Available online www.jsaer.com

***Journal of Scientific and Engineering Research*, 2022, 9(2):28-33**

Research Article

ISSN: 2394-2630
CODEN(USA): JSERBR

Depositional Processes, Facies and Environment of Deposition of the Upper Miocene (Seravillian/Tortonian) Sediments in the Jokg Field – Eastern Niger Delta

Omoboh, Jonathan Obukowho, Odigi, Minapuyi I. Okengwu, Kingsley O.

University of Port Harcourt, Port Harcourt Nigeria

Abstract This work aim to identify the depositional environments of the Seravillian/Tortonian sediments of the coastal swamp depobelt in the Niger Delta basin through the features preserved in the facies by depositional processes. The vertical change in grain size - a product of change in energy of the depositional processes preserved in the identified facies was employed to identify the depositional process (s) that generate the facies. The change in grain size was identified from the gamma ray log trend which have been known to correlate and calibrated with grain size changes. The interval studied within the upper Miocene in the "JOKG" Field, reveals that the sediments were deposited by fluvial processes (erosion, transport, sediment supply and deposition) and shoreline processes (sediment supply, transport, deposition, wave and tidal current redistribution of deposited sediments). The upper section of the interval is dominated by fluvial processes as it contains predominately of sediments which fines upward and sometimes blocky in log trend. The lower part is characterized by sediments which fine downward and coarse upwards with occasional occurrence of sediments that fine upwards. These represents shoreline processes which were occasionally interrupted with fluvial processes. The dominant of the fluvial processes in the upper section show that continental environment occur in the upper section while transitional to shallow marine environment occur in the lower part, since these processes are predominant in these environments respectively. This work thus helps to identify a depositional environment from the predominant of identified processes producing its facies.

Keywords Depositional processes, Facies, Environments of Deposition

Introduction

Depositional processes are the generator of facies. Facies are thus products of processes of sedimentation. The features left by the processes as they generate Facies, help to identify the process (s) that produce the Facies [1]. All depositional environments have unique process (s) operating within them and thus unique arrangement of facies [2]. Sedimentary Facies analysis helps to understand the processes and controls leading to the formation of sedimentary rocks [3]. The innate characteristic of all facies in every depositional environment result from their grain size distribution pattern, composition, sedimentary structures and connate water chemistry [3]. Sediment size variation pattern and the types of structures present are the two most noticeable characteristic of sedimentary facies, most importantly in siliciclastic rocks [4]. This paper aim to identify the depositional processes that generated the upper Miocene sediments of the JOKG Field using the features preserved on the Facies. The name JOKG was used to code the field for proprietary reason.

The two major unique features of the Eastern Niger Delta geology that separate it from other part of the Delta is the presence of the Qua-Iboe shale and Afam Clay [5]. The Qua-Iboe Shale is believed to result from the collapse of the Continental shelf in the Eastern part of the Delta creating local subsidence and accommodation space for the deposition of the sediments during marine transgression [6]. The Afam Clay member resulted from an ancient and persistent submarine river channel which cut the rock units in the eastern portion of the delta up to 1000m deep and was later filled with many cycles of deposition of sediments from Oligocene to Pliocene [5]. The three main rock lithostratigraphic unit of the Niger Delta (Benin Formation, Agbada Formation and Akata Formation) are well represented also in the Eastern Niger Delta. The Afam Clay Member occur within the Benin Formation while the Qua –Iboe shale occurs between the Benin and Agbada formation.

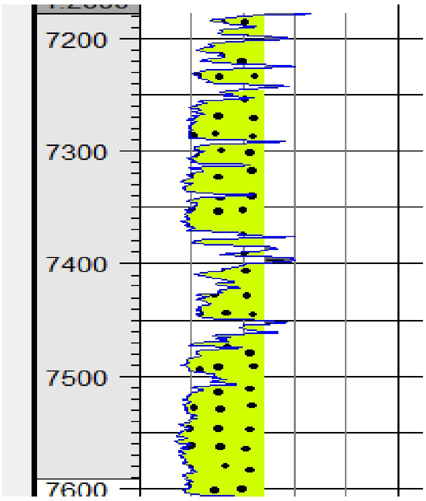
Materials and Methods

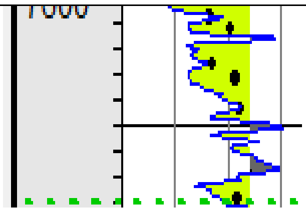
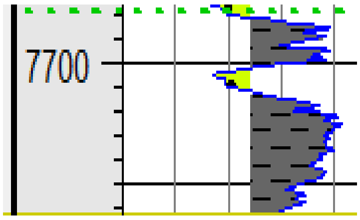
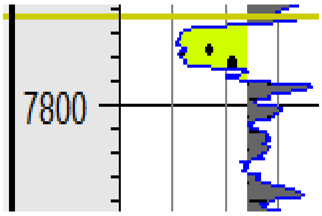
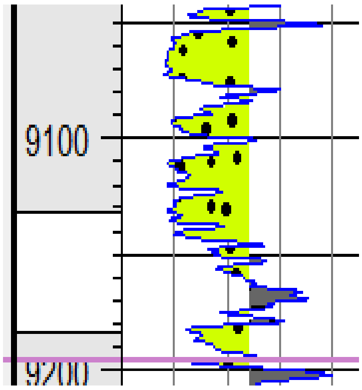
Thirteen well logs with some biostratigraphic information were used for the study.

Depositional processes from which the facies were produced were inferred from structures produced on the facies. These includes sediment size trend that is always specific to individual processe(s) and facies types. Grain size variation pattern and velocity of transportation of grain during deposition are related [2]. Larger grains are deposited at high velocity while smaller grains are deposited at low velocity according to stroke law [4]. This means that upward grain size decrease represents steady reduction in transport velocity during sediment accumulation. The opposite is valid as well. Availability of sediment from the source also determine the volume and sorts of sediment carried and deposited [2]. Changes in water depth or sea levels alters the transportation velocity and thus size of sediment deposited in any environment [2]. Gradient of depositional site also determine the flow speed at which sediments accumulates and their sizes [7]. Since particles sizes and clay/ argillaceous volume recorded from gamma ray are related [8], grain size variation was interpreted using gamma ray trend to be either fining (decreasing) upward or coarsening (increasing) upward. This is specific to depositional processes [1]. The resistivity log signature with the neutron log trend with unique pattern of variation with the quartz content and thus sediment size [8] was incorporated with the trend of gamma ray. The combined depositional processes seen, confirms environment of deposition.

Result and Discussion

Table 1 below show some of the facies seen in the interval

Depth Interval (ft)	Electrofacies and facies	Inferred Environment
Well 8 7607 – 4388	Sharp base, cylindrical shape with minor intervening bell shape, and funnel shapes, overall upward particle size decrease, upward increase argillaceous content – Channel facies 	Upper delta plain environments, such as meandering channel, braided channel, and flood plains
7681 – 7607	Funnel shape having gradational base, upward sediment size increase with decreasing argillaceous content- facies of mouth bar / shoreface	Mouth bar environment / shoreface environment

Depth Interval (ft)	Electrofacies and facies	Inferred Environment
		
7766 - 7681	Gradational base, bell shape with minor funnel shape at top, upward sediments size decrease with increase in clay / shale content – marine clay 	Pro delta environment
7849 – 7766	Gradational base, bell shape with minor intervening funnel shape, overall, upward decrease in grain size, upward increase in clay / shale content – marine clay facies 	Pro delta environment
9200 - 9042	Funnel shape repeated with gradational base, upward increase in grain size, upward decrease in clay / shale content – shoreface facies 	Upper shoreface

Discussion

The Delta plain facies interpreted occurs within the Benin formation. They are product of fluvial processes: erosion, bedload transport, suspension transport, gravity and debris flow. Erosion occurs during smash flood, large scale flooding and continuous stream discharge [3]. These generate the channels into which sediments are deposited as the flood or discharge wanes. The channel dimension and shape have relationship with its capability to cut vertical incision and migrate laterally [3]. Vertical incision cuts the material over which flood or discharge flows, deepening the channel. This makes more space available for transport and deposition of sediment. Channel that flows perennially, or receive flow from smaller rivers due to variation in climate, generate deep vertical incision sometimes accompanied with widening [3]. Erosion of cut bank of the channel and accumulation of sediments eroded on the point bar cause lateral migration. The channel aspect ratio (width to thickness ratio) depends on its lateral migration and vertical incision ability. All sediment in channels moving either as traction carpet of bedload, suspended load, will ultimately accumulate as transport velocity wanes. For movement in suspension, accumulation takes place anytime the upward force due to turbulent keeping the sediment suspended is less than the downward force (W) pulling down the sediment which is directly related to sediment dimension according to strokes law [4]

$W = pd^2g/^{18U}$

Where, W equals particle fall velocity, p is density different between fluid and particles, d is diameter of particle, g is gravity acceleration and U is dynamic viscosity. This will produce decrease in sediment size upward as the velocity of flow continue to slow down over time in the channel, due to channel side way migration, reduction in slope, or increase in water level where the channel flows into. This generate the finning upward facies units of Benin formation figures 1 and 2 below, however, some parts like floodplain are lacking due to their removal through erosion by succeeding channels.

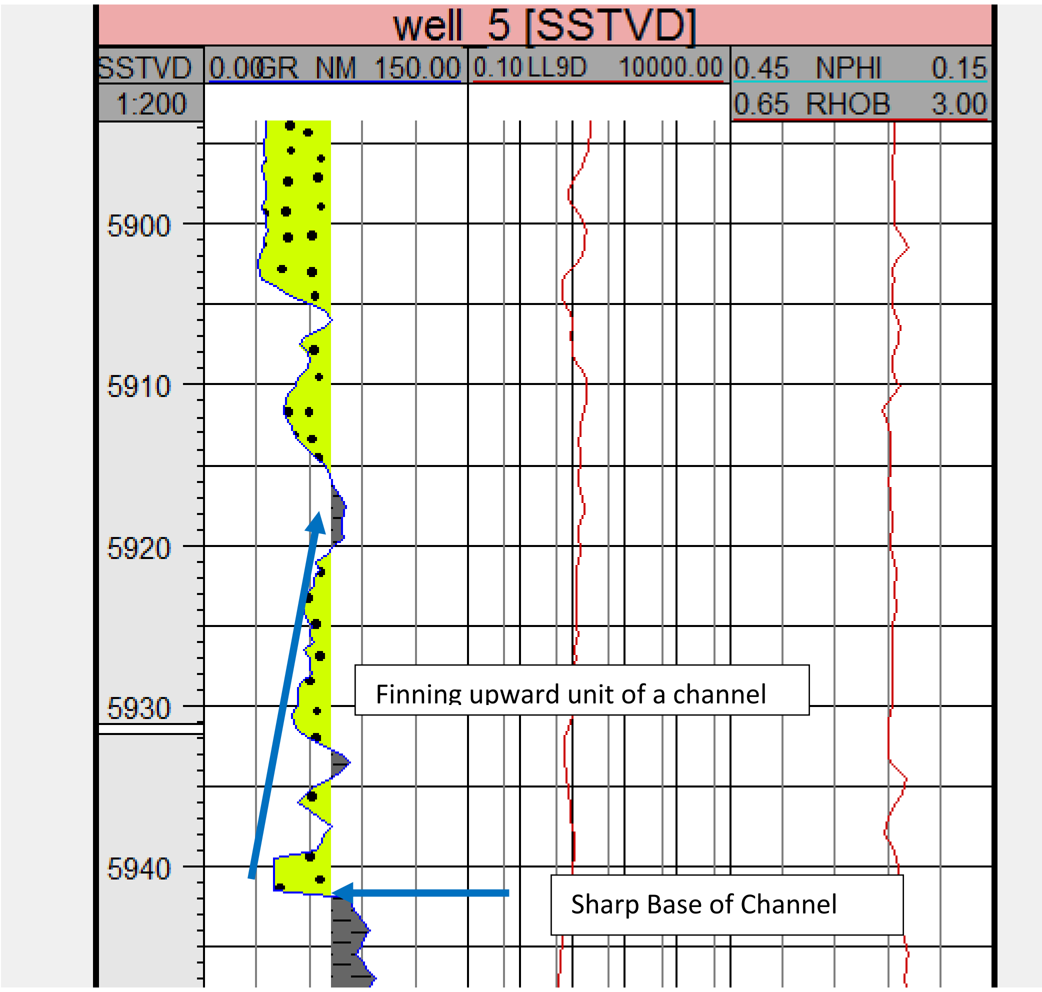


Figure 1: Finning upward unit with a sharp base of a channel facies in Benin Formation.

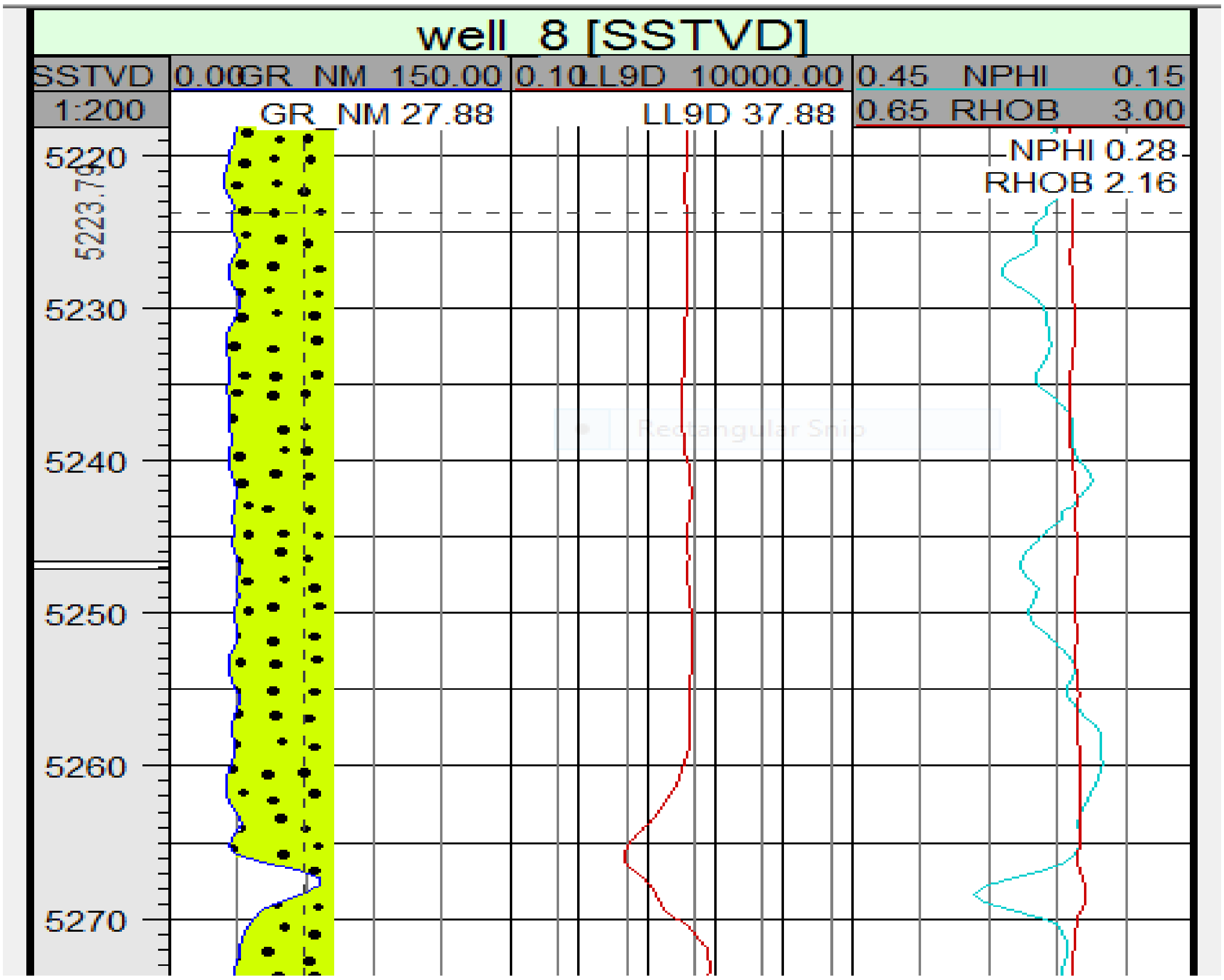


Figure 2: Channel facies of the Benin formation with the finning up signature and sharp base (note that fine components have been removed by succeeding channel)

The finning upwards units are dominant in the upper section of the interval Table 1 above while the coarsening upward units are more in the lower parts. Since the channel facies is dominant in the upper section of the interval, it confirms that continental facies occurs at the upper section of the studied interval while shallow marine (delta front) environment lies below the continental environment.

Conclusion:

The dominants of the fluvial facies help to define the depositional environment of the sediments in the upper part of the field while the dominants of coarsening upward units help to identify shallow marine (delta front) environment below. The work thus show the paths to the revelation of the environment of deposition of sediments through the identification of the most predominant processes with their corresponding products (Facies)

References

[1]. Omoboh, J.O., and Odigi, M.I. (2020). Lithofacies and Environmental Analysis of Reservoir Sandstones in the ABOM Oil field of Eastern Niger Delta, Nigeria. Journal of Geography, Environment and Earth Science International, 24(8), 34-43. December, 2020.

[2]. Nichols, G. (2009): Sedimentology and Stratigraphy. Blackwell Scientific Publication, 2nd edition, 1-4, 44-85,179-196.

[3]. Reading, H. G. (1996). Sedimentary Environments: facies and stratigraphy. Blackwell Publication, 3rd edition, 5-11, 15-23,154-228.

[4]. Tucker, M. E. (1991). Sedimentary Petrology. Blackwell Scientific Publication, 2nd edition, 18-28, 55-77.

[5]. Reijers, T. J. A. (1996). Selected Chapters on Geology: Sedimentary Geology and Sequence Stratigraphy in Nigeria, Three Case Studies and a Field guide. Shell Petroleum Development Corporation corporate Reprographic Services Warri.

[6]. Reijers, T. J. A. (2011). Stratigraphy and Sedimentology of the Niger Delta. GWO- Training and Travel Geologos, 17, (3), 133 – 162.

[7]. Boggs, S. J. (2006). Principles of Sedimentology and Stratigraphy. Pearson Education Inc, 4th edition, 289-303.

[8]. Rider, M. H. (2002). Geological Interpretation of Well Logs. Rider French Consulting Limited, 2nd edition, 226 – 260.