

Bright Spots, Dim Spots: Geologic Controls of Rock Properties and AvO Response in the Niger Delta Basin

Krzysztof M. (Chris) Wojcik

Shell Americas, Houston, TX

chris.wojcik@shell.com

Abstract

Direct Hydrocarbon Indicator (DHI) support for hydrocarbons in the Niger Delta has been recognized for several decades. Largely unconsolidated Tertiary shallow marine and deepwater clastics are characterized by strong amplitude response related to hydrocarbon presence. Bright-spot amplitude anomalies have been an attractive exploration target since early 70s. However, even in a well-calibrated basin as the Niger Delta, amplitudes do not always 'work'. Both false positives, as well as hydrocarbon-bearing reservoirs without any DHI support, are fairly common. The remaining exploration potential in the Niger Delta is still significant thus there is a clear driver to improve our ability to assess the potential for DHI support beyond classic bright-spot plays, as well as to polarize exploration risks to avoid costly failures.

The assessment of any seismic anomaly always includes an observational component and a predictive component. A comprehensive and robust predictive framework must be based on a detailed, geologically-driven integration of the available data across different scales, from a thin section to a seismic loopset, and with a good understanding of geologic controls of elastic rock properties. Key geological variables, such as reservoir and seal texture, pressure history and diagenesis, impact the type, magnitude and detectability of DHI's. The rock properties knowledge and understanding of geologic controls can be organized into robust, basin or play-wide predictive frameworks enabling forward modeling of any subsurface scenarios and comparison with the actual seismic data in the prospective areas.

The classic Niger Delta bright-spot play can be considered mature, so there is a clear need to extend the amplitude-driven exploration to include other types of DHI's such as dim spots and other more subtle anomaly types. The dim spot plays, with generally weaker hydrocarbon signal, are elusive, but they are recognized as holding large, generally under-explored potential. This paper presents an overview of key controlling factors that impact seismic response and cause rapid transition from bright spots to dim spots, and the transition from amplitude to AvO anomalies. Many clastic Tertiary basins globally follow similar stratigraphic and diagenetic evolution, thus the Niger Delta example may be a good analogue for subtle DHI plays elsewhere.