MAJOR LITHOLOGY OF TAU FIELD DEFINED BY DENSITY IN THE NIGER DELTA BASIN

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ABSTRACT

The analyses of three wells were performed using Hampson Russell Software for the purpose of defining density in the Niger Delta basin. The results of delineation of the wells reservoir show sand-shale base line as < 75 API and > 75 API for sand and shale respectively, which are the two major lithologies identified; high (greater than 50 ohms) resistivity and high (> 25%) porosity; low (< 5%) volume of shale and low (< 5%) water saturation indicating a hydrocarbon bearing formation. Selecting clean sand necessitates different crossplots of density versus different velocities of wave for all the wells using gamma ray as shale-sand sequence discriminator. The dominant lithology at the top of Tau ($\boldsymbol{\tau}$) reservoir is seen as shale; the dominant lithology in the reservoir is sandstones.

INTRODUCTION

The distribution of reservoir fluids (gas, oil and water) trapped in a reservoir is determined by the laws of Physics. Gas has the lowest density among the three fluids; it is therefore trapped at the top of the reservoir when it occurs in free-phase. Crude is trapped near the top of the reservoir between the water below and the gas above it. Differences in densities caused buoyancy of hydrocarbons to occur because of their respective fluids; the flow through the reservoir is in response to differential pressures that exist in a reservoir rock. The density log does not accurately identify most lithologies due to the varied range of rock densities, mineral configurations and porosities. Shales density ρ is within 18 x 10^{-1} to 28 x 10^{-1}gcm^{-3}. Sandstones, shales, limestones and dolomites have bulk density varieties that overlay each other (Kearey *et al.*, 2002; Reynold, 1997).

The geological arrangements and the lithologies of the subsurface are revealed by the well data. Well lithology analysis is to estimate lithological and reservoir characteristics from the available log. Usually, shale creates above 75% of the clastic infill in sedimentary zone; stays on top of productive zone (Bosch *et al.*, 2002; Sheriff, 1991; Hun *et al.*, 1986).

GEOLOGY AND LOCATION

Niger Delta province contains only one identified petroleum system called the Tertiary Niger Delta (Akata-Agbada) petroleum system. The rock from primary source is the upper Akata formation. Oil is produced from sandstone facies within the Agbada formation; the main target is the turbidite sand located in the upper Akata formation in deep water offshore or may be onshore (Tuttle, *et al*., 1999; Kulke, 1995; Ekweozor & Daukoru, 1994). The formation has an estimate of up to 7 x 10^3 metres thick (Doust & Omatsola, 1990).

Figure 1 indicates that τ Field is located some kilometres southwest of Port Harcourt in the Niger Delta within latitudes 3^0N and 6^0N; longitudes 5^0E and 8^0E. This region experiences heavy rainfall between March and October as well as dry season from November to February (Atat *et al*., 2012; George *et al*., 2010).

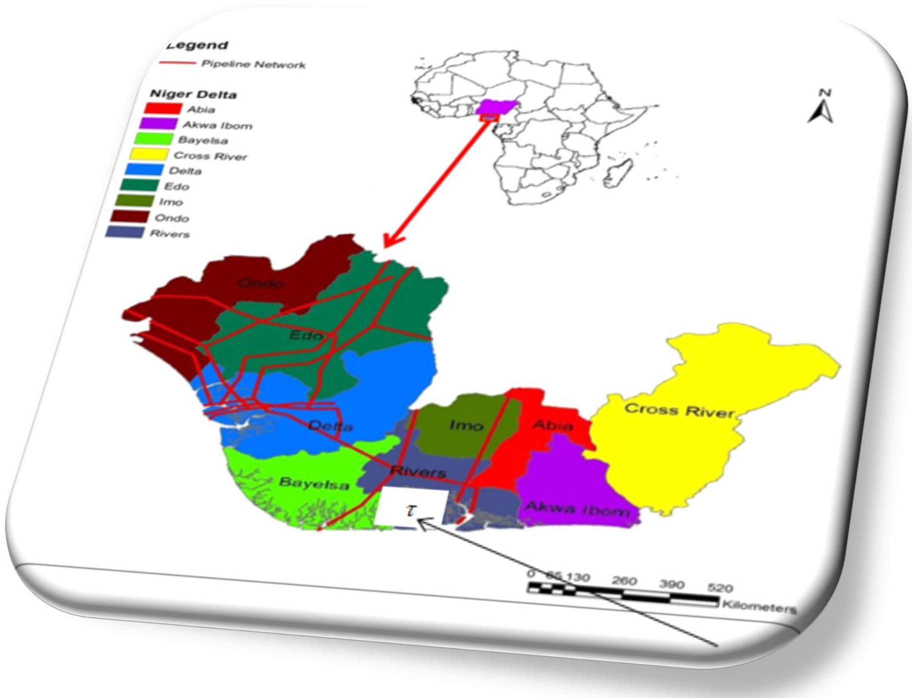

Figure 1: Map of Africa showing the Niger Delta region (red box) and oil pipeline (Sam *et al.*, 2017).

MATERIALS AND METHODS

Three wells were available with suite of logs including caliper, gamma-ray, resistivity, density and sonic velocity (V_p). These data were analysed using Hampson Russell Software (HRS). The log Import interface of the software was used to import well data; subjected the data to conditioning (were spurious values with edited out); well-log analysis carried out to determine the reservoir zones and lithology identification and estimation of rock attribute (such that the s-wave velocity was generated from p-wave velocity information).

RESULTS AND DISCUSSION

The result of lithology identification is presented in Figures 2 to 7. Figure 2 is the wireline logs showing the delineation of well A reservoir. The well has the sequence of the Niger delta formation which is dominantly shale/sand/shale. The well was analysed in terms of lithology. Sandstone is characterised by low gamma ray value (< 75API-sand baseline), high resistivity (> 50 ohm), low V_{sh} (< 5%), low water presence (< 5%) and with high value of porosity (> 25%). Also, the shale lithology is indicated by high GR (> 75API), the corresponding increase in V_{sh} and water saturation except decrease in resistivity. Well B (Figure 3) and well C (Figure 4) show similar characteristics with well A in terms of lithology with the presence of a marker indicating the reservoir which was correlated between three wells. With Lindseth approach, Figure 7 defines the variation of compressional wave velocity V_p with p-impedance (and Figures 5 and 6 noted curves with Gardner approach) with linear curve fitting for major lithologies identified.

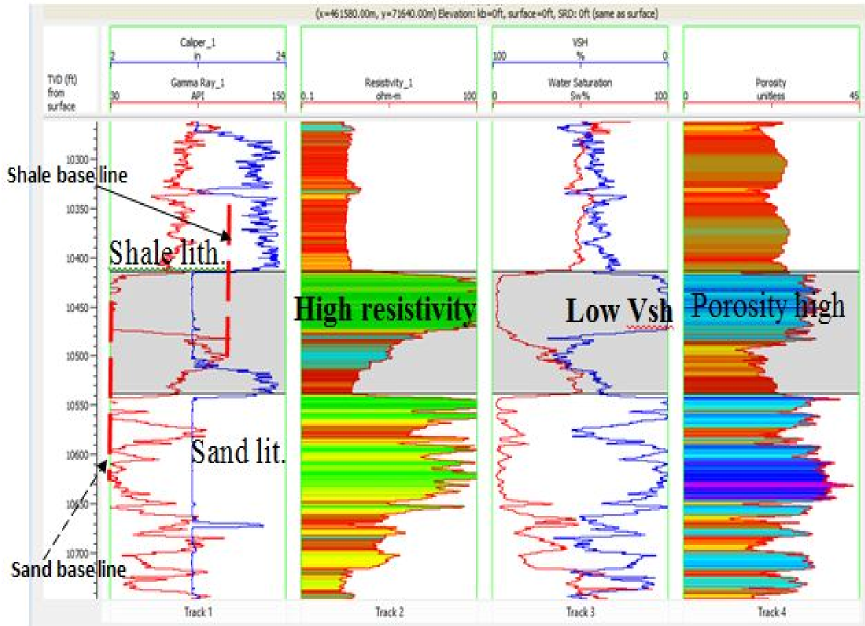

Figure 2: Delineation of well A reservoir.

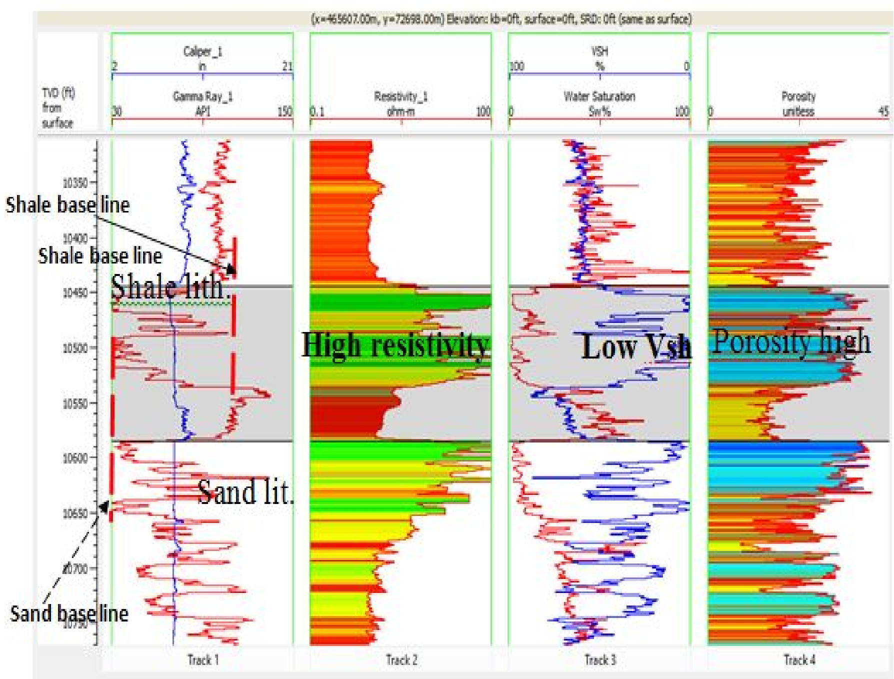

Figure 3: Delineation of well B reservoir.

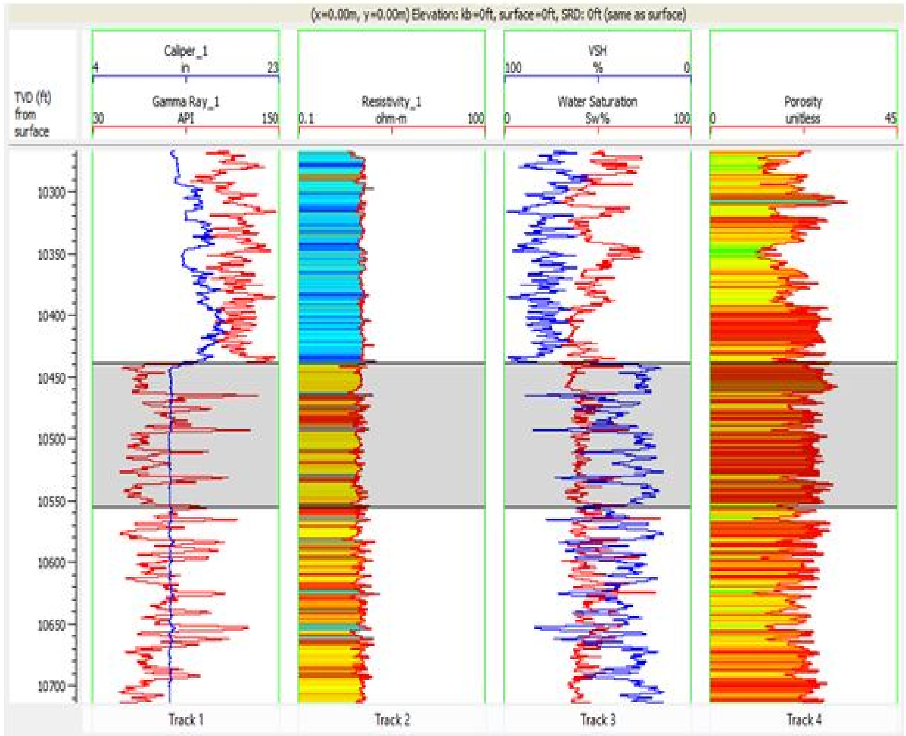

Figure 4: Delineation of well C reservoir.

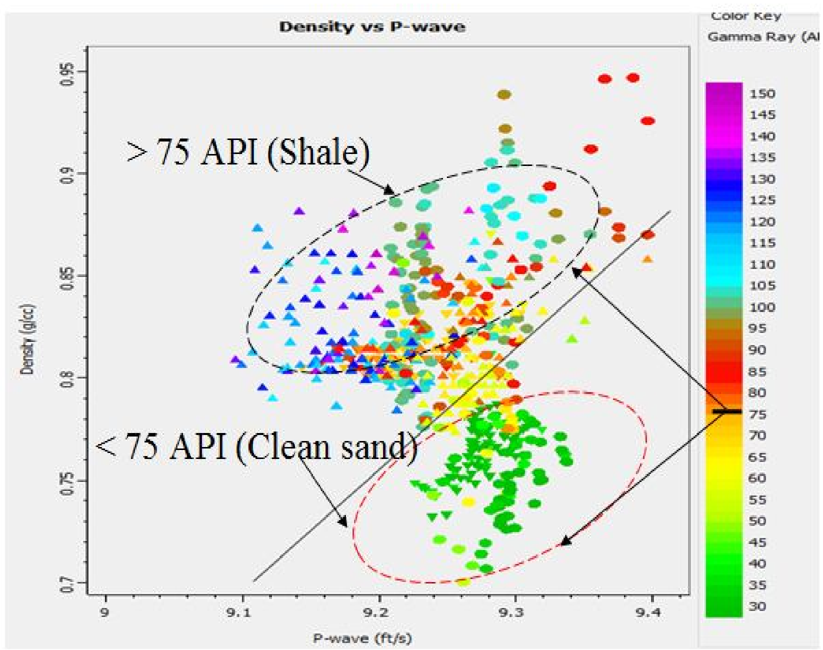

Figure 5: Sand-shale cut-off in wells A – C by means of a cross-plot of density ρ and compressional wave velocity V_p. The sand is coloured green-yellow; shale-rich has cyan-pink colour.

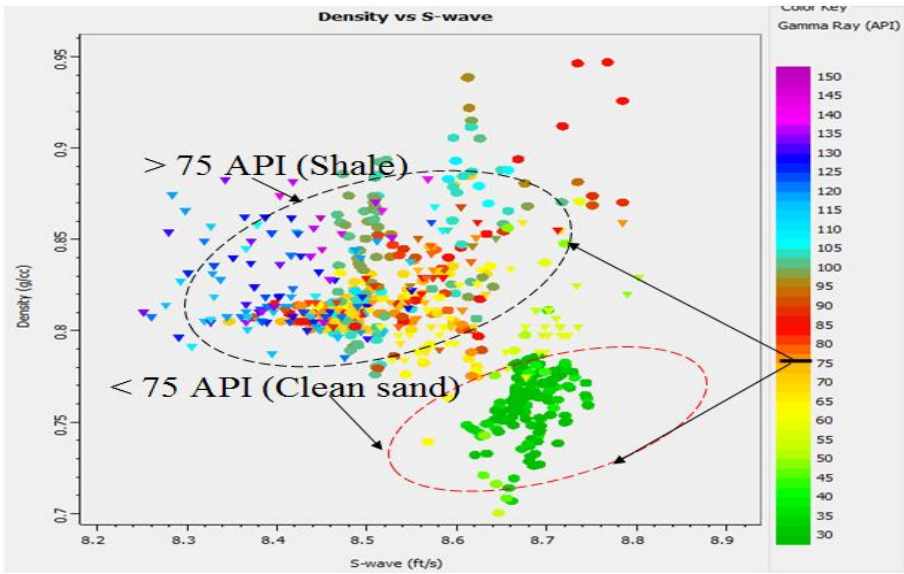

Figure 6: Sand-shale cut-off in wells A – C by means of a cross-plot of density ρ and shear wave velocity V_s. The sand is coloured green-yellow; shale-rich has cyan-pink colour.

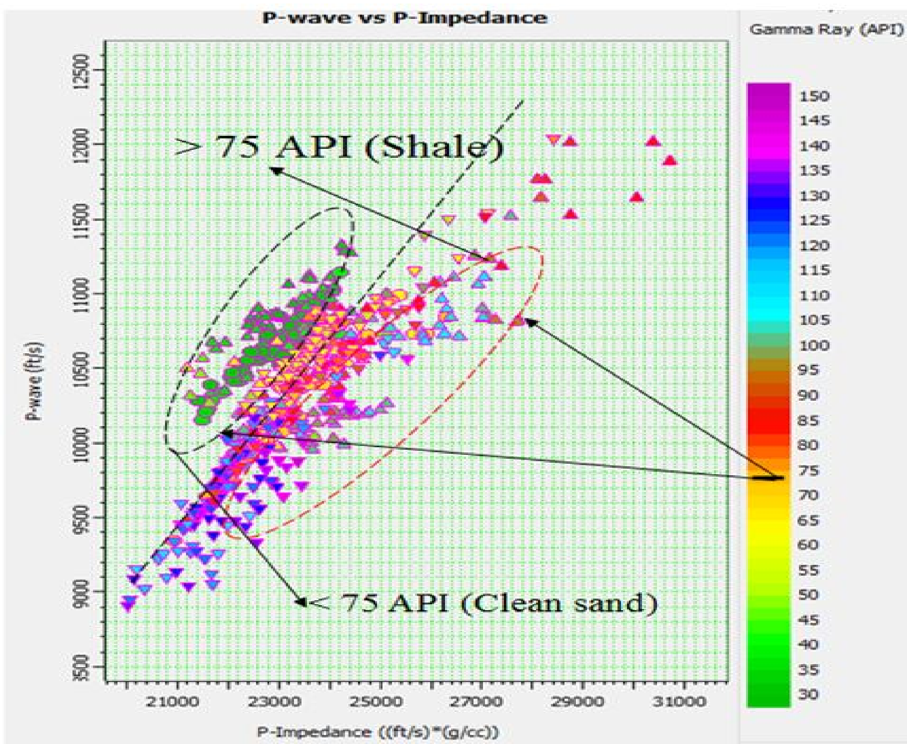

Figure 7.0: A plot of V_p vs p-impedance with linear curve fitting for distinct sand (green) and shale (pink) for wells A – C.

CONCLUSION

Log information was investigated for sands and shales. Identification of lithologies required information on Gamma Ray (GR) records. The sand-rich is coloured green-yellow; shale-rich has cyan-pink colour (Figures 5.0 and 6.0). In the basin of Niger Delta, the cut-off is frequently 65 API such that GR greater than this value, defines shales; sands are apportioned to lower values. Yet, there are also high GR sands in the basin; this may be noted mistakenly as shales. Selecting clean sand and shale portions for this investigation necessitates different crossplots of density versus different velocities of wave for all the wells using gamma ray as shale-sand sequence discriminator. The dominant lithology at the top of τ reservoir is seen as shale with API value greater than 75; the dominant lithology in the reservoir is sandstones with API value less than 75.

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