Technical Exploration Report: Greenfield Detection via RSS-NMR

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Application of passive orbital NMR for regional screening and deep reservoir analysis

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1. Step Zero: Regional Frequency Acquisition and Calibration

Large-scale exploration of frontier or virgin areas (greenfields) requires mapping considerable areas (tens of thousands of square kilometers) without the initial deployment of teams or ground infrastructure. Data acquisition relies on passive orbital satellite flyovers using nuclear magnetic resonance.

The geometric selection of strata at depth is carried out using the fundamental Larmor relation:

$$\omega_0 = \gamma \cdot B_0$$

By varying the excitation and reception frequency (ω_0), the system overcomes the limitations of the overlying sedimentary cover, which behaves like a transparent dielectric medium. This targeting allows for the surgical probing of precise horizons up to 7 kilometers deep, directly measuring the signal from hydrogen protons (^1H) in the reservoir rock.

2. Mass Filtering: Radical Elimination of Dry Risk

The absence of historical wellheads in undeveloped basins poses a significant financial risk to exploration drilling. Large-scale NMR data analysis addresses this issue through the application of an analytical funnel based on transverse relaxation times (T2).

Areas composed of dense clays, compact formations, or immature rocks confine water within narrow capillary spaces. Under the effect of aggressive surface relaxation, the NMR signal is critically attenuated, displaying a T2 well below the cutoff thresholds (T2 < 33 ms for sandstones, T2 < 92 ms for carbonates). The processing algorithm automatically masks these sterile zones, allowing 70% to 80% of the block surface to be instantly excluded before incurring significant seismic expenses.

3. Isolation of 'Sweet Spots' and Direct Qualification of Fluids

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Once the dense areas are eliminated, the high-value sectors stand out as large-amplitude anomalies with long relaxation times. These 'Sweet Spots' characterize formations with open and interconnected porosity, essential for ensuring commercial productivity.

The intersection of the longitudinal (T1) and transverse (T2) relaxation constants characterizes the molecular nature of the fluids present:
• Light oil: Identified by a highly stable and harmonious T1/T2 ratio between 1 and 2, associated with intermediate to long time constants.
• Natural gas: Demonstrated by a pronounced diffusion anomaly, combining a very long longitudinal T1 (several seconds) with a transverse T2 artificially shortened by the micro-gradients of the porous matrix.

4. Strategic Advantages of Greenfield Deployment

• CAPEX Optimization: Heavy 3D seismic acquisition and exploration drilling are no longer deployed blindly over vast areas, but surgically concentrated on the precise contours of hydrocarbon reservoirs revealed by NMR.
• Competitive Discretion: Because the acquisition is entirely satellite-based and passive, it requires no ground visibility. The potential of a basin can be validated confidentially, avoiding the arousal of competitors or premature land speculation.
• Accelerated Cycles: The overall evaluation of a greenfield project is completed in 4 to 6 months, compared to several years of conventional geophysical studies, providing a decisive first-mover advantage.

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