



Lithofacies and depositional environment of the Amasiri Sandstone, southern Benue Trough, Nigeria



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ABSTRACT

Eight lithofacies typical of tidally-influenced shelf, mass flow and turbidity current processes characterize the Amasiri Sandstone (Cenomanian – Turonian) in the southern Benue Trough, Nigeria. The cross bedded sandstone lithofacies (Sxm) in Afikpo area were deposited in tidally influenced, shallow sandy shoreline environment while similar lithofacies associated with the conglomeratic lithofacies (Sfc) in Akpoha are proximal canyon–fill deposits. The conglomeratic lithofacies with rip-up clasts together with the massive, horizontal-bedded lithofacies (Smm) and parallel-laminated sandstone lithofacies (Sfl) in Akpoha were deposited in confined channels in proximal submarine canyon setting. The wavy/ripple-laminated sandstone lithofacies (Sfw) and very fine grained bioturbated sandstones lithofacies (Sfb) represent weakly confined distributary splay and unconfined associations in proximal to distal submarine canyon settings. The bioturbated mudstone lithofacies (Msb) and parallel-laminated mudstones lithofacies (Msl) comprise the bypass/levees association in the inner to outer shelf and in the distal canyon settings. Overall, these lithofacies indicate deposition in shelf to deep water depositional environments.

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1. Introduction

The depositional model for the Amasiri Sandstone of the Eze-Aku Formation, southern Benue Trough has been controversial. [Reyment \(1965\)](#) interpreted the Eze-Aku Formation as shallow water deposits based on ammonite contents while [Murat \(1972\)](#) regards the shale as transgressive deposits in shallow shelf setting. [Petters \(1978\)](#) and [Iwobi \(1991\)](#) also consider the Eze-Aku Formation as shallow marine on the basis of foramineferal content.

In the study area, the dominantly shaly Eze-Aku Formation changed facies to a sequence of sandstones interbedded with shales and minor limestones referred to as the Amasiri Sandstone by Shell D'arcy geologists ([Whiteman, 1982](#), p. 42), ([Table 1](#)). This sandstone represents the uppermost part of the Eze-Aku Formation on the eastern limb of the Abakaliki Anticlinorium and occurs as parallel ridges trending in a NE–SW direction ([Fig. 1](#)). The sandstones have been variously interpreted as tidal/subtidal shallow marine deposits ([Banerjee, 1980](#)); storm-dominated shallow shelf deposits ([Amajor, 1987](#)), marginal marine sand deposits ([Ojoh, 1990](#)). Recently [Odigi \(2012\)](#) described the Amasiri Sandstone which clearly belongs to the pre-Santonian Eze-Aku Formation

([Simpson, 1954](#); [Reyment, 1965](#); [Banerjee, 1980](#), [Whiteman, 1982](#); [Amajor, 1987](#)), as part of the Campanian–Maastrichtian Nkporo Formation. He interpreted the rocks as deposited in alluvial fan, braided river, point bar and deltaic environments.

This study has carried out a detailed outcrop and lithologic description of the Amasiri Sandstone from Amasiri to Akpoha ([Fig. 1](#)) in order to identify the rocks and their critical descriptive features, particularly, the composition and sedimentary structures. These have been used to review the depositional model for the Amasiri Sandstone in the light of the above discussed controversies.

2. Regional tectonic and stratigraphic setting

The Amasiri Sandstone was deposited in the southern Benue Trough during the late Turonian ([Reyment, 1965](#)). The Benue Rift was installed as the failed arm of a trilate rift system during the breakup of the Gondwana supercontinent and the opening up of the southern Atlantic and Indian Oceans in the Jurassic ([Burke et al., 1972](#); [Benkheilil, 1982, 1989](#); [Hoque and Nwajide, 1984](#)). [Genik \(1993\)](#) showed that the Benue Rift is part of the West and Central African Rift System which originated during the splitting apart of the Gondwana supercontinent.

The stratigraphy of the southern Benue Trough was described by [Murat \(1972\)](#) and [Hoque \(1977\)](#) in the concept of three tectonic

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Table 1

Stratigraphic Framework of southern Benue Trough and Anambra Basin showing the position of Eze-Aku Group and Amasiri Sandstone relative to other formations in southeastern Nigeria (Modified from Hoque, 1977).

AGE		STRATIGRAPHIC SEQUENCE	BASIN/ CYCLE
EOCENE		AMEKI /NANKA FM	ANAMBRA - AFIKPO BASIN (Second Sedimentary Cycle)
PALEOCENE		IMO SHALE	
UPPER CRETACEOUS	DANIAN	NSUKKA FM	
	MAASTRICHTIAN	AJALI SS	
		MAMU FM	
		NKPORO GROUP/ ENUGU SHALE	
	CAMPANIAN		UPLIFT + FOLDING
	SANTONIAN		
	CONIACIAN	AWGU FM	ABAKALIKI BASIN (First sedimentary Cycle)
	TURONIAN	EZE-AKU GROUP Amasiri Ss Eze-Aku Sh	
CENOMANIAN	ODUKPANI FM		
LOWER CRETA.	ALBIAN	ASU RIVER GROUP	
PRE CAMBRIAN		BASEMENT COMPLEX	

– sedimentary cycles. Sedimentation in this rift structure started with deposition of alluvial fans and lacustrine sediments in the Aptian – Albian period. These sediments belong to the Mamfe Formation (Reyment, 1965) in the southern Benue Trough. Two cycles of marine transgressions and regressions occurred from the middle Albian to the Coniacian culminating in the deposition of marine mudrocks, sandstones and limestones as well as pyroclastic flows and basic intrusives with an estimated thickness of 3500 m (Murat, 1972; Hoque, 1977). These sediments belong to the Asu River Group (Middle Albian), the Odukpani Formation (Cenomanian), the Eze-Aku Formation (Turonian) and the Awgu Formation (Coniacian).

A relaxation of the causative mantle plume during the Santonian period set up a stress regime that resulted in sub-crustal compressional folding and uplift of these earlier synrift (pre-Santonian) sediments into the Abakaliki Anticlinorium and the simultaneous subsidence of the western margin into the Anambra Basin and the eastern platform into the Afikpo Sub-basin (Murat, 1972; Burke et al., 1972; Hoque and Nwajide, 1984). The Amasiri Sandstone belongs to the Eze-Aku Formation and outcrops within the Afikpo Synclinorium on the southeast margin of the Abakaliki Anticlinorium. Table 1 shows the stratigraphic framework of the southern Benue Trough and Anambra Basin (Murat, 1972; Reyment, 1965) and the stratigraphic position of the Amasiri Sandstone.

3. Methodology

Out of the several outcrops mapped, nine (9) outcrop sections of the Amasiri Sandstone were described from Akpoha to Afikpo, using critical descriptive lithologic characteristics such as

lithology, texture, physical and biogenic sedimentary structures and fossil contents. The lithologic and sedimentological characteristics of the described outcrop sections were captured using a logging format designed to provide an insight into the vertical variation in lithology, texture (grain size, sorting, roundedness), physical and biogenic sedimentary structures, fossil content, bed thickness, and contact types. Lithofacies were also recognized using the descriptive above listed lithologic and sedimentological characteristics of the rocks. Outcrop photographs of some of the described sections were taken and the characteristic features of the lithofacies were correlated with their lithologic logs. The vertical lithofacies transition patterns were used to interpret the paleoenvironment of deposition following the method of Pemberton et al. (1992) and Maill (2000).

4. Results and interpretation

4.1. Outcrop description

4.1.1. Outcrop 1 – Behind Government Technical College (GTC), Akpoha

This outcrop occurs on a ridge trending in a NE–SW direction covering a lateral extent of about 100 m along the ridge (Fig. 2a). The basal section of the outcrop consists of a sandy conglomerate comprising of a structureless (massive), thickly bedded, fine to medium grained sandstone, containing irregular-shaped limestone rip-up clasts, floating in a sandy matrix (Fig. 2b). The rip-up clasts are randomly distributed in the rock and vary from 5 to 40 cm in diameter. Some of the clasts have dissolved out leaving open holes in the rock.

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