Amasiri Sandstone Characterization; Insights from Petrology, Geochemistry and Reservoir Potential Studies

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Abstract— The Amasiri sand stone ridge of the Ezeaku formation was studied for reservoir potentials, and geochemical analysis from which sedimentary features were derived. Field observations show that the sandstones occur in a linear, parallel northeast-southwest trending ridges. Sandstone strata of this group are fine to coarse grained, slightly bioturbated, cross-stratified and rippled bedded which deduce foreshore to superficial marine below wave base. Deductions from petrographic examination indicates the existence of quartz, feldspar, rock remains and muscovite. The computed framework grains suggest feldsparthic (subarkosic) sandstone that is sub matured, the compositional framework grain data plotted in the Craton interior and recycled Orogen arenas. The prediction is thus, that these sandstones under examination results from comparatively low-lying granitoid and gneissic sources, accompanied by sands that are recycled from associated platform or Inert Edge Basins. Data analysis of the geochemical test unvailed that the samples are preferentially enriched with SiO2, TiO2, Al2O3 and Fe2O3 and lessening in K2O, Na2O, MgO and CaO. Chemical Index of Alteration (CIA), Chemical Index of weathering (CIW) and Mineralogical Index of alteration (MIA) calculations show that there was intense weathering at source area, relevant geochemical plots suggest that the sand stone is of none marine origin, deposited in semiarid region (inferring sub mature status) in a passive tectonic continental margin. Reservoir studies shows that porosity ranges from 36.48% - 43.70% with an average of 40.09% while permeability ranges from 1.3945x10-2 – 3.0577x101-2, these values compare satisfactorily with hydrocarbon producing reservoirs in the Nigerian Niger Delta Region and can support hydrocarbon accumulations and production if other elements of petroleum systems are in place.

Keywords— eze-aku formation, reservoir, petrography, geochemical, sandstones, index.

INTRODUCTION

The sandstone under study is a member in the Ezeaku Formation which is in the Afikpo sub - Basin. It outcrops massively about 500 meters from the Tipper Garage near Amasiri Junction of Ebonyi State. It has been named by various researchers as the Amasiri sandstone and predicted to be Turoninan from fossil record (Reyment, 1965).The southern Nigeria sedimentary Basin which hosts the study area have been explored by many academics such as Reyment (1965) Cratchley and Jones (1965) and Offodile (1976). Murat (1972) endeavored a paleogeographic explanation of the Cretaceous and lower Tertiary rocks in the southern Nigeria centered on main depositional series consequent from three main tectonic events. Kogbe (1976) and Offodile (1976) contributed to works that examined the sedimentary components within the Benue trough. The Turonian Eze-Aku Formation of the lower Benue Trough is dominated by shales and sandstones with minor limestones (Reyment, 1965). In the South - Eastern portions of the Trough, there are a number of northeastern-southwest trending sand bodies developing noticeable sandstone ridges and are aligned to the axis of the Trough (Amajor, 1987). Works of various authors suggests shallow marine environment and likely tidal deposits but Amjor (1987) differed from them saying that the area under study is neither storm nor tide dominated. Results from petrographic studies by Hoque (1977) and Amajor (1987) concludes the facies as texturally and compositionally immature feldspathic arenites. Field investigation shows that the sandstones exist as a linear, parallel northeast-southwest aligned ridge underlain unconfomably by a shale facie. The geochemical composition of sedimentary rocks, is a complex function of various variables such as source material, weathering, transportation, sorting, digenesis and tectonic setting. (Midleton 1960, cox et al 1995). According to (Hiscott 1984) examples of using geochemical data from sediments in unraveling sedimentary processes are increasing in literature. Geochemical analysis thus enables proper classification and characterization of terriginous clastics. This sandstone is highly indurated and can comfortably be mistaken for hard rock from a distance at first observation. This outcrop has been studied for the purpose extracting sedimentary characteristics from geochemical imprints and reservoir studies.

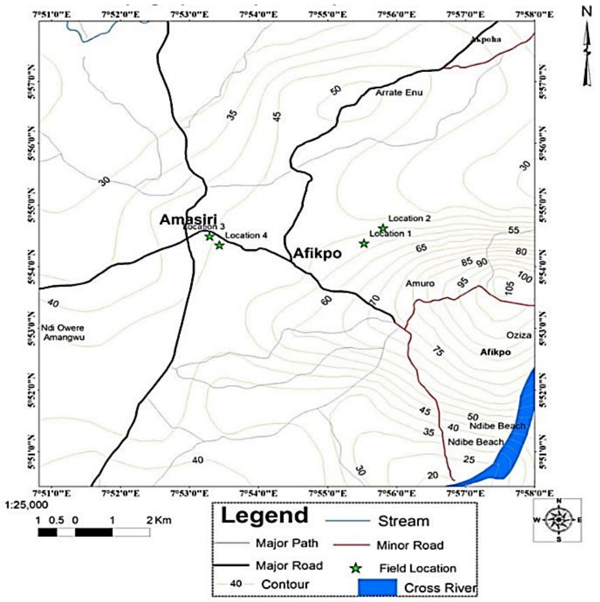


Figure 1: *Map of the study area*

The study area is made accessible by the Afikpo/Abakaliki express way. It is located at tipper garage, about 500 meters from Amasiri Junction Ebonyi State. The outcrop lies on both side of the express road, having been cut through by the road construction.

Geology of study area

The Benue Trough had been organized into pull-apart sub-basins or grabens shaped by sinistral strike-slip rearrangements inherited from pre-existing transcurrent fault zones in the Pan- African active strap (Benkhelil, 1989; Nwajide, 2013).

It is part of the much bigger West and Central African Split Structure (Fairhead, 1988; Genik, 1993) which originated during the fragmentation of the Gondwana supercontinent and the opening of the southern Atlantic and Indian Oceans in the Jurassic (Burke et al., 1972; Benkhelil, 1982; 1989; Fairhead, 1988). The stratigraphy of the southern Benue Trough was designated by Murat (1972) and Hoque (1977) using the concept of three tectono - sedimentary cycles.

Three such series of marine transgressions and regressions happened from the Albian to the Coniacian (Nwajide, 2013). Murat (1972) observed that the geologic past of the southeastern Nigeria has been organized by three foremost tectonic phases.

Consequent on this, the alignment of the key basin has been moved resulting to the Abakaliki anticlinorium, the Afikpo sub basin, the Anambra and the Niger Delta Basins. In fig. 3, the lithostratigraphic framework together with the age of the Amasiri sandstone is shown

m.y	AGE	ABAKALIKI – ANAMBRA BASIN	AFIKPO BASIN
30	Oligocene	Ogwashi-Asaba Formation	Ogwashi-Asaba Formation
54.9	Eocene	Ameki/Nanka Formation/ Nsugbe Sandstone (Ameki Group)	Ameki Formation
65	Palaeocene	Imo Formation Nsukka Formation	Imo Formation Nsukka Formation
73	Maastrichtian	Ajali Formation Mamu Formation	Ajali Formation Mamu Formation
	Campanian	Npkoro Oweli Formation/Enugu Shale	Nkporo Shale/ Afikpo Sandstone
83 87.5	Santonian	Agbani Sandstone/Awgu Shale	Non-deposition/erosion
	Coniacian		Eze Aku Group (incl. Amasiri Sandstone)
88.5	Turonian	Eze Aku Group	
93 100	Cenomanian – Albian	Asu River Group	Asu River Group
119	Aptian Barremian Hauterivian	Unnamed Units	
	Precambrian	Basement Complex	

Figure 2: *Lithostratigraphic framework of southern Benue trough and Afikpo Sub basin. (Igwe et al 2013).*

The Amasiri Sandstone, a member of the Eze Aku Group was deposited in the first tectonic phase, and outcrops east and west of the Abakaliki Anticlinorium.

METHODOLOGY

This study was made possible by desk study, field work and relevant laboratory analysis. After relevant literatures were reviewed, field work was embarked upon for outcrop examination and sample collections for analysis. Laboratory analysis carried out included; geochemical analysis (XRF), porosity and permeability tests.

Flied work was along the Afikpo – Abakaliki express way at Tipper Garage about 500 meters from Amasiri Junction. The choice of this location was due to the occurrence of an extensive outcrop (about 3 kilometers length and 10 meters wide). Coordinates of the location were obtained, outcrop extensiveness (height, width and lateral distance) was inspected. Sampling depended on visual inspection of textural properties recognizable in the field (as it varied laterally and vertically).

Tools used in the field work included; geologic hammer, machete, spade, trowel, masking tape, global positioning system (GPS), topography map, geologic map, sample bags, measuring tape, digital camera, chisel, and field notebook.

Geochemical Analysis: Seven samples were retrieved from the five beds that was mapped for geochemical analysis. % grams samples were first disaggregated cautiously to preserve their grain shape and then subjected to X-ray fluorescence (XRF) analysis. A PW1480 X-ray fluorescence spectrometer using a

Rhodium tube as the X-ray source was used. The technique reports concentration as % oxides for major elements.

From the result of the geochemical analysis, various geochemical deductions and relevant cross plots and were made to infer;

a) Chemical Index of Alteration (CIA) (Al_2O_3/ (Al_2O_3+CaO+Na_2O+K_2O) and Chemical Index of Weathering (CIW) (Al_2O_3/ (Al_2O_3+CaO+Na_2O) after (Fedo et al 1995) was calculated to indicate climatic condition during sedimentation and degree of source area weathering
b) Sediment maturity and climatic condition during sedimentation; Log of SiO_2 was cross plotted with (Al_2O_3+K_2O+Na_2O) (after sttuner and Dutter 1986)
c) Sediment source (discriminate marine from non-marine) cross plot of Fe_2O_3/K_2O vs. MgO.
d) Tectonic setting was predicted using Log of K_2O/Na_2O vs SiO_2 after (Roser and Krosch 1986)

The thin section slides were studied using petrographic microscope for minerals identification, the photomicrograph taken (Fig.2) the modal composition (Table 1) and the recalculated modal examination data (Table 3) created. Petrographic sorting was done using quartz (Q), feldspar (F) and rock fragment (RF), after Dott (1964). The mineral maturity was computed using the mineralogical maturity index (IMM) of Nwajide and Hoque (1985).

Reservoir Parameters

Reservoir Porosity is one minus the solid bulk fraction of a sample and can be computed from the bulk and particle densities. (Dp), describes the fraction of the total volume occupied by solids.

Total porosity (St), is therefore = 1 – Db/Dp

SOIL BULK DENSITY

The ratio of the bulk density (Db), to the particle density (Dp), describes the portion of the total volume occupied by solids. Total porosity (St), is therefore = 1 – Db/Dp SOIL BULK DENSITY The weigh square core sampler of dimension (6cm by 6cm by 2cm) was weighed and recorded as M1 (g). The core cutter was then driven through the soil sample and properly trimmed at both end of the cutter, the quantity of the soil sample together with cutter were then taken as M2 (g) and the mass of soil that filled the cutter was then obtained by deducing M1 from M2 and recorded as M3 The volume of the cutter was the gotten from the dimension. The bulk density is then calculated from mass / volume relation.

Bulk density (Db) = Mass of soil/Volume of soil

SOIL PARTICLE DENSITY

100 mL volumetric flask was filled with distilled water to 60 mL, a 50g of an oven dried soil was measured and added to the volumetric flask enclosed the 60 mL of water to determine the volume of soil, the volume was observed by the rise of volume of the water in the volumetric flask and the value logged. The particle density is then calculated by dividing the quantity of the soil by it volume. Particle density (Dp) = Mass of oven dried soil/Volume of the soil Total porosity (St) = 1 – Db/Dp Reference:

ASTM D 5550-94: Normal test technique for specific gravity of soil solids by gas pycnometer

ASTM (2006c). "Standard D4253: Standard test methods for maximum index density and unit 400 weight of soils using a vibratory table."

ASTM (2006d). "Standard D4253: Typical test techniques for maximum index density and unit 400 weight of soils using a vibratory table." ASTM (2006d). "Standard D4254: Standard test approaches for lowest index density and unit weight of soils and computation of relative density."

PERMEABILITY METHOD

Size the initial mass of the pan along with the dry sample (M1). Take away the cap and upper chamber of the permeameter by removing the knurled cap nuts and lifting them off the tie rods. Measure the inside width of the higher and lower chambers. Compute the average inside width of the permeameter (D). Keep one porous stone on the inward support ring in the base of the cavity then place a filter paper on top of the porous stone.

Blend the sample with sufficient distilled water to avert the particle sizes from separating while they are being placed into the permeameter. Add sufficient water so that the blend can flow easily. Using a scoop in a spherical motion to form an even layer, pour the ready soil into the lower cavity, filling it to a depth of 1.5 cm. Keep one porous stone on the inward support ring in the base of the cavity then place a filter paper on top of the porous stone. Blend the sample with sufficient distilled water to avert the particle sizes from separating while they are being placed into the permeameter. Add sufficient water so that the blend can flow easily. Using a scoop in a spherical motion to form an even layer, pour the ready soil into the lower cavity, filling it to a depth of 1.5 cm. Keep the compression coil on the absorbent stone and replace the chamber cap and its closing gasket. Secure the cap tightly with the cap nuts. Measure the sample length at four locations around the circumference of the permeameter, compute the average length, and log it as the sample length. Keep the pan with the remaining soil in the drying oven. Adjust the level of the funnel to permit the continual water level in it to continue a few inches beyond the top of the soil.

Attach the malleable conduit from the tail of the funnel to the lowest passage of the permeameter and keep the valves on top of the permeameter open. Run tubing from the top outlet to the sink to gather any water that is given off. Open the bottom valve and allow the water to run into the permeameter. As soon as the water starts to flow out of the top control (de-airing) faucet, close the control faucet, letting water run out of the vent for some time. Close the lowest outlet valve and disengage the tube at the bottom. Attach the funnel tubing to the top side port. Open the bottommost outlet faucet and increase the funnel to an appropriate height to get a rationally stable current of water.

Permit suitable time for the flow pattern to even out. Log the time taken to fill a volume of 750 – 1000 mL with the graduated cylinder, and then measure the temperature of the water. Repeat this procedure 3 times and compute the average time, average volume, and average temperature. Log the quantities as t, Q, and T, correspondingly. Measure the vertical distance between the funnel head level and the chamber outflow level, and record the distance as H.

Take away the sauce pan from the drying oven and measure the final mass of the pan along with the dry soil (M2)

$k = QL/Aht$

Where,

k = coefficient of permeability

Q = volume of water collected in time t

h = head causing flow

A = cross sectional area of sample and L = length of sample

Reference: ASTM D2434: Normal experimental technique for permeability of Gritty soil (Constant Head)

RESULTS AND DISCUSSION.

Petrology

The detrital frame work grains of the Amasiri sandstone comprise quarts, feldspar, and muscovite. Quartz has been the leading framework grain in the examined thin section (Table 1). The percentage range of quartz is 64% to 84%. The monocrystalline and polycrystalline grains have straight to strongly undulose extinction (Fig.2). The quartz grains are sub angular to sub surrounded. Feldspar constitutes 6% to 14% of the detrital grains of the sandstones. Rock fragment about 4% to 15%. Muscovite exists in minor amounts. Matrix contributes 4% to 8% of the detrital segment. Cementing constituents about 3% to 7%. From the plot of the framework configuration of quartz, feldspars and rock remains for sandstone classification after Dott (1964) (Fig. 3), all the samples plotted in the subarkose arena; the sandstones are therefore categorized as subarkosic sandstones.

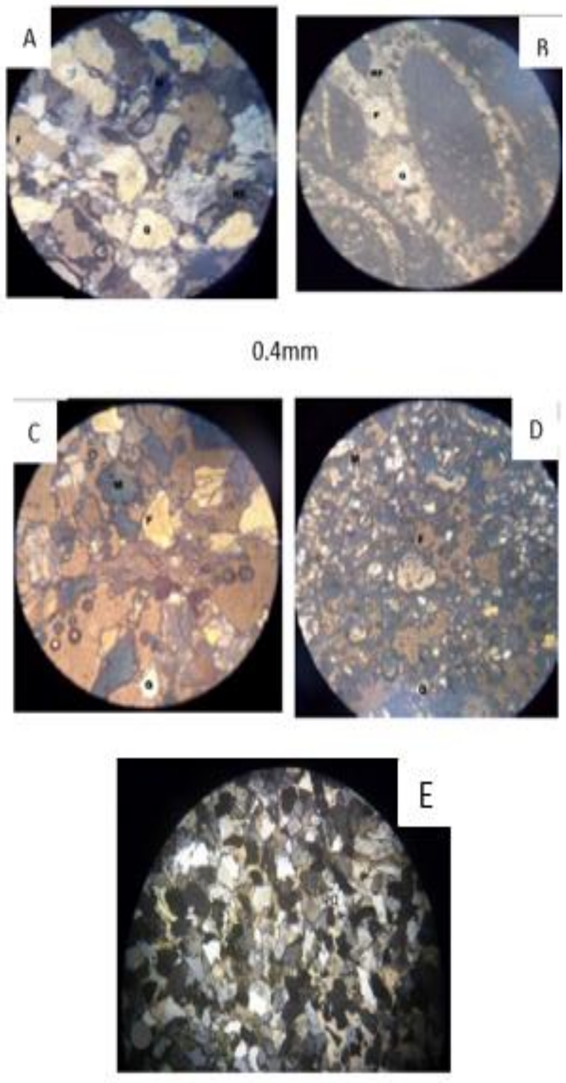
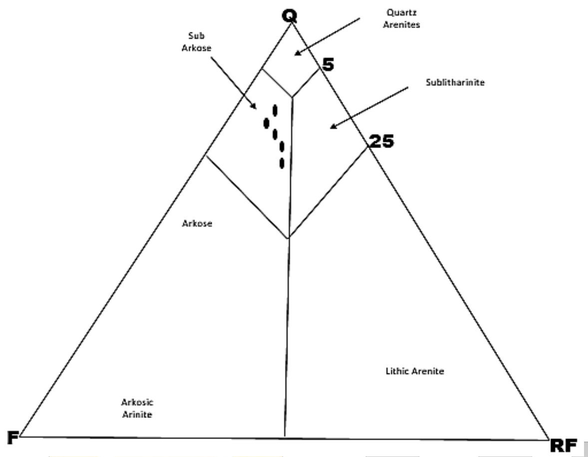


Figure 2: *Photomicrograph displaying of thin section samples*

Table 1: *showing Quarts, Feldspar and Rock Fragment count from thin section*

Sample No	Quartz	Feldspar	Rock Fragment
Ama1	84	11	4
Ama2	79	10	11
Ama3	69	13	8
Ama4	64	18	17

Figure 3: *Classification of*



terrigenous sandstones of Amasiri using Dott, 1964 diagram

Fig.4 proposes both metamorphic and igneous origin for the sandstone under analysis. In the QFR ternary illustration of Dickinson et al., (1983), the compositional framework grain data plot in the Craton interior and reprocessed Orogen sections (Fig. 4). The samples that plotted in the Craton interior area are mature sandstones resulting from comparatively low-lying granitoid and gneissic origins, augmented by recycled sands from related platform or Inert Margin Basins (Dickinson et al., 1983). This low relief and short conveyance expanse gave rise to characteristically quartzo-feldsparthic sandstones of classic subarkosic property.

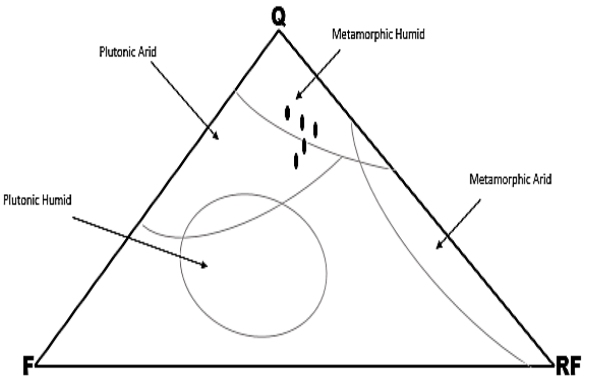


Figure 4: *The result of source rock on composition of Amasiri sandstone using suttner et al., (1981) diagram*

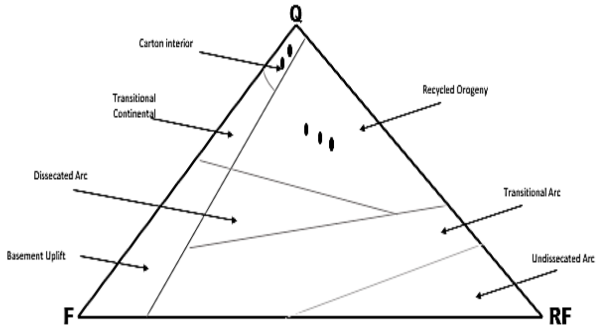


Figure 5: *QFRF Ternary diagram for the Amasiri sandstone, after Dickinson et al., (1983)*

Mineralogical Maturity

The mineral maturity is computed after the mineralogical maturity index (IMM) of Nwajide and Hoque (1985), given as;

$$\text{IMM} = \frac{\text{Proportion of Q}}{\text{Proportion of F} + \text{Proportion of RF}}$$

$$\text{IMM} = \frac{74}{13+10} = \frac{74}{23} = 3.2$$

Since IMM value is less than 9 but greater than 3 as calculated above; hence the Sandstone is said to be sub mature after Nwajide and Hoque, 1985). Fig. 10

Limiting % of Q and (F + RF)	MI and maturity stage
Q =≥ 95% (F + RF) = 50%	MI = ≥ 19 suppermature
Q =95-90% (F + RF) = 5-10%	MI = 19- 9.0 submature
Q = 90-75% (F + RF) =10-25%	MI =9.0-3.0 submature
Q =75-50% (F + RF) = 25-50%	MI =3.0-1.O immature
Q = < 50%	MI ≤ 1
(F + RF) > 50%	Extremely immature

Figure 6: Maturity scale of Sandstone by Nwajide and Hoque (1985)

Geochemical analysis

Table 2: *Geochemical data*

Sample ID	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2O	TiO_2	SO_2	LOI	CIA	CIW
Ama 1	55.78	25.76	1.13	0.12	0.27	4.63	0.13	0.06	0.01	11.95	0.84	0.99
Ama 2	60.81	21.25	0.44	0.22	0.3	6.14	0.19	0.05	0.01	10.53	0.76	0.98
Ama 3	57.88	24.21	1.14	0.19	0.27	5.01	0.15	0.07	0.02	10.93	0.81	0.98
Ama 4	60.17	21.34	0.43	0.24	0.28	5.98	0.21	0.07	0.01	10.44	0.76	0.97
Ama 5	55.56	25.22	1.04	0.41	0.2	5.34	0.17	0.05	0.01	12.00	0.81	0.97
Ama 6	71.78	13.83	0.69	0.23	0.07	4.66	4.2	0.18	0.19	3.99	0.60	0.75
Ama 7	60.57	21.1	0.48	0.39	0.32	5.12	0.21	0.06	0.02	11.7	0.79	0.97
Ava.	60.37	21.81	0.76	0.26	0.24	5.27	0.75	0.08	0.34	10.22	0.78	0,94

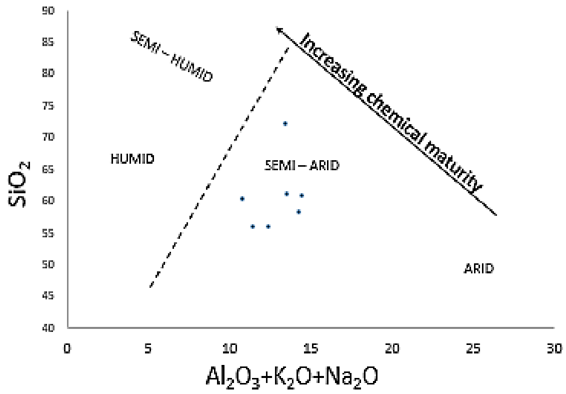
From (table 2), the outcome of main element composition of all the samples analyzed, the compositional dissimilarity reflects modifications in the chemical and mineralogical composition of the sediment, especially in the quartz-feldspar ratio. SiO_2 copiousness ranges from 55.56% to 71.78%; TiO_2 ranges from 0.05 to 0.18% whereas Al_2O3 ranges from 13.83 to 25.22%, Fe_2O3 ranges from 0.42 to 1.32%, MnO was absent, MgO ranges from 0.07 to 0.32%, Na_2O from 0.17 to 4.2%, CaO ranges from 0.22 to 0.41% and K_2O ranges from 4.66 to 6.14%. The Amasiri sandstone is enriched in SiO_2, TiO_2, Al_2O_3 and Fe_2O_3 and depleted in K_2O, Na_2O, MgO, CaO. With the absence of MnO_2. This revealed that SiO2 is mainly present as quarts and Al is mainly stored in the clay mineral framework as an essential constituent. The following derivatives were made from the geochemical data to ascertain the grade of weathering at source area, maturity of the sediment and basin's tectonic setting via geochemical method.

The period and degree of weathering in siliciclastic deposits can be decoded through observing the association among alkaline and alkaline earth elements (Nesbitt and Young, 1982). The characteristics of the source rocks such as mineralogical, chemical, structural and other dynamics like influence of climate, proneness of such rocks to weathering. Huntsman-Mapila (2005) acknowledged some dynamics influencing the chemical makeup of siliciclastic sedimentary rocks that impact the extent of weathering of the source area and their tectonic setting. Nesbitt et al., (1996) submitted that the chemical makeup mostly hinge on on the composition and the weathering situations at the source rock area. The degree of the intensity of chemical weathering /change of the sediment source rocks was proven by calculating the chemical index of alteration (CIA), and chemical index of weathering (CIW) and Mineralogical Index of Alteration (MIA) (Nesbitt and Young, 1982, Fedo et al., 1995). The CIA and CIW are inferred in similar ways with values of 0.5 or 50% for un-weathered upper continental crust and roughly 1 for highly weathered materials with complete elimination of alkali and alkaline earth elements (Mclennan et al., 1993, Mongelli et al., 1996).

Low CIA values (0.5 or less) also could reveal cool and /or desert environments (Fedo et al., 1995, Price and Velbel, 2003). The CIA oscillated from 0.60 – 0.84 (av. 0.77 or 77%) while the range values of CIW is from 0.75 – 0.99 (av. 0.94 or 94%) showing a high grade of weathering of the parent rock materials and tropical/ warm climate during deposition. Values of MIA between 0 and 20 % is suggestive of inception of weathering, between 20-40 %, weathering is weak, 40-60 % (moderate) while 60-100 % is regarded as strong to extreme degree of weathering and above 100% shows that complete weathering of a primary material has taken place. The MIA value ranges from 57.59 – 73.47 with an average of 63.38. This confirms high degree of weathering in line with CIA and CIW.

Climatic and Environmental condition during Deposition.

The degree of chemical weathering in the source region hinge on on the change of climate towards warm (arid or semi-arid) or humid situation (Jacobson et al., 2003). The application of the ratio of SiO_2 / (Al_2O_3 + K_2O + Na_2O) for paleoclimatic condition during deposition in any basin is well accepted by many workers. Scatter plot of $SiO_2/Al_2O_3+K_2O+Na_2O$ has been used by Suttner and Dutta 1986 to infer climatic condition during sedimentation. This categorizes between humid, semi-arid and arid climatic conditions from this, chemical maturity can also be predicted. These climatic conditions can be looked as humid – very matured sediments, semi humid – matured sediments, semiarid – sub matured sediments while arid – immature sediments. The sediment of the Amasiri sand stones in fig. 7a plotted in the semiarid space (inferring sub matured conditions). Also, plot of CIA against Al_2O_3 in fig 7b displayed that the sediments are moderately weathered. Thus they are sub matured sand stones. This is in sync with the sub matured condition predicted by the Index of Mineralogical Maturity after Nwajide and Hoque, 1985.



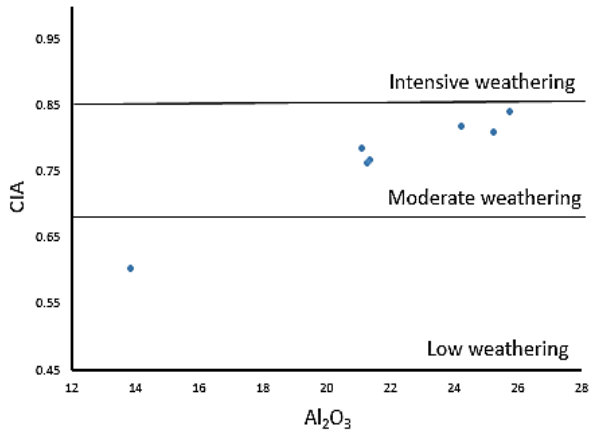
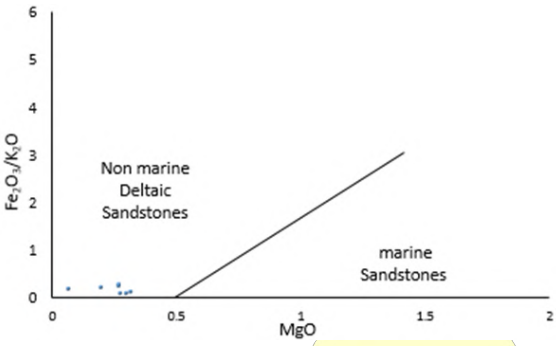


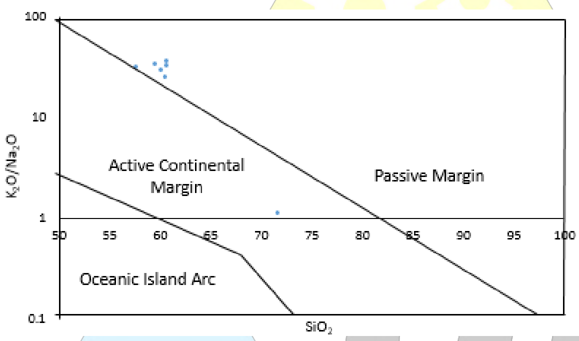
Figure 7a and 7b: *Scatter plot of $SiO_2/Al_2O_3+K_2O+Na_2O$ and plot of CIA / Al_2O_3 respectively showing climatic condition during sedimentation and extent of weathering.*

Sediment Source and Tectonic Setting

Binary plots after Ratcliffe et al 2007 has revealed that non marine sandstones have very low values of fe_2O_3 and MgO while for marine sandstones, reverse is the case. The sediments of Amasiri sand stones according to the plot (figure 8), are none marine sandstones.



8A



8B

Figure 8A: *Binary plot delineating marine from none marine sandstones (After Ratcliffe et al., 2007) and* ***8B:*** *Tectonic delineation using K_2O/Na_2O versus SiO_2 (after Roser and krosch 1986).*

The most vital indications for the tectonic situations of basins come from the comparative depletion of the oxides like CaO and Na2O (the most lebile elements), in the midst of others. The oxides are understood to show supplementation or reduction of quartz, K-feldspars, micas and plagioclase. The proportion of the most stable elements to the lebile ones increases towards the inactive brim to the relative tectonic stability (Armstrong-Altrin et al., 2004) and hence signifying protracted weathering. Tectonic discrimination using K_2O/Na_2O versus SiO_2 has been created by Roser and Korsch (1986). This cross plot distinguishes deposits deposited in inert continental brims, Active continental margin, and Oceanic Island arc. The samples from Amasiri sandstones (in fig. 13) plotted in the passive margin space. This is because there is preferential enrichment of immobile elements over movable elements towards the passive margin.

Table 3: Reservoir Potentials (Porosity and permeability)

S/N	Sample ID	Thickness (Ft)	Sample Description	Grain size/sorting	Coefficient Permeability (K) Cm/sec	Porosity (%)
1	BED 1	16.0	Greyish brown Sandstone	M/ well sorted	2.4354×10^{-2}	40.34
2	BED 2	15.0	Brownish Grey Sandstone	F – M/ well sorted	1.6709×10^{-3}	39.50
3	BED 3	15.0	Greyish brown Sandstone	M/ well sorted	1.3945×10^{-2}	41.20
4	BED 4	12.0	Greyish brown Sandstone	M/ well sorted	3.0577×10^{-2}	43.70
5	BED 5	10.0	Greyish Sandstone	F – M /well sorted	1.6932×10^{-3}	36.56
6	BED 6	13.0.0	Brownish Sandstone	F – M / well sorted	2.7516×10^{-3}	36.48

N = Fine and M = Medium

The porosity and permeability of the six beds of Amasiri sandstone as reported in table 3 Ranges from 43.70% - 36.56% and $2.7516x10^{-3}$ - $1.3945x10^{-2}$ respectively. The value of these parameters matches satisfactorily with those of hydrocarbon impregnated reservoirs of the Nigerian Niger Delta.

CONCLUSION

This study suggests that the sandstone ridge under study is felspathic, subarkosic, and sub – matured. Formed from a plain that is of a low altitude granitoid and gneissic origins and augmented by reprocessed sands from associated platforms or passive brim basins. Geochemical derivatives indicated intense weathering at source area, non – marine origin that is deposited in a semiarid region (inferring sub – matured conditions) and a inert brim tectonic setting. The reservoir potentials are very good and can support hydrocarbon accumulations and production if other elements of the petroleum systems are in place.

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