar and pressed at 3 mm pellets with a hand press. In order not to distort the crystallinity of mineral phases in the samples, the mixing was set to 3 min allowing for minimal grinding as suggested by Tan (1998). Peaks were reported based on percentage (%) transmittance to given wavelengths; recorded in the range of 4000 - 200 cm^{-1}. Elemental analysis based on ICP-MS was determined on a Perkin Elmer Elan 6100 instrument. The method of analysis used was similar to that reported by Zhai et al. (2003, 2008). The elemental analyses were conducted on an alkali metal (Rb), two alkali earth metals (Ba and Sr), 11 transition metals (Sc, V, Cr, Co, Ni, Cu, Zn, Y, Zr, Nb and Mo), one rare earth element (Th) and one other metal (Pb). These elements were chosen because of their possible association with clay minerals and toxicity potential.

RESULTS

Six minerals were identified in the geophagic clay samples: primary minerals were quartz, SiO_2, K-feldspar, $KAl_3Si_3O_{10}(OH)_2$ and mica (possibly muscovite), $KAlSi_3O_8$; and secondary minerals were, kaolinite, $3Al_2Si_2O_5(OH)_4$; montmorillonitic smectite, $(Na, Ca)_{0.33}(Al, Mg)_2Si_4O_{10}(OH)_2.nH2O$ and goethite, FeO.OH. Diagnostic peaks for the identification of the minerals together with the international centre for diffraction data (ICDD) reference numbers, and the crystal system, d-values, peak intensity and Miller Indices of the minerals are presented in Table 1. All the samples contained quartz and kaolinite, one sample from Nigeria and four from Cameroon had mica, two samples from Cameroon contained smectite, another two samples from Cameroon

Table 1. Mineralogical data of diagnostic peaks used in identifying quartz, kaolinite, mica, smectite, goethite and feldspar by X-ray powder diffraction technique (after ICDD, 2001).

ICDD (2001)	Radiation and filter	Crystal system	d-values (Å)	Intensity (%)	Miller indices
Quartz					
46-1045	Cu$K\alpha_1$ Ge Mono	Hexagonal	4.26	16	(100)
			3.34	100	(101)
			1.82	13	(112)
Kaolinite					
29-1488	Cu$K\alpha$ Ni	Monoclinic	7.1	100	(001)
			4.41	60b	(110)
			3.56	100	(002)
14-164	Cu$K\alpha$ Mono	Triclinic	7.17	100	(001)
			4.36	60	(110)
			3.57	80	(002)
Mica (Muscovite)					
7-25	Cu$K\alpha$ Ni	Monoclinic	10.1	100	(001)
			4.49	90	(020)
			3.36	100	(003)
6-263	Cu$K\alpha$ Ni	Monoclinic	9.95	95	(002)
			3.32	100	(006)
			2.57	55	(116)
21-993	Cu$K\alpha_1$ Ni	Monoclinic	9.91	85	(001)
			4.50	100	(020)
			2.56	75	(131)
46-1409	Cu$K\alpha$ Ni	Monoclinic	9.97	30	(002)
			3.32	100	(006)
			1.99	50	(224)
Smectite					
29-1499	Cu$K\alpha$ Ni	Monoclinic	2.15	100	(001)
			4.45	55	(101)
			2.56	35	(107)
29-1498	Cu$K\alpha$ Ni	Monoclinic	13.6	100	(100)
			4.46	65	(105)
			2.56	18	
13-135		Hexagonal	15.0	100	(001)
			5.01	60	(003)
			4.50	80	(100)
Goethite					
29-713	Co$K\alpha$	Orthorhombic	4.18	100	(110)
			2.69	35	(130)
			2.45	50	(111)
Feldspar (Microline)					
19-932	Cu$K\alpha_1$ Mono	Triclinic	4.22	45	(201)
			3.29	50	(202)
			3.24	100	(040)
19-926	Cu$K\alpha_1$ Mono	Triclinic	4.22	100	(201)
			3.26	80	(130)
			3.25	100	(220)
(Orthoclase)					
31-966	Cu$K\alpha_1$ Mono	Monoclinic	4.22	70	(201)
			3.77	80	(130)
			3.31	100	(220)

Table 2. FTIR spectrophotometric peaks for geophagic clay samples from Cameroon. Wave numbers in cm-1 of main absorption bands for geophagic clays from Cameroon compared to pure kaolinite.

Pure kaolinite	CAM1	CAM2	CAM3	CAM4	CAM5	CAM7	CAM8	CAM9	Remarks
3694	3695	3695	3695	3692	3692	3693		3693	
3650			3650	3648	3649				
3620	3624	3624	3621	3621	3621	3621	3621	3621	
	1649		1636	1638		1637	1636	1641	Smectite occurrence around 1635 region
1114	1120	1120	1116	1116	1116	1115		1115	Quartz and possibly muscovite occurrence at 1029 region and quartz could occur at 1085
1010	998	1003	992	993	992	994	988	993	
936									
912	907	908	909	909	909	908		909	
790	794	795	792	791	795	791	777	792	Interference could occur for quartz at 785 - 820, smectite at 797 and muscovite at 799
752	749		749	748	748	749		748	
693			671	643	644	676	693	677	Quartz interference could occur at 695
537	520	523	520	519	520	520	518	520	
468			451	452		455			
430	449	451			451				
		419						435	
	392	392							

had goethite, and feldspar was identified in three samples from Cameroon (Figure 1). Mean values for the two dominant minerals in the geophagic clays from Cameroon were 63.6 wt% quartz, and 21 wt% kaolinite; and from Nigeria were 65.3 wt% quartz and 30 wt% kaolinite.

Tables 2 and 3 reflect summary results of FTIR spectrophotometric analysis of geophagic clays from Cameroon and Nigeria, respectively; with indication of OH stretching at bands 3621, 3624, 3648, 3649, 3650, 3692, 3693, 3694 and 3695 cm^{-1}, and OH deformation bands observed at 907, 908 and 909cm^{-1}. Bands associated with SiO stretching were 692, 994 and 695 cm^{-1}; 753 and 754 cm^{-1}; and 791, 795 and 796 cm^{-1}, whereas SiO deformation bands were 1007, 1032 and 1033 cm^{-1}. These bands are very close to those obtained for pure kaolinite. Peaks for pure kaolinite with the chemical formula $Al_2Si_2O_5(OH)_4$, are also given in the two tables. Other peaks corresponding to smectites, muscovite and quartz were also identified.

Figures 2 to 17 give a summary of elemental concentrations in the geophagic clays based on results obtained from ICP-MS analysis. Concentrations for alkali metal and alkali earth metals are reported in Figures 2 to 4. The lowest Rb concentration in the samples was 1 ppm for CAM-1; the highest was 136 ppm for CAM-8; and the mean concentration was 50 ppm (Figure 2). Barium concentrations were generally < 200 ppm except for three samples from Cameroon which had Ba concentrations between 480 and 950 ppm; and its mean concentration was 330 ppm (Figure 3). Except for three samples containing < 2 ppm of Sr, the rest of the samples had concentrations between 66 and 98 ppm; with a mean Sr concentration of 64 ppm (Figure 4).

The concentrations of transition metals in the samples are summarized in Figures 5 to 15. Lowest and highest Sc concentrations in the samples were 6 and 28 ppm, respectively; and its mean concentration was 18 ppm (Figure 5). Vanadium was detected in eight of the samples. For samples in which it was detected, its lowest and highest concentrations were 81 and 176 ppm, respectively, with its mean being 84 ppm (Figure 6). Concentrations for Cr and Co were almost similar and generally very low (< 10 ppm per sample) except for two samples (CAM-7 and CAM-9) which were 28 and 78 ppm for both elements; and their mean concentrations being 1.5 ppm (Figures 7 and 8). Similarly, samples CAM-7 and CAM-9 had higher concentrations of Ni (120 and 159

Table 3. FTIR spectrophotometric peaks for geophagic clay samples from Nigeria. Wave numbers in cm-1 of main adsorption bands for geophagic clays from Nigeria compared to pure kaolinite.

Pure kaolinite	NIG 1	NIG 2	NIG 3	Remarks
3694	3692	3694	3692	
3650	3650		3650	
3620	3621	3623	3621	
	1636	1649	1635	Smectite occurrence around 1635 region
1114	1116	1119	1115	
1032	1024		1025	Quartz and possibly muscovite occurrence at 1029 region and quartz could occur at 1085
1010	991	996	993	
936				
912	908	907	909	
790	792	795	791	Interference could occur for quartz at 785-820, smectite at 797 and muscovite at 799
752	749	749	748	
693	644	675	643	Quartz interference could occur 695
537	519	519	520	
468			452	
430	451	450		
		391		

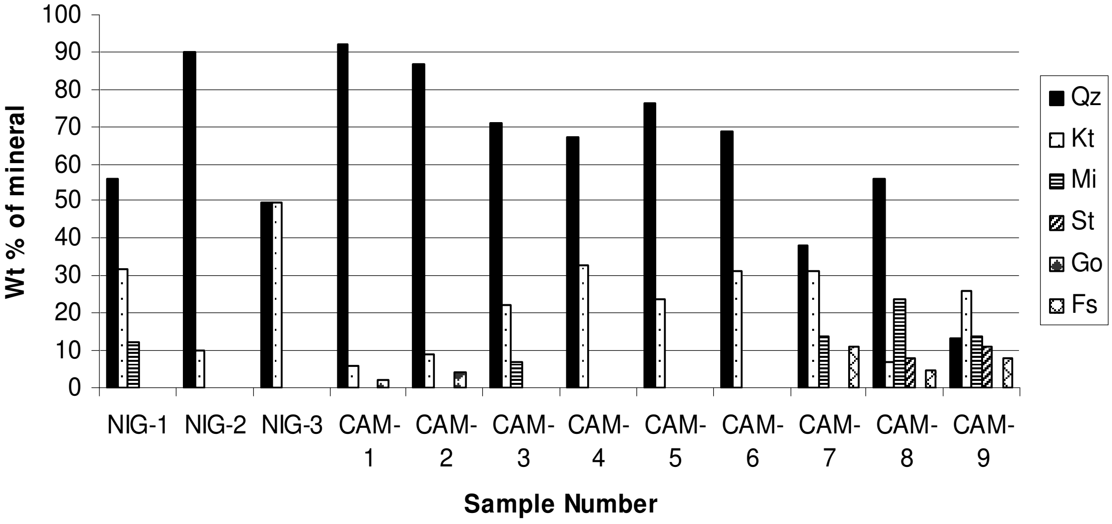

Figure 1. Weight percentages (Wt%) of minerals abundances in geophagic clay samples from Cameroon and Nigeria. Qz = Quartz, Kt = kaolinite, Mi = mica, St = montmorillonitic smectite, Go = goethite and Fs = K-feldspar.

ppm respectively) and Cu (58 and 49 ppm respectively) compared to the other samples; and the mean concentrations of the two elements in the samples were 42 ppm, respectively (Figures 9 and 10). The lowest concentration of Zn was 50 ppm and its highest concentration was 250 ppm with mean concentration being 110 ppm (Figure 11). The lowest and highest Y concentrations in the samples were 18 and 78 ppm, respectively; and its mean concentration was 49 ppm (Figure 12). Although the lowest concentration of Zr was 100 ppm, seven samples had concentrations of 200 ppm per sample; and the other three samples (NIG-2, CAM-1

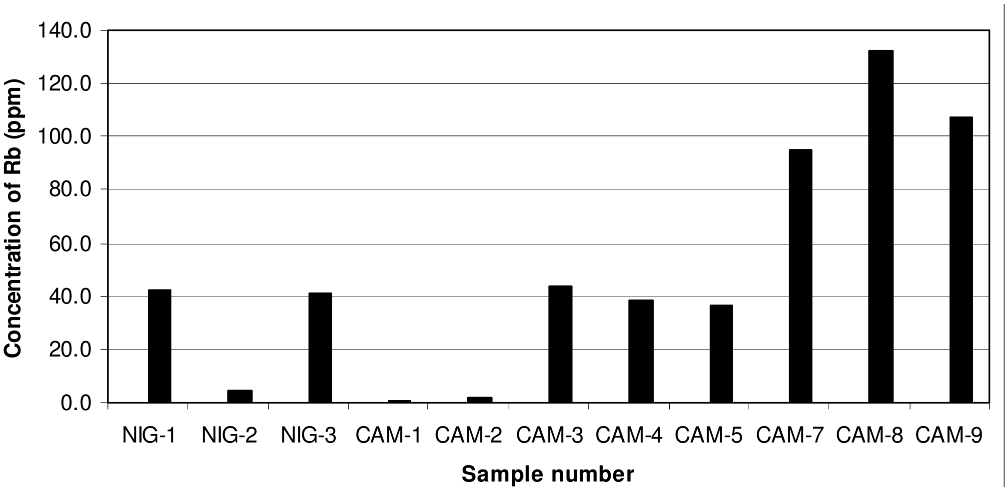

Figure 2. Rubidium concentrations in geophagic clay samples from Cameroon and Nigeria.

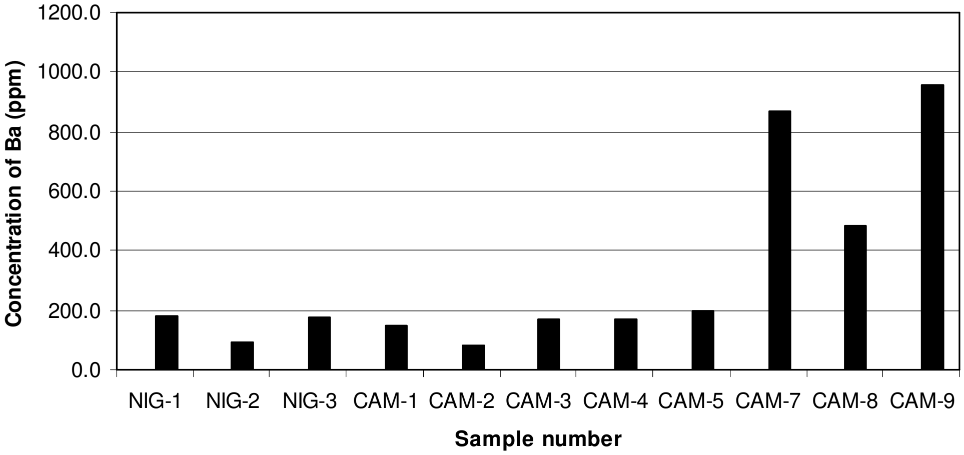

Figure 3. Barium concentrations in geophagic clay samples from Cameroon and Nigeria.

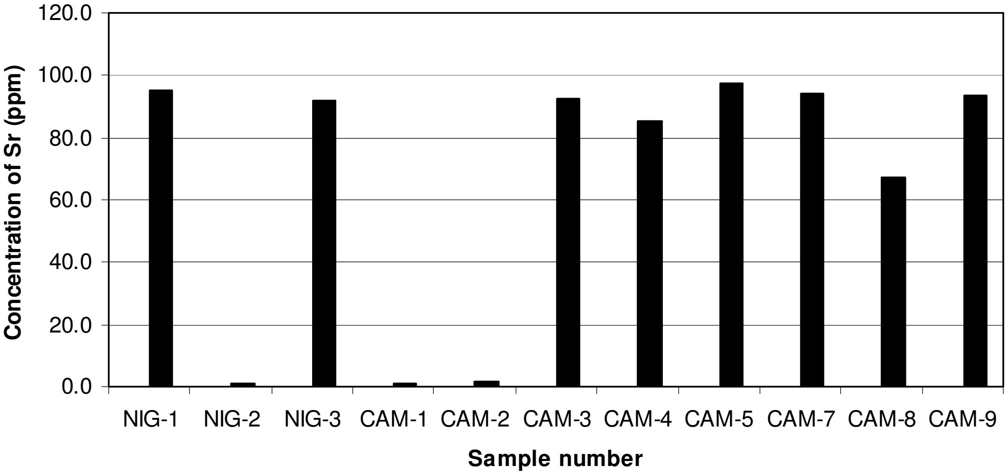

Figure 4. Strontium concentrations in geophagic clay samples from Cameroon and Nigeria.

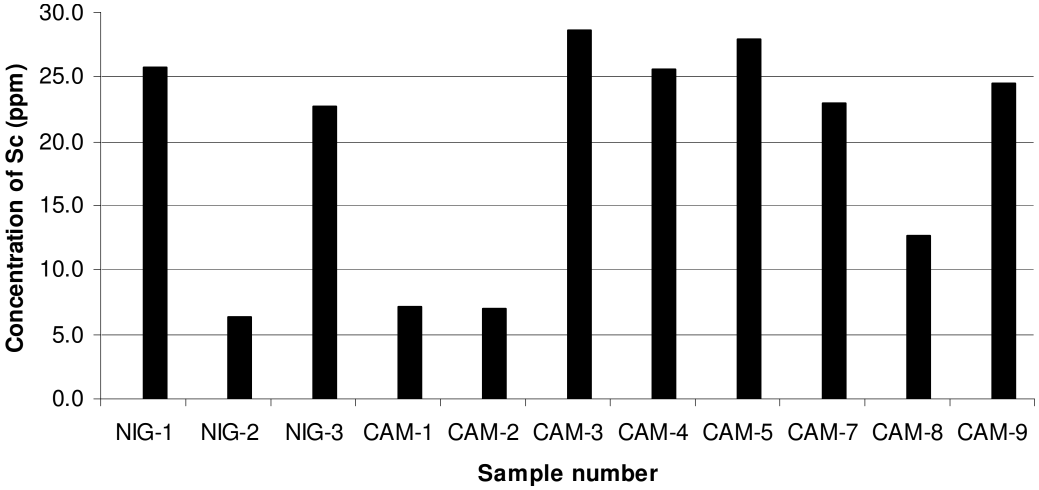

Figure 5. Scandium concentrations in geophagic clay samples from Cameroon and Nigeria.

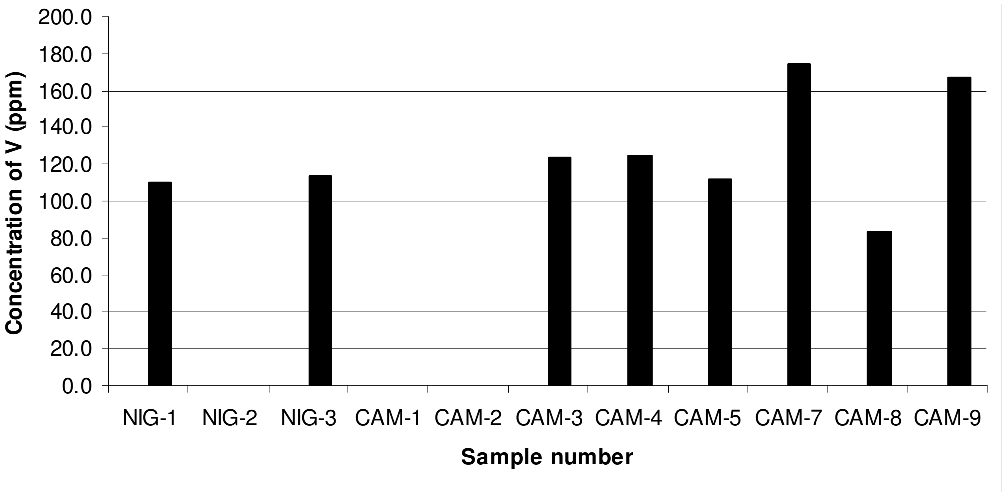

Figure 6. Vanadium concentrations in geophagic clay samples from Cameroon and Nigeria.

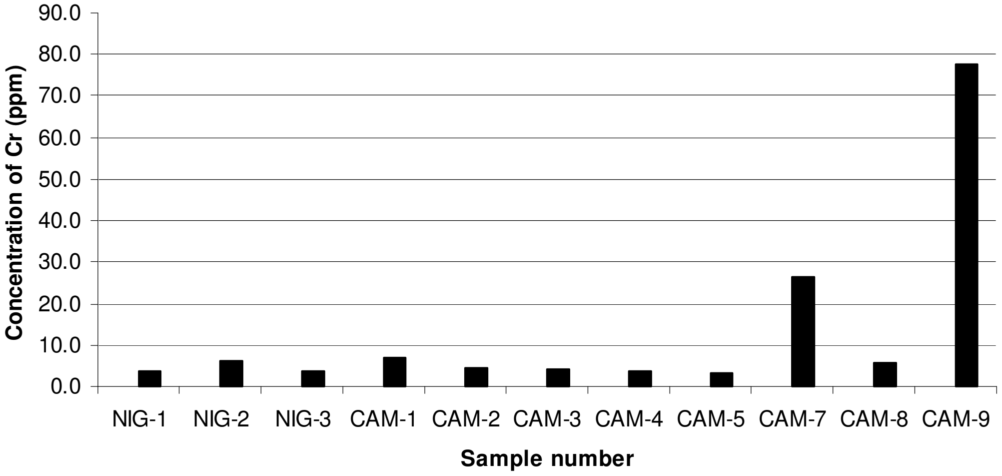

Figure 7. Chromium concentrations in geophagic clay samples from Cameroon and Nigeria.

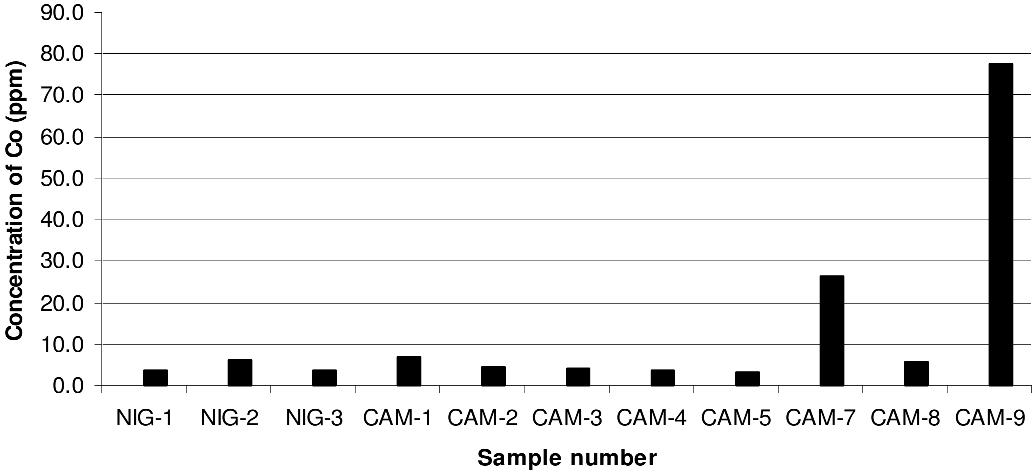

Figure 8. Cobalt concentrations in geophagic clay samples from Cameroon and Nigeria.

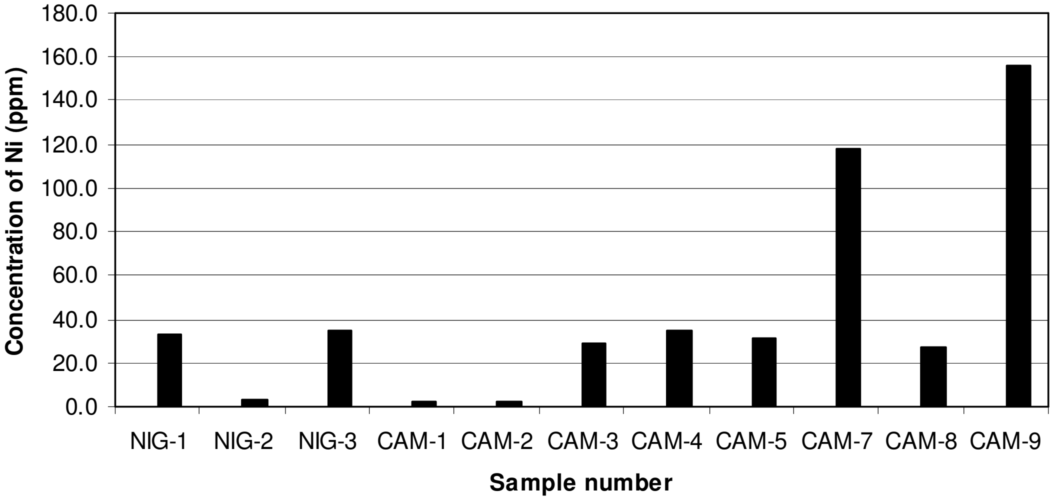

Figure 9. Nickel concentrations in geophagic clay samples from Cameroon and Nigeria.

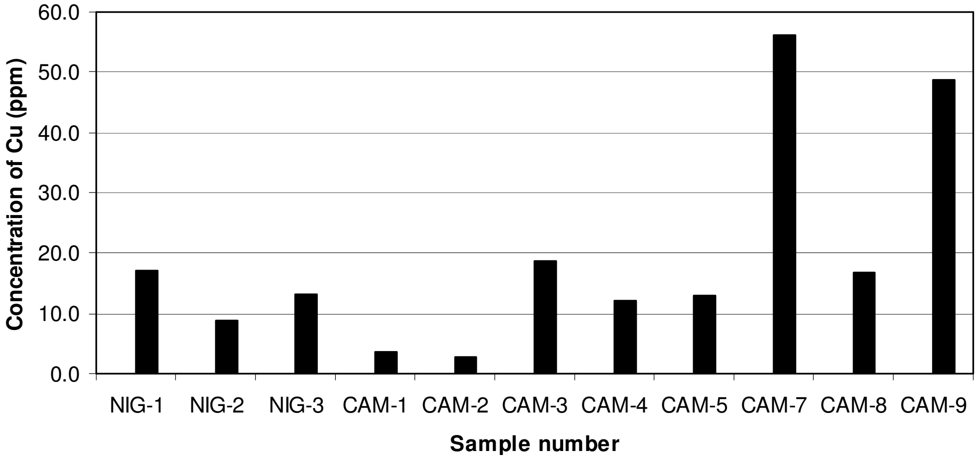

Figure 10. Copper concentrations in geophagic clay samples from Cameroon and Nigeria.

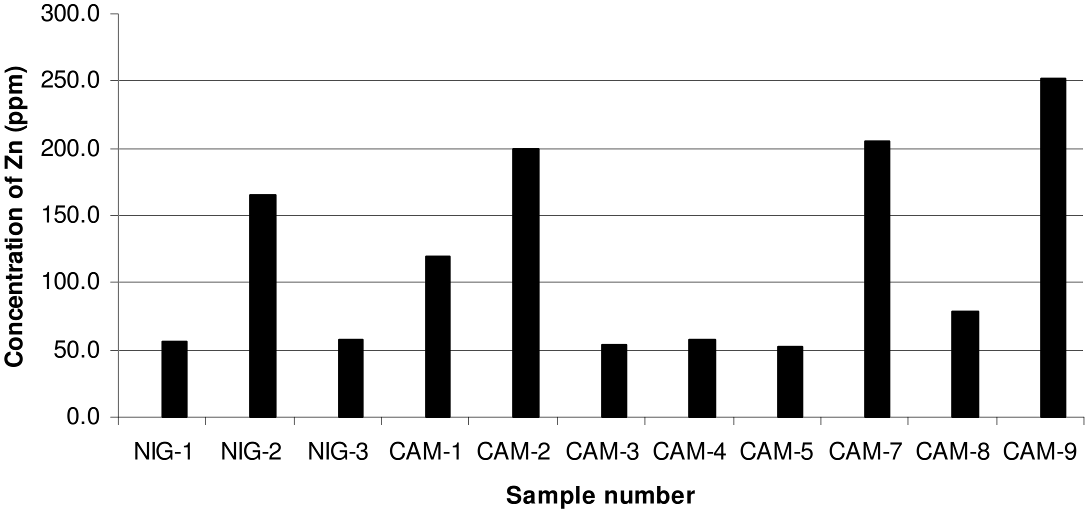

Figure 11. Zinc concentrations in geophagic clay samples from Cameroon and Nigeria.

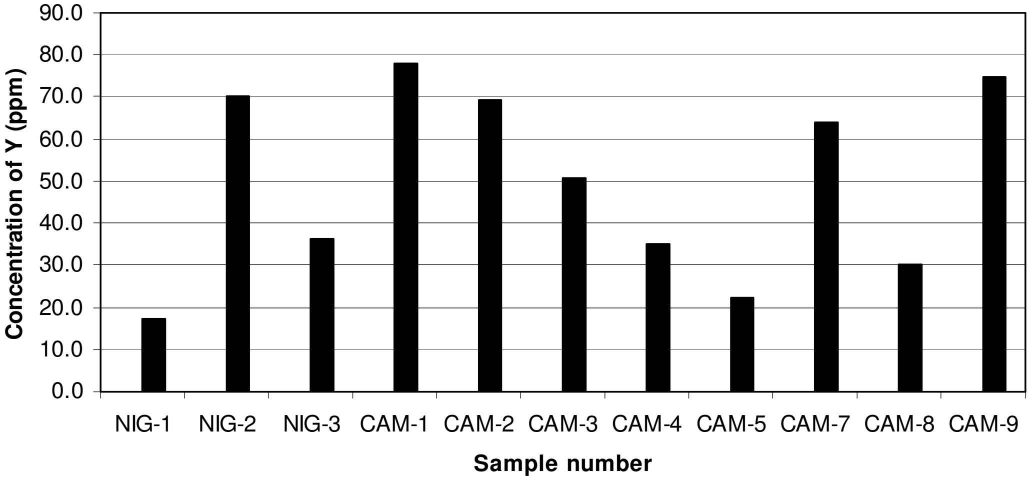

Figure 12. Yttrium concentrations in geophagic clay samples from Cameroon and Nigeria.

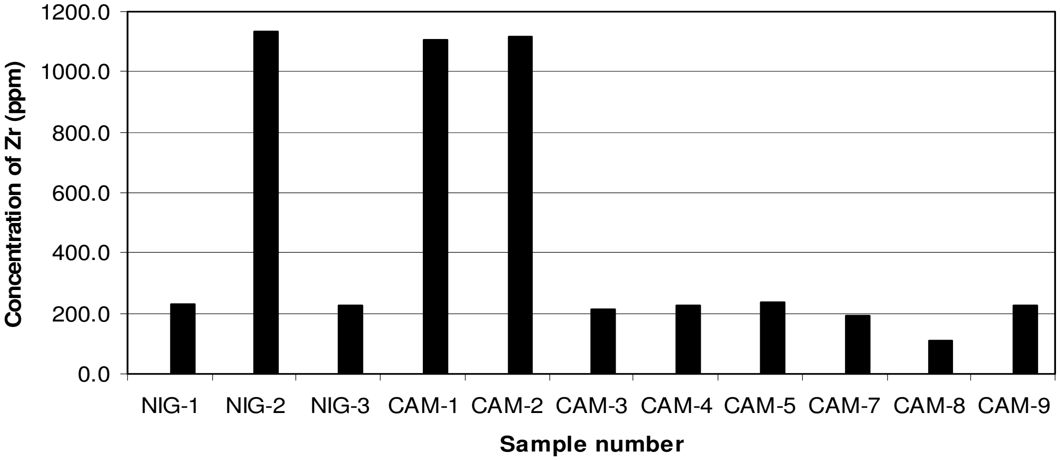

Figure 13. Zirconium concentrations in geophagic clay samples from Cameroon and Nigeria.

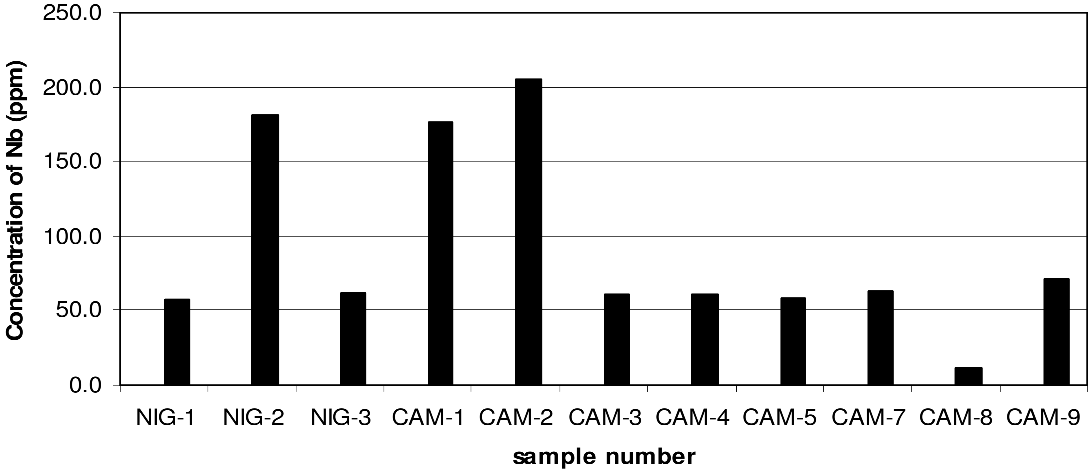

Figure 14. Niobium concentrations in geophagic clay samples from Cameroon and Nigeria.

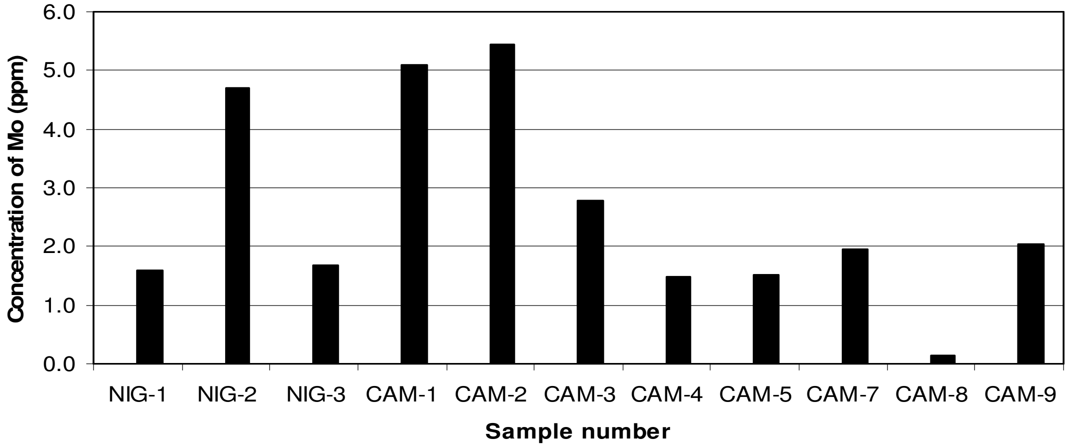

Figure 15. Molybdenum concentrations in geophagic clay samples from Cameroon and Nigeria.

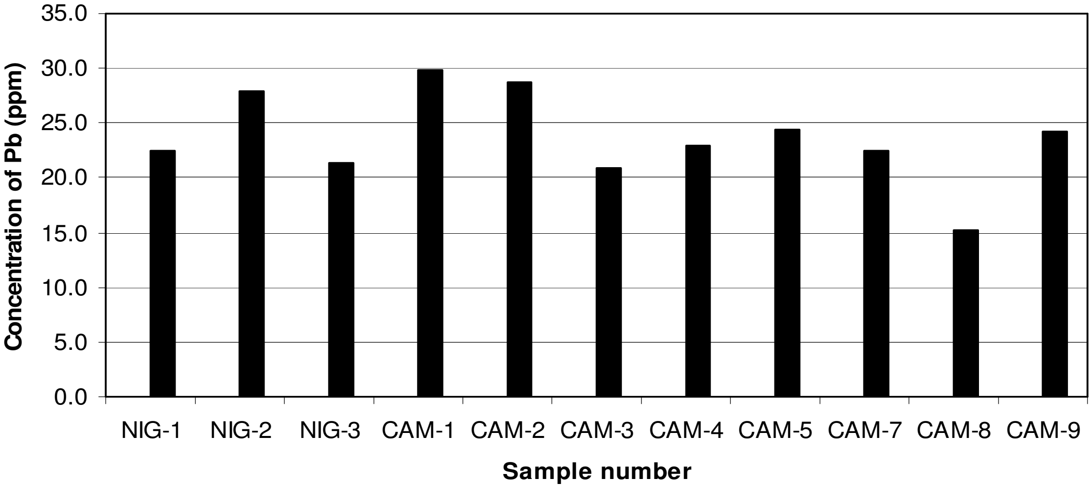

Figure 16. Lead concentrations in geophagic clay samples from Cameroon and Nigeria.

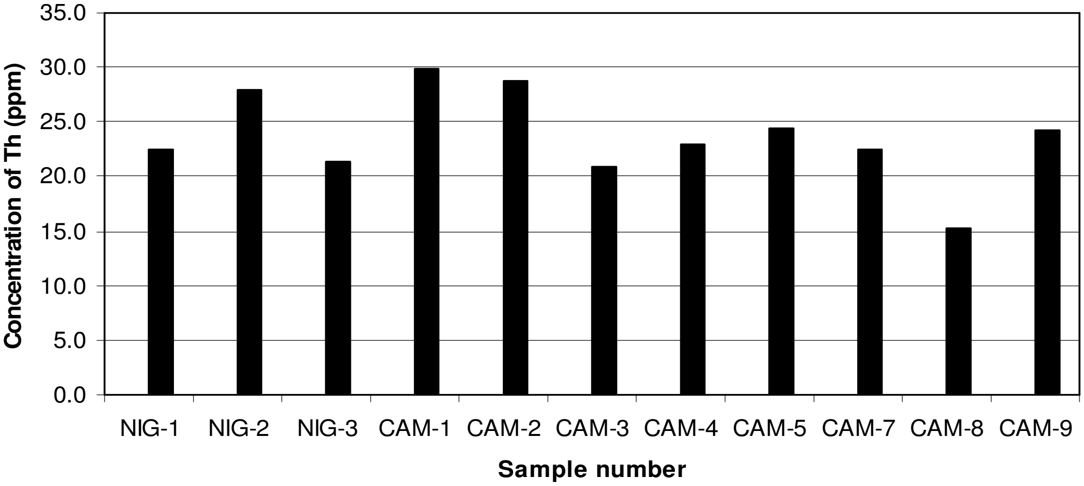

Figure 17. Thorium concentrations in geophagic clay samples from Cameroon and Nigeria.

and CAM-2) recorded the highest Zr concentrations ranging from 1100 to 1160 ppm. Its mean concentration in the samples was 436 ppm (Figure 13). Similarly, these three samples which recorded highest Zr concentrations also had the highest concentrations of Nb which were 180, 170 and 208 ppm, respectively. The lowest concentration was 18 ppm and the mean concentration was 101 ppm (Figure 14). Molybdenum concentrations were in general very low; with lowest concentration being 0.2 ppm, highest concentration being 5.5 ppm, and its mean concentration being 3 ppm (Figure 15).

Lead and Th concentrations in the clay samples were both similar and in general low (Figures 16 and 17). Their lowest and highest concentrations were 15 and 30 ppm, respectively; and their mean concentration being similar was 24 ppm.

DISCUSSION

The mineral assemblage does infer the genesis of the geophagic clays to be of secondary sedimentary origin. The samples consisted of secondary minerals. The clay minerals could possibly have altered from primary minerals particularly feldspar (such as microcline) and mica (such as muscovite), as depicted in equations 1 and 2, respectively, for the most dominant clay mineral, being kaolinite, contained in the sample. The altered minerals later transported to basins of deposition, accumulated in significant quantities.

$$2KAl_3Si_3O_{10}(OH)_2 + 2H^+ + 3H_2O \rightarrow 3Al_2Si_2O_5(OH)_4 + 2K^+ \quad (1)$$

K-feldspar kaolinite

$$2KAlSi_3O_8 + 2H^+ + 9H_2O \rightarrow Al_2Si_2O_5(OH)_4 + 2K^+ + 4H_4SiO_4 \quad (2)$$

mica kaolinite

Considering the high quartz content in the samples, another possible formation mechanism for kaolinite could have been from the alteration of feldspathic arenites (arkose) rich in quartz (Ekosse, 2001). Mean concentrations of analysed clay samples in ppm of samples were as follows: Ba = 330, Cr = 1.5, Co = 1.5, Cu = 42, Ni = 42, Sr = 64, Rb = 50, Zn = 110, Y = 49, Zr = 436, Nb = 101, Pb = 24, Th = 24, Mo = 3, Sc = 18 and V = 84; which are significantly low. The low elemental concentrations could be attributed also to the genesis of the clays. With the aid of mostly groundwater activity, erosion and transportation of altered clay-size particles took place prior to sediment deposition. In the process of erosion and transportation, ions are lost and clay minerals become purer and more refined (Ekosse, 2001). Clays are inert over a very wide pH range covering acidic and basic conditions (Murray, 1963). Although the pH of fluids in the gastro-intestinal tract varies as follows: saliva = 6.5, gastric juice = 1 and duodenal juice and bile = 8 (Oomen et al., 2000); the chemically inert nature of kaolinitic clay over a wide pH (Murray, 1963) inhibits corrosive activities. Quartz contained in the geophagic clays exhibits strong chemical inertness; and thus may not react with juices of the gastro-intestinal tract.

Bioavailability of transition elements vary, as less soluble elements decrease with time of settling, others such as V and Mo, increase with time, and many others remain constant or have low concentrations as proven by Tateo et al. (2006). By implication, the geophagic clays from Cameroon and Nigeria, with their very low concentrations of the transition metals, may tend to release and make bioavailable very low concentrations of ions in traceable quantities which could not be toxic to human health. The significantly low concentrations of these elements in the geophagic clays may be contributory to their not being released in ionic form. Moreover, the cation exchange capacity (CEC) of kaolin is among the lowest for clay minerals (Ekosse, 2001) creating very few exchangeable sites for ions. The particle sizes of the studied clay makes them suitable to form coatings in the gastro-intestinal tract.

The aforementioned properties of geophagic clays have made them to be associated with the detoxification of compounds in food, alleviation of gastrointestinal disorders inclusive of diarrhea, relief of excess acid in the digestive tract (Wilson, 2003) and as supplementation of mineral nutrients, such as Ca, Cu, Fe, Mn and Zn (Johns and Duquette, 1991). It could be deductively inferred that geophagic individuals who consume clays could possibly benefit from the chemical compositions and properties of these clays applied to medicinal usage. Kaolinitic clays are active ingredients in pharmaceutically available products such as kaopectate and bolus alba, are excellent adsorbents of lipids and proteins, could be used for the removal of non specific haemaglutinin inhibitors from serum, and consumed for the containment of stomach disorders (Environmental Health Criteria 231, 2005). Subject to sodium carbonate treatment, affordable and effective kaolinitic clays could be used as antacids (Linares et al., 2004).

The studied clays have very low concentrations of alkali metal, alkali earth metals, transition metals, and rare earth element. Transition elements could be risky to human health depending on type and quantity consumed. Zinc is generally considered to be non-toxic, but can cause vomiting, dehydration, electrolyte imbalance, abdominal pain, nausea, dizziness, lack of muscular coordination, and renal failure (World Health Organisation, 1993). Although it may be essential for human health (World Health Organisation, 1993), an intake of 5 mg/day is considered toxic, and may lead to gastrointestinal disturbances, icteric discoloration, nausea and dermatitis (Alloway and Ayres, 1993). Other researchers have reported the recommended daily allowance (RDA) of Zn to be 10 mg (Hooda et al, 2002). Cadmium has a long biological half-time in the body and accumulates with age; and at high levels above 60 µg/day, it is known to affect the renal, skeletal and respiratory systems, and causes itai-itai disease (World Health Organisation, 1993; Alloway and Ayres, 1993). Although Cr is a micronutrient essential for carbohydrate metabolism in animals, it is carcinogenic to the respiratory organs (Alloway and Ayres, 1993). An intake of > 500 mg/day of Co is considered to be toxic (Alloway and Ayres, 1993). Nickel can be carcinogenic, and may cause dermatitis, eczema, vertigo and dyspnoea to exposed human population (World Health Organisation, 1993). Excessive ingestion of Cu could lead to severe mucosal irritation and corrosion; capillary, hepatic and renal damages; and gastrointestinal and neural disturbances (World Health Organisation, 1993).

Usage of clay as an active ingredient for treatment of an array of ailments and diseases is widespread and forms an integral part of African traditional medical practice. The World Health Organization (WHO) has recognized traditional medicine as an invaluable means of satisfying the basic health care needs of 80% of the World’s population (World Health Organization, 1978). While the practice of traditional medicine enjoyed widespread support amongst the African people, the arrival of colonialists spelt resentment over the practice to even outright ban by some colonial missionaries. Today, this hostile approach is largely abandoned and the use of traditional or alternative remedies is gaining in popularity. Calls are now being made for the systematic evaluation of traditional remedies by scientific methods to ascertain their efficacies and maintain strict observation of safety standards. The integration of traditional medicines in the western health care system is more and more being discussed and legislated in some countries (Lantum, 1985), and geophagic clays could be considered as potential candidates.

Conclusion

This study has established the mineralogical and chemical compositions of geophagic clays from Cameroon and Nigeria. Analysis from XRPD and FTIR indicate the clays to be dominated by quartz and kaolinite; and to a minor extent smectite and goethite. The clays had very low concentrations of Rb, Ba, Sr, Sc, V, Cr, Co, Ni, Cu, Zn, Y, Zr, Nb, Mo, Th and Pb. The minerals assemblage and low concentrations of elemental impurities are indicative of these samples to be refined clays of sedimentary origin. Geophagic individuals consuming these clays may benefit from their possible medicinal and nutritional values, although there are possibilities of allied human health risks.

Clayey soils vary considerably in their mineralogical and chemical compositions; therefore their potential risks to human health can only be determined on a case by case study. A similar observation has been advanced by Ferrell (2008), who explains that caution should be applied in comparing mineralogical and chemical data of medicinal clays. Nonetheless, clays of sedimentary origin are suggested as better geophagic clays compared to those of primary origin because they usually contain low concentrations of elemental impurities. Considering the fact that geophagic practice cannot be eliminated, educating geophagic individuals on the risks and benefits as well as safe preparation, storage and use of geophagic clays should be encouragingly intensified.

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