

**QUANTITATIVE AVA ATTRIBUTES ANALYSIS USING  
SIMULTANEOUS AND ELASTIC IMPEDANCE  
INVERSIONS:  
A CASE STUDY OF 'SANDFISH' FIELD, IN THE NIGER DELTA.**

**BY**

**ADESANYA, OLUWAKEMI YEMISI**

**MATRIC NO: 099076017**

**MARCH, 2017**

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**B.Sc. (LASU); M.Sc. (UNILAG)**

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**SCHOOL OF POSTGRADUATE STUDIES  
UNIVERSITY OF LAGOS**

**CERTIFICATION**

**This is to certify that the Thesis:**

**QUANTITATIVE AVA ATTRIBUTES ANALYSIS USING SIMULTANEOUS AND  
ELASTIC IMPEDANCE INVERSIONS:**

**A CASE STUDY OF ‘SANDFISH’ FIELD, IN THE NIGER DELTA.**

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**By:  
ADESANYA, OLUWAKEMI YEMISI  
in the Department of Geosciences**

..... <b>AUTHOR’S NAME</b>	..... <b>SIGNATURE</b>	..... <b>DATE</b>
..... <b>1<sup>st</sup> SUPERVISOR’S NAME</b>	..... <b>SIGNATURE</b>	..... <b>DATE</b>
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..... <b>SPGS REPRESENTATIVE</b>	..... <b>SIGNATURE</b>	..... <b>DATE</b>

## **DEDICATION**

This study is dedicated to the merciful and unrivalled God that has made the study possible. The dedication also extends to my father, Late Engr. Felix Adesanya, who sleeps in the bosom of the Lord. May his gentle soul rest in peace! Amen.

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## ABSTRACT

The global energy demand is rising and production from mature fields is on the decline while oil and gas companies are expanding activities into increasingly challenging areas. Currently, misinterpretation of seismic data due to subtle features of complex reservoirs has resulted in bypass of hydrocarbon zones and drilling of many dry holes. The combination of Simultaneous and Elastic impedance inversion techniques has been applied to estimate amplitude variation with angle (AVA) attributes such as P-impedance ( $Z_P$ ), S-impedance ( $Z_S$ ), density ( $\rho$ ), lambda-rho ( $\lambda\rho$ ), mu-rho ( $\mu\rho$ ), Poisson's-ratio ( $\sigma$ ), near and far elastic volumes with a view to reducing risk, enhancing hydrocarbon discovery and optimizing development plans in 'Sandfish' Field located offshore, Niger Delta. Four 'Sandfish' (Sfn) wells (Sfn-01, Sfn-02, Sfn-04 and Sfn-05), check-shots and 3D seismic data of five angle stacks ( $6^\circ$ - $12^\circ$ ,  $12^\circ$ - $18^\circ$ ,  $18^\circ$ - $26^\circ$ ,  $26^\circ$ - $32^\circ$  and  $32^\circ$ - $42^\circ$ ) were used in the study. Sensitivity analysis involving cross-plots of petrophysical and elastic properties from well data was first carried out to establish rock property relationships in the interval of interest. Biot-Gassmann fluid substitution analysis was also used to reveal variation of rock properties to pore-fill types. Low frequency (0-2 Hz) models were generated from interpolation of high-cut-filtered compressional wave velocity log (P-sonic), shear wave velocity log (S-sonic) and density log guided by interpreted four seismic horizons. The low frequency models were used to broaden the spectrum and estimate the elastic volumes. The five partial angle stacks varying from  $6^\circ$ - $42^\circ$  were simultaneously inverted using Jason's Rock-Trace® inversion software which iterated trial inversions until the model sufficiently matched the seismic data. The near ( $6^\circ$ - $12^\circ$ ) angle and far ( $32^\circ$ - $42^\circ$ ) angle stacks were inverted to complement the results from the simultaneous inversion. The inverted  $Z_P$ ,  $Z_S$ , and  $\rho$  volumes from simultaneous inversion were used to derive  $\sigma$ , volume of sand ( $V_{sand}$ ),  $\lambda\rho$  and  $\mu\rho$  volumes. The Sensitivity analysis carried out established that  $Z_P$  and  $Z_S$  were good candidates for lithology and fluid discrimination in the field of study. The cross-plot of Inverted  $Z_P$  and well  $Z_P$  gave a correlation coefficient of 86% indicative of high quality inverted volume which will reduce exploration risk. The study revealed that  $\lambda\rho$  was a better lithology and fluid discriminator when compared with other derived elastic volumes used in the study. The inversion results further showed good match with well logs from Sfn-04 away from the well control reflecting that the technique could be adopted in areas with limited well data. The elastic volumes revealed good correlation at 1850 ms and 2050 ms though the prospects were more visible at the far elastic volume compared to  $Z_P$  from simultaneous inversion and near elastic volume. The low  $\sigma$  from the fluid prediction map showed presence of hydrocarbon while lithology map reflected high  $V_{sand}$  of good quality. The study concluded that rock-property models from simultaneous and elastic impedance inversions were effective predictive tools for lithology and fluid types.

**Keywords:** Elastic Impedance Inversion, Simultaneous Inversion, Low Frequency Models, Reservoir Development.