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Petrophysical Analysis on Radioactive Sands for Koala Field in Termit Basin, Niger

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The neighbouring region of Termit Basin is the Niger Delta which is located on the southern section of Nigeria. Several investigations carried out in Niger Delta from 1971 to 2012 found that there is wide geological spread of radioactive sands [1]. 35-45% of the producing wells are believed to contain the anomaly. The mentioned literature, highlights the importance of identifying radioactive sand layers as it affects the volume estimation of a reservoir.

Radioactive sands are often misinterpreted as shales in petrophysical analysis specifically under the gamma ray (GR) log. Presence of clays and minerals can cause high radioactivity causing the GR log to detect shales instead of sands. This can cause potential pay zones to be overlooked unless an integration of other logs, core samples and laboratory data is used.

Based on the statement, two main objectives can be identified: 1) To identify the presence of radioactive sands and 2) To evaluate the source of radioactivity.

The best way in determining radioactive sands is by analysing thin sections but in the scenario where only well logs are available, a four-step approach can be used. Steps conducted using conventional logs are: (i) Comparison of GR log with calliper log along with density and neutron density logs. (ii) Analysing assumed layers through density – neutron (NPHI Vs RHOB) cross plots. (iii) Interpretation of radioactive source using spectral gamma ray (Uranium, Thorium and Potassium) and (iv) Identifying contributing minerals using Potassium vs Thorium cross plots (spectral gamma ray components).

The summarized phases begin with the observation of GR log and calliper log. If GR log indicates the presence of shale while calliper detects mudcake, it might indicate sandstone layer. This is because mudcake only sticks to porous and permeable layers such as sandstones, not shales. To further confirm, the crossing of NPHI log and RHOB log which is low in reading shows characteristics of sandstones while shales is vice versa as shown in **Figure 1**.

Next, density neutron cross plot is applied for the assumed radioactive sand layers. If the plots of any layers fall on the sandstone line or beneath it, there might be additional minerals present. The minerals might be the radioactive source contributors as it does not fall on the sandstone line as shown in **Figure 2** where the density and porosity value a little higher. The first two steps are to identify radioactive sands which is important as it could increase the reservoir thickness.

The subsequent steps are for the identification of radioactive source. Three common naturally occurring radioactive elements in rocks are uranium, potassium and thorium. Analysis of spectral gamma ray which consist of three spectrums whereby each individual spectrum indicates different source of radioactivity. Increase in Thorium reading indicates the presence of clay minerals and heavy minerals as shown in **Figure 3**. For example: Kaolinite, illite, smectite and chlorite for clays and monazite and/or zircon (found near granitic highlands, in unconformities or erosional surfaces) for heavy minerals. On the other hand, increase in the Potassium reading indicates minerals such as illite and sylvite and its sandstone which is high in mica minerals and K-feldspar. Uranium increment is associated with phosphates and organic compounds (shales, plants, shell fragments, euxinic environments) [2]. In addition, sometimes increase in the Uranium reading in the sandstone layer is due to the water saturated in it which was washed out from the shale layer beneath the sandstone lithology.

The final step is using Potassium Vs Thorium cross plot to identify the type of minerals found in the radioactive layers. The cross plot includes nine minerals which are kaolinite, montmorillonite, chlorite, mixed layers, illite, and muscovite which are clay minerals and the other three which are glauconite, biotite and orthoclase. **Figure 4** shows the presence of 3 minerals which are kaolinite, montmorillonite and chlorite. Mineral identification will help in choosing suitable composition for drilling mud as different clay minerals would affect the porosity and permeability of the reservoirs. Hence, the statement given does explain the importance of identifying the type of radioactive minerals.

In this paper, 8 wells from Koala Field in Termit Basin, Niger was used as an example to show the characteristics of radioactive sands using conventional logs. Identification of the radioactive sands and each different contributing source is explained as well as their importance. In conclusion, revaluation of fields for radioactive sands can increase the volume estimation as well as production rate of a field.

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References

O. Chudi and R. Simon, "Petrophysical Characterization of Radioactive Sands-Integrating Well Logs and Core Information: A Case Study in the Niger Delta," in Nigeria Annual International Conference and Exhibition, 2012.

L. Wan, J. Liu, F. Mao, M. Lv, and B. Liu, "The petroleum geochemistry of the Termit Basin, Eastern Niger," Marine and Petroleum Geology, vol. 51, pp. 167-183, 2014.

B. Liu, L. Wan, F. Mao, J. Liu, M. Lü, and Y. Wang, "Hydrocarbon Potential Of Upper Cretaceous Marine Source Rocks In The Termit Basin, Niger," Journal of Petroleum Geology, vol. 38, pp. 157-175, 2015.

J. D. Fairhead, "The Mesozoic West and Central African Rift System: Qualitative Evaluation," Search and Discovery, 2009.

M. Harouna and R. Philp, "Potential petroleum source rocks in the Termit Basin, Niger," Journal of Petroleum Geology, vol. 35, pp. 165-185, 2012.

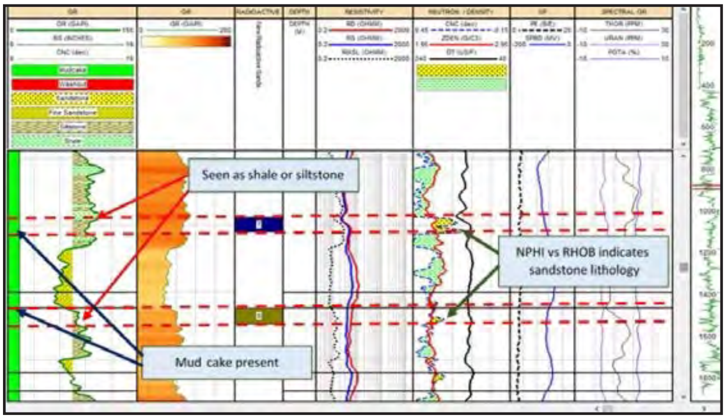

Figure 1: Radioactive sands interpretation based on present of mud cake with comparison of gamma ray results and NPHI - RHOB crossing in Koala CE-1.

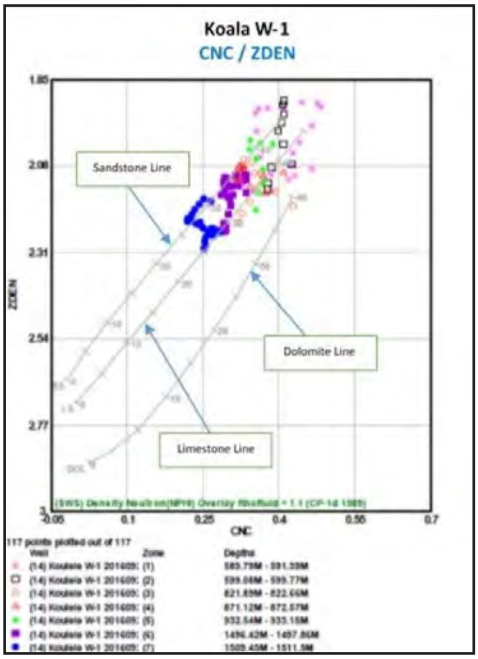

Figure 2: NPHI Vs RHOB cross plot indicating the interpreted radioactive sands as having characteristics of sandstone as there are points of interpreted zones that falls onto the sandstone line.

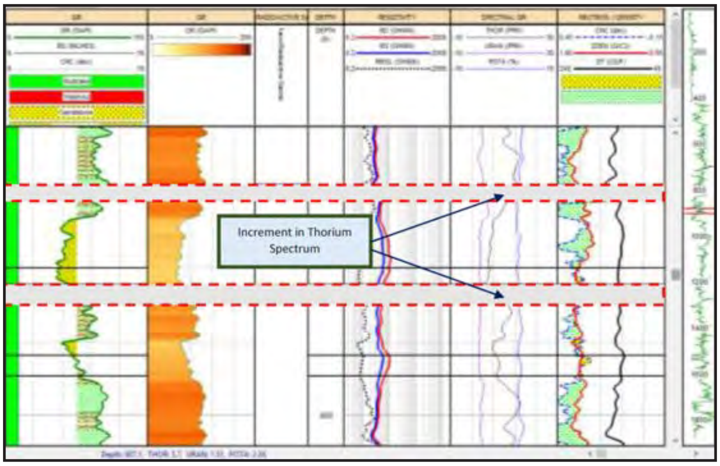

Figure 3: Spectral Gamma Ray - Thorium spectrum increase in interpreted radioactive sands layer 7 and 8 in Koala CE-1 well.

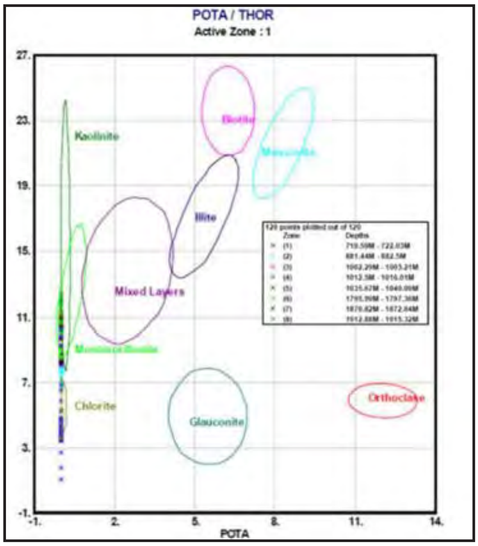

Figure 4: Potassium vs Thorium cross plot of radioactive sand zones in Koala N-1 well indicating the presence of potential clay minerals of chlorite, montmorillonite and kaolinite.