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[EA]Advance Mud Gas Evaluation in Complex Clastic Reservoirs while Drilling in Usano Field of PNG*

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Abstract

Drilling in the Usano Field is difficult due to the complex geology and extreme terrain associated with the Papuan fold and thrust belt region. The field is structurally complex, with an abundance of faulting, which creates a system of compartments. The tectonic history of the area results in significant geomechanical challenges that result in a variety of borehole problems which can lead to evaluation difficulties. The discoveries made so far contain prolific Jurassic and Cretaceous sandstone reservoirs.

PNG highlands reservoirs consist of siliciclastic sequences, predominantly fine- to medium-grained, quartz-rich sandstone grading to occasional coarse-grained in places. Hydrocarbon-bearing sequences are relatively low porosity and high permeability with the reservoir quality in producing intervals ranging between 10% to 20% porosity and associated permeability ranging in the hundreds to a few thousands of milliDarcy. Advanced gas data was obtained to deliver an early understanding of reservoir level, type of fluid in place, identifications of contacts (GOC and OWC) and identification of potential vertical flow barriers while drilling. This was achieved by utilizing an advanced mud gas analysis system that provided high-resolution chromatographic analyses of thirty (30) different components between methane (C1) and n. octane (nC8). This is achieved using two (2) different sets of Dual FID Chromatographs receiving drilled gases via a constant-volume, degassing acquisition system located in the flowline (Figure 1). The Dual FID chromatographs deliver better gas peak separation and help reduce analysis cycle times.

Case Study 1

A GOC (Gas Oil Contact) was not visible on LWD logs but Advance mud gas evaluation identified the contact in Toro A, which is consistent with interpreted RDT pretests and FLID (Fluid Identification), post-drill. A sudden increase in heavier gas components observed through clear changes in ratios such as C1/C4-C8, Alkanes/Aromatics, C1/C6 and C1/C7 confirmed an increase from lighter to heavier fluid composition with increasing depth, which plays a significant role in identification of the GOC. In the same interval the increase of aromatics (Benzene and Toluene) provides strong supporting evidence for the interpretation (Figure 2).

Case Study 2

Petrophysical interpretation based on LWD recorded responses indicated hydrocarbons in all sand lobes of the Toro Sandstone, with an interpreted OWC (Oil Water Contact) in Toro C. Formation pressures acquired using RDT tool established the Oil and Water gradients, however could not be used to confirm the log derived inferred contact due to the scattered nature of the pressure data. Advance mud gas evaluation helped to confirm the OWC, by utilising traditional C1 to C5 as well as heavier gas ratios (Figure 3).

Reference Cited

Newton, S., C. Liu, M.S. Al-Dwaish, M. Al-Harbi, J. Esterabadi, A. Shoeibi, and G. Ferroni, 2014, The Application of Mud Gas Analysis in the Evaluation of a Complex Carbonate Reservoir: SPWLA 55th Annual Logging Symposium.

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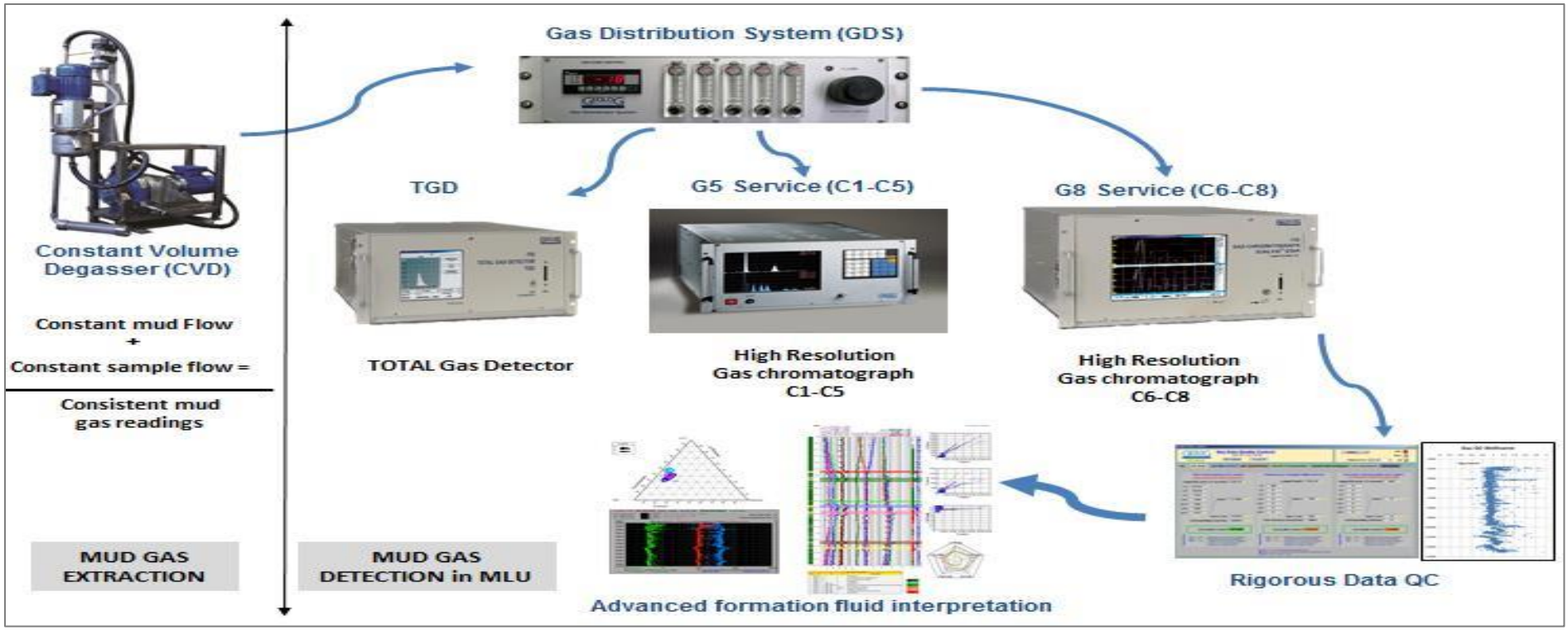

Figure 1. Advanced gas detection system workflow.

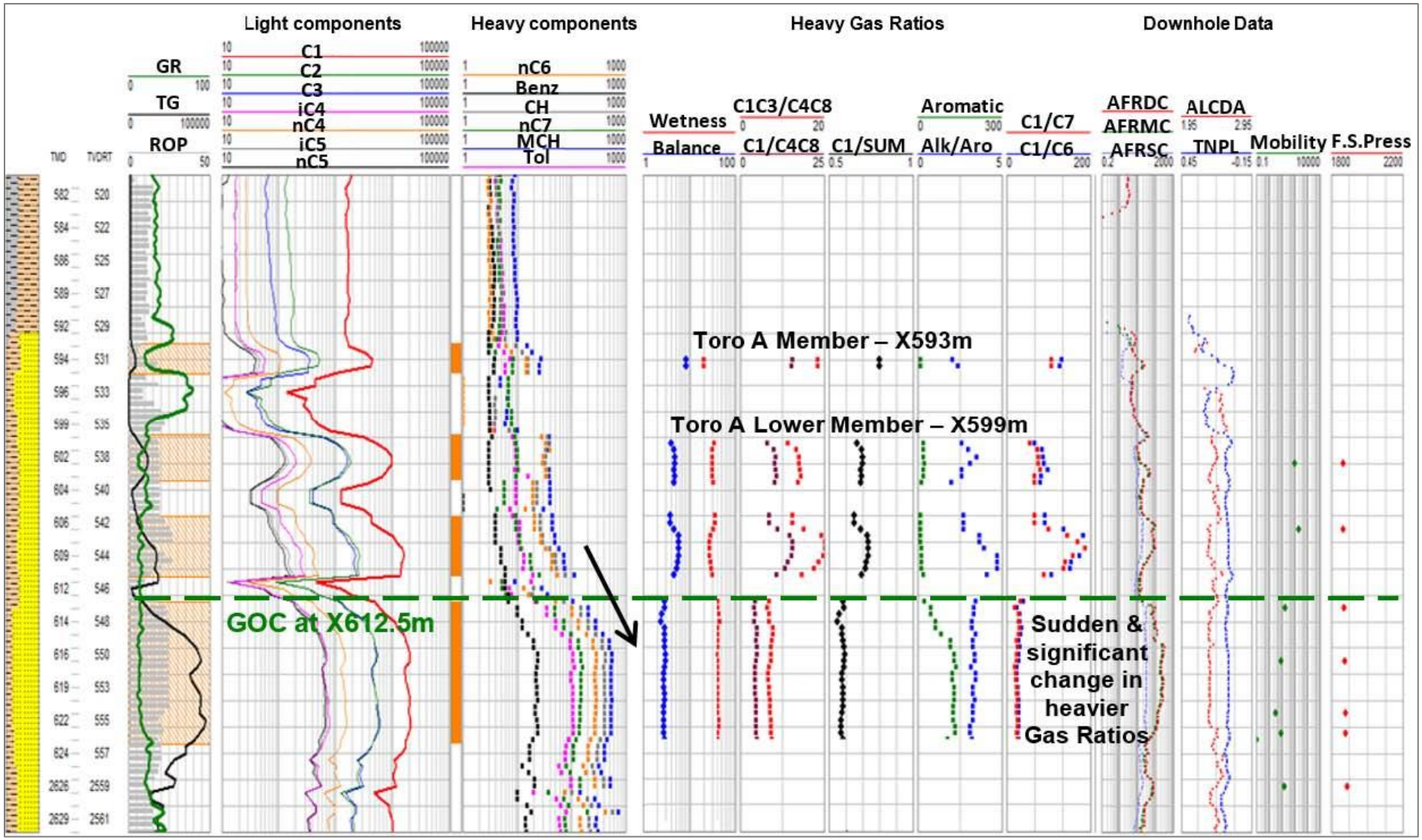

Figure 2. Mud gas components/proxies for identification of GOC in Toro A Member with downhole logging data.

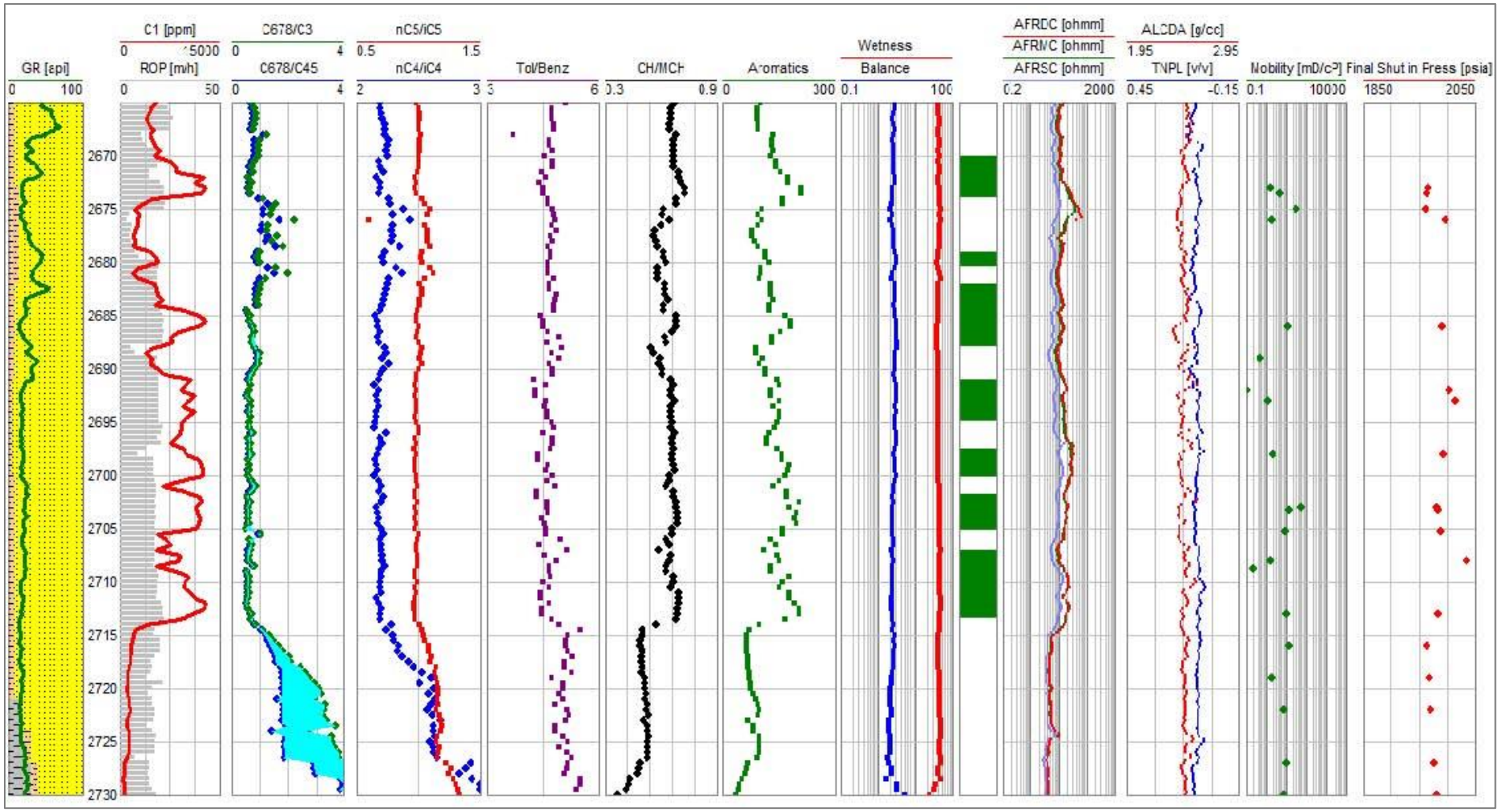

Figure3. Mud gas proxies for identification of OWC in Toro Formation with downhole logging data. The sudden decrease in aromatic content and change in cyclic components (MCH) / isomers (iC4, iC5) indicate a change in fluid type, the OWC at X713 m.