

Thermogenic Wet Gas Anomaly, A Reliable Tool for Evaluating Caprock Leakage

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Petroleum caprock is an essential element of a petroleum system, with a major role of preserving hydrocarbon accumulations, it's an ultimate factor to consider in exploration of petroleum, risking of leakage, storage of waste (nuclear) and environmental concerns such as the capture, storage and sequestration of CO₂. Contemporary studies on caprock leakage have witnessed the use of seismic sections, petrophysics of caprock sections and correlations studies between caprock sections and reservoirs based on molecular geochemistry in corroboration with the petroleum system data and structural history of the field.

This study presents the use of thermogenic wet gas data and stable carbon isotope ratios derived from headspace gas data obtained during drilling for evaluating leakage of immature petroleum caprocks, which in corroboration with the maturity data of the end members of the formations, pressure data and structural history of the field serves as a composite fast and reliable tool for a better understanding of the leakage mechanism and potential migration pathways of the leaked petroleum through the matrix of the caprocks. This study has successfully been applied to fields in the North Sea and is proposed to be useful for fields within the Nigerian Continental Shelf. The study uses thermogenic wet gas - depth profiles (TGD profiles), thermogenic signature - depth profiles (TSD profiles) and Carbon Isotope ratio - depth profile (CID profiles).

The profiles are obtained as logview plots using Techlog 2007.3 while the descriptive lithology is modelled using Genesis 4.8 softwares. Essentially the vitrinite reflectance of the caprock formations ensures that the formations are immature and yet to generate indigenous hydrocarbons, the TSD profile describes the maturity of the hydrocarbon. The TGD profiles reflects the composition of wet gas in the caprock, it also shows the height of wet gas above the reservoir-caprock interface, which could be associated with high pressure induced leakage or leakage due to the higher buoyancy pressure which exceeds the capillary entry pressure of the seal.

In overpressured deep water areas of West Africa and overpressured Tertiary Deltas such as the Niger Delta, the TGD, TSD and CID profiles could be used in corroboration with the pressure data, to ascertain the mechanism of leakage in petroleum caprocks.