OBAFEMI AWOLOWO UNIVERSITY

THE STUDY OF DEEPWATER DEPOSITIONAL ELEMENTS USING SEISMIC GEOMORPHIC AND STRATIGRAPHIC TECHNIQUES IN "ACE" FIELD, NIGER DELTA

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CERTIFICATION

This is to certify that this workwas carried out by **AKINDULURENI John Olaolu**(SCP14/15/H/0016) in the Department of Geology, Faculty of Science, Obafemi Awolowo University, Ile-Ife. Thethesis has been read and approved as meeting part of the requirements for the award of Master of Science (M.Sc.) Degree in Applied Geology. To the best of our knowledge, the thesis has not been presented elsewhere for the award of any degree.

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DEDICATION

Rest in peace, Akerele Tayo

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The All-Sufficient God, Hallowed be Your Name. I remain, always, in Your debt.

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ABSTRACT

This study analyzed well log data from “ACE” Field in deep-offshore settings of the Niger Delta, identified the deepwater depositional elements from 3D seismic data and characterized the geomorphology and stratigraphy of the identified depositional elements. These were with a view to investigating the occurrence of depositional elements, their formative processes and reservoir potential in the study area.

The dataset included processed 3D seismic data (1160 inlines and 1117 crosslines), geophysical well logs (Gamma Ray, Density, Sonic, Neutron, Resistivity) and checkshot data for one well. A synthetic seismogram was generated to tie the well data to the seismic data. Lithofacies within the well were identified and their gross depositional environments were predicted from the gamma ray log motifs. Seismic interpretation involved the picking of faults based on abrupt termination of events and change in reflection pattern. Horizons inferred to be candidate sequence boundaries corresponding to depositional surfaces indicative of documented depositional elements were mapped across the seismic volume. The mapped horizons served as input for generating seismic surfaces and attribute maps that gave planform images of identified depositional surfaces and their associated depositional elements. Seismic stratigraphic analysis was also carried out to determine the seismic sequences in the study area and their associated seismic facies.

The well log analysis revealed that the studied interval was predominantly characterized by thick sequences of shale, deposited in a low-energy environment, interbedded by relatively thin hydrocarbon bearing turbidite sands. Twenty-nine (29) faults with approximate E-W trends and steep dips were mapped in the study area. Seismic sequence analysis revealed five (5) seismic sequences (Sequence A through to Sequence E) with their characteristic seismic facies. The depositional elements delineated included a submarine incised valley, an erosional channel belt and a leveed channel. Other features include; erosional scallops, erosional and fault-scarped terraces, linear grooves as well as scours of mass transport deposits (MTDs). The meandering laterally migrating channel-fills observed within the submarine incised valley, the isolated channel-fills within the erosional channel and the levee deposits were found to be characterized by high amplitude sandprone deposits.

The study concluded that the depositional elements within the study area were formed from repeated erosive turbidity flows and other mass transport processes. The fill-deposits assessed within the depositional elements had good reservoir potential and hydrocarbon exploration significance.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Deepwater environments are sedimentary environments where marine gravity-flow processes occur. These gravity flows are mixtures of sediment and water moving under the influence of gravity, such as turbidity currents, debris flows, grain flows, fluidized flows, cohesive flows (Emery and Myers, 1996). They are located in present-day sea depths in excess of 200 m from the shelf break through the slope and down to the basin floor. Deepwater systems, which are a combination of the marine-sediment gravity-flow processes, their environments and associated deposits, are also commonly referred to as turbidite systems (Mutti and Normark, 1987; 1991), turbidite system complex (Stelting *et al.*, 2000), and submarine fans (Bouma *et al.*, 1985). They are formed as a result of the complex interaction of many factors that affect all sedimentary basins such as tectonics, climate, sediment supply, eustatic sea-level etc. (Stow *et al.*, 1985). The three main influences that control the nature of deepwater depositional systems are tectonics, sediment supply, and sea-level fluctuations (Fig. 1.1).

Tectonics affect deepwater deposition in four ways; where sediments are delivered to the basin, the geometry of the basin margin and the basin itself, the bathymetry of the basin, and the way local tectonics affect the distribution of a deepwater system. Hinterland and climate affect the rate, type, and source of sediment supply; these in turn affect the depositional processes of the basin and the shape, type, and nature of both near-shore and shelf systems.

The sediment delivery systems in deepwater are affected by sedimentary processes at play in the basin and these ultimately impact on the reservoir characteristics (Fig. 1.2). The factors that influence the complex sedimentary cycle include;

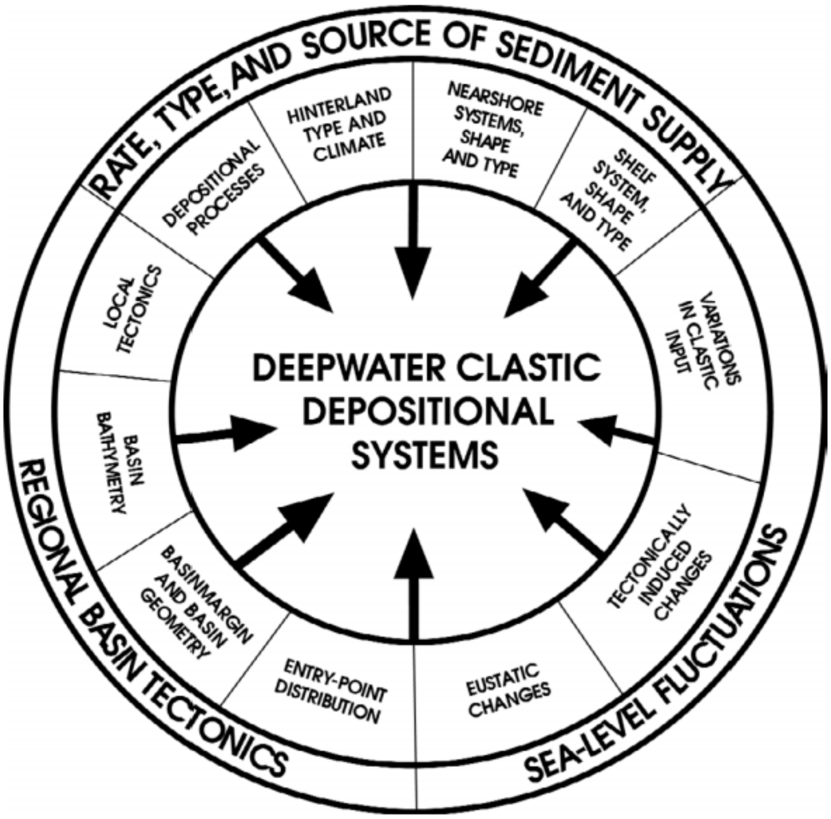

Figure 1.1: Controls on the Development of Deepwater Clastic Depositional Systems(Richards *et al.*, 1998).

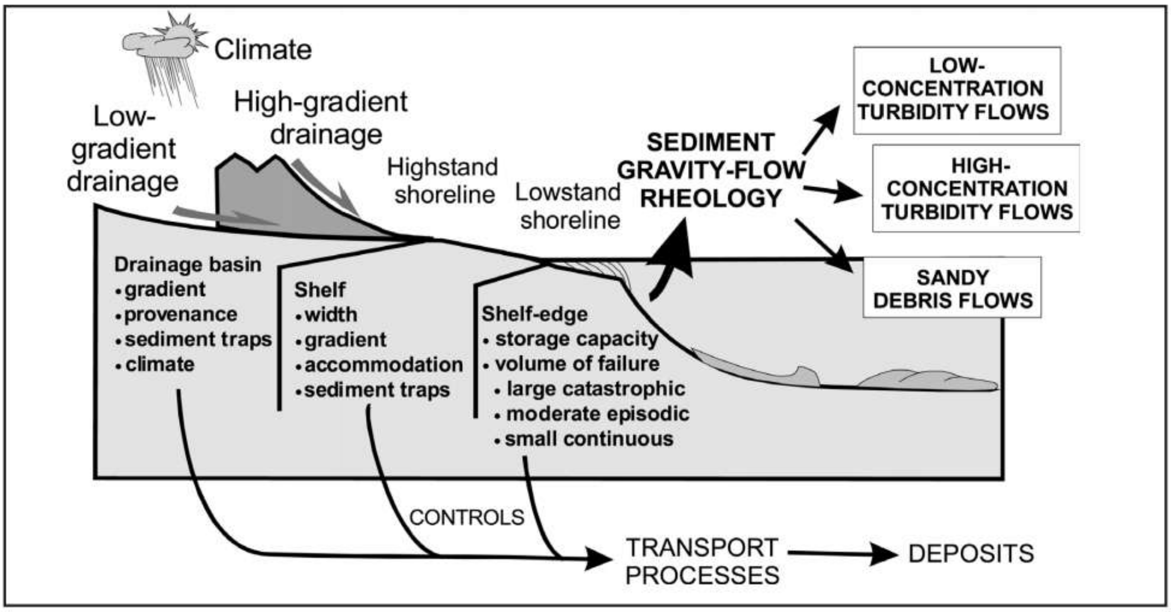

Figure 1.2: Schematic Cross Section across a Margin, Illustrating the Influence of the Sediment Delivery System on Reservoir Characteristics (Garfield *et al*., 1998).

(a) the nature of the basin's drainage in terms of gradients, provenance, sediment type, and climate;

(b) the shelf (widths, gradients, accommodation);

(c) the capacity of the shelf edge to store shallow-marine sediments prior to their resedimentation to deepwater;

(d) the nature of the sediment gravity flows to deepwater (large catastrophic flows from earthquakes, moderate episodic flows from major floods, or small continuous hyperpycnal flows from continuous floods); and

(e) the rheology of the flows (low-concentration versus high-concentration flows versus sandy-debris flows) and their resulting deposits.

Sea-level fluctuations can affect deepwater systems through eustatic changes and tectonically induced changes and by varying the supply of clastic input (Weimer and Slatt, 2004).

1.1 Location of Study Area

The Niger Delta is located along the western margin of Africa in the Gulf of Guinea. The study area is a field located 120 km offshore southwestern Niger Delta, beyond the continental shelf, at about 1300 m water depth between Latitudes 4° 26' N and 4° 42' N and Longitudes 4° 28' E and 4° 43' E (Fig. 1.3).

1.2 Statement of Research Problem

Research works on the deepwater depositional systems and processes in the Niger Delta are sparse resulting in limited understanding of the geology at play in the region. The need for further studies of the submarine depositional system in the basin to enhance current understanding of the system and improve the prediction of hydrocarbon exploration targets becomes imperative, hence this study.