Petrophysical and Sequence Stratigraphic Analyses

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Introduction

Well logging might be translated as “a record of characteristics of rock formations traversed by a measuring device in the well bore. There will always be a possibility of finding more oil and gas deposits if more accurate exploration techniques are employed in its search from the history of petroleum exploration and also proper knowledge of the underlying geology helps to accurately predict the hydrocarbon potential and reserve estimation of a petroleum field. It is very important to determine and understand the petrophysical properties and mechanical properties of eservoir rocks, accurate estimates of porosity and permeability values in certain stratigraphic intervals can be derived from well log types, i.e. sonic, neutron or bulk density logs.

Sequence stratigraphic approach has turned out to be one of such unique techniques for generating exploration prospects and predicting reservoir and seal qualities in both stratigraphic and structural traps. Sequence stratigraphy evolves as an aspect of stratigraphy that subdivides rock record using a succession of depositional sequences composed of genetically related strata as regional and inter-regional correlative units (Haq *et al.*,1988). Thus, genetically related facies are studied within a frame work of chronostratigraphically significant surfaces (Van Wagoner *et al.*, 1990), and rock units that are genetically related are constrained by time lines (Reijers, 1998).

The objectives of this research are to utilize petrophysical and sequence stratigraphic analysis approach using 3D seismic, check shot, geophysical well log data to delineate the reservoir units in the field, determine the geometric properties of the reservoir rocks and a potential unifying framework for interpreting the stratigraphy of the deltaic sequence within a particular field in the Niger Delta. Nigeria.

Theory and/or Method

The materials used for this research include digital 3-D seismic lines, borehole logs, velocity check shot survey data and a base map of the field. The available software for this project include petrel™ 2009, interactive petrophysics and surfer 2010.

Figure 1.1 is a flow chart depicting the steps involved in the interpretation of well logs and seismic data. These steps of data analysis and interpretation include the following: Data

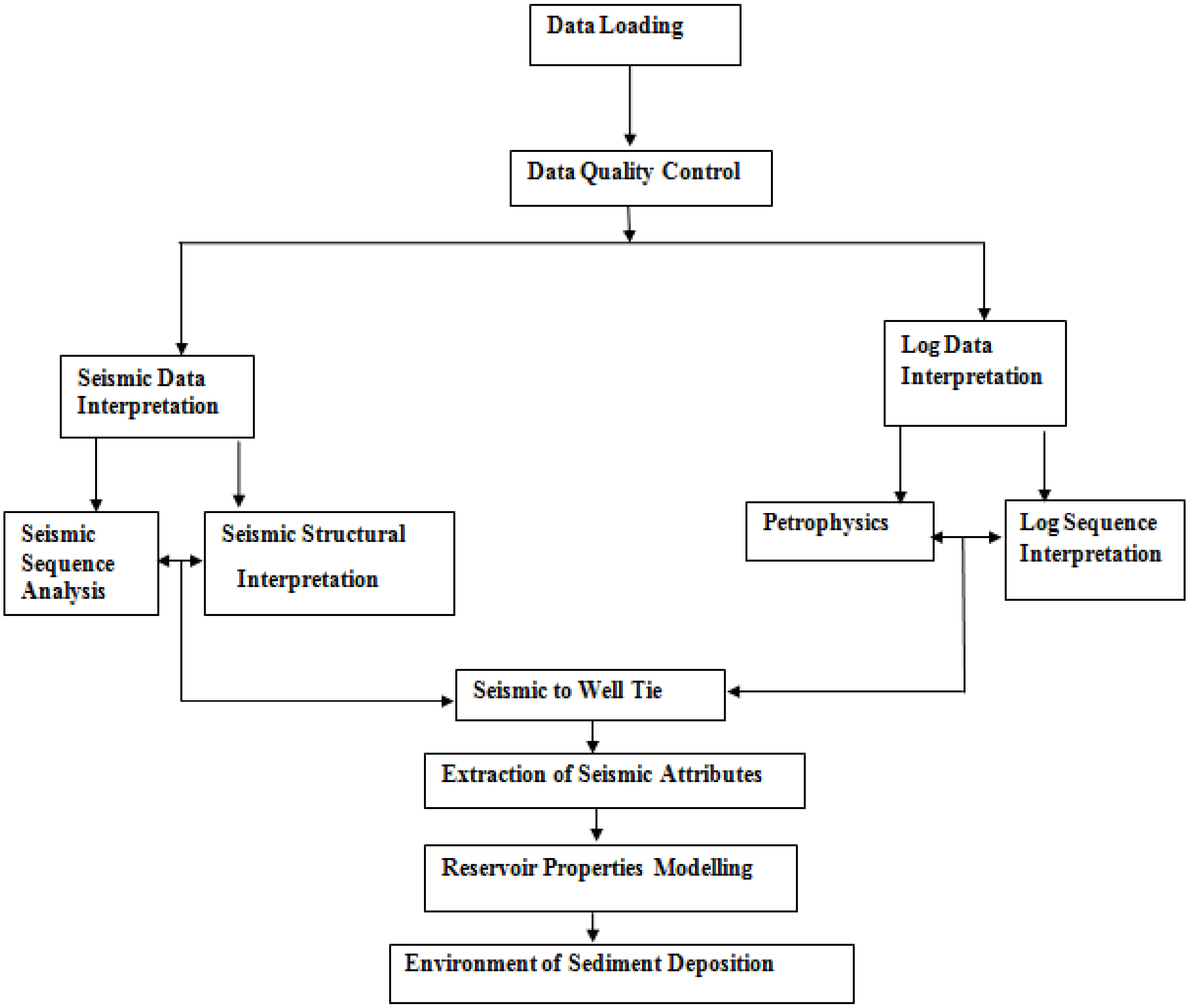

Figure 1.1: Flowchart Showing the Procedure of Methodology

loading, quality control, seismic data interpretation, log data interpretation, seismic to well tie, extraction of seismic attributes, reservoir properties modelling and environments of sediment deposition.

The suite of wireline logs available for this project include: gamma ray, neutron, density, sonic and deep resistivity. Prospective intervals and hydrocarbon bearing reservoirs were delineated and identified on the basis of logs signatures. Both qualitative and quantitative interpretations were carried out in this research. Qualitative log Interpretation entails the visual inspection and description of anomalous regions on logs in relation to petrophysical parameters. Some important parameters considered during qualitative log interpretation include log: shapes, lithology, hydrocarbon and water bearing zones, fluid contacts, fluid type, stratigraphic surfaces, parasequence stacking patterns and environments of sediments deposition. In quantitative log interpretation, reservoir properties determined are porosity, volume of shale, gross sand, net sand, net to gross, water saturation, hydrocarbon saturation, permeability, irreducible water etc, using mathematical expressions.

The seismic volume was imported into a user defined folder in SEG-Y format and then realized. 3 D seismic data interpretation was performed on the realized volume. The network of faults was identified and mapped using criteria such as reflection discontinuity at fault plane, and vertical displacement of reflectors. Prominent seismic marker surfaces which corresponded with sequence boundaries were also mapped on the basis of reflector quality (continuity and events strength) and prospectivity. To ensure accuracy of the interpretation, well to seismic tie was essential. The two methods that were used to tie well with seismic data are check shot data and synthetic seismogram. Synthetic seismogram was produced from sonic and density logs, this was necessary to establish a relation between well information and seismic data.

The horizons mapped on both crosslines and inlines were used to generate a 3 D grid that was auto tracked and used to generate time and depth structural maps of the sequence boundaries. These structural maps gave insight into the probable structure harbouring oil and gas in the area of study. Sediment deposition takes place on land, desert and marine environments. This project tries to study the mechanism of sediment transport and deposition in a field offshore Niger Delta. Log shapes and seismic reflection patterns were utilized for the evaluation of environment of sediment deposition.

Conclusions

The area of study is covered by 3D seismic lines and a suite of borehole logs from five wells. Borehole logs were used in the description of sequences, systems tracts and characterization of hydrocarbon bearing reservoirs. The gamma ray aided lithologic identification, resistivity log indicated nature of fluids (hydrocarbon and water) and neutron and density logs indicated the porosity as well as fluid types.

Borehole data played a complementary role to surface seismic. They ensure accurate determination of key stratigraphic surfaces and resultant time structural maps that are productive.

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