Case Study: Representative Formation Gas extraction and accurate analysis with MPD application in offshore environment

GEOLOG SURFACE LOGGING

National Oil Company drilled a well in Mediterranean Sea. The drilling led to a new gas discovery, under evaluation, in the XXX formation of gross sandstone pay with good petrophysical properties.

GeoMPD Deployment

In order to monitor the formation gas from the well, a standard Constant Volume Degasser (CVD) gas trap was installed on the shale shakers and the GeoMPD gas extraction solution was installed on the secondary flow line on a by-pass manifold ahead of the Mud Gas Separator (MGS). This installation enabled the safe, consistent extraction of undiluted, and therefore representative, gas from the drilling fluid more efficiently, as the placement of GeoMPD ensures 'pure' gas sampling, before the drilling fluid enters the Mud Gas Separator or surface lines whereupon entrained gas composition is artificially affected.

The fully-enclosed GeoMPD consists of:
- A self-cleaning probe installed on a 6" bypass line located in the Low Pressure (LP) line, downstream from the MPD skid and upstream to the MGS.
- Pressure, Volume, Temperature Control System of the drilling fluid extracted
- Suction lines and analyzing system.

The self-cleaning probe is installed on the by-pass line (Fig. 1) ahead of the Mud Gas Separator (MGS). The extracted mud is passed through the Control System (Fig .2) that reduces the mud pressure to ambient, and then samples a constant volume of drilling fluid at a stabilized temperature. The gas is then sampled and analyzed in the Mudlogging unit by a Dual FID Chromatograph (C1-nC5) and Dual FID Star Gas Chromatograph (fully eluted C6-C8 components).

Fig.1: Self-cleaning probe installed on the 6" by-pass line

Fig.2: Pressure control, regulator and gas extractor

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Challenge

In standard drilling operations, the usual drilling fluid sampling point is located at the shaker box. However, in MPD applications, the mud return is diverted through the mud gas separator (MGS) ahead of the shaker area and consequently is gas-depleted. The gas measured from the GeoMPD system provides reliable, unaffected data due to its position; the GeoMPD is installed downstream from the MPD on the Low Pressure (LP) line from the flow spool, before the MGS.

Solution

During drilling with MPD, the two extraction and sampling systems were run in parallel; the standard CVD at the shale shaker and the GeoMPD located in the LP pressure line upstream to the MGS using the self-cleaning probe. The two gas samples were analyzed by two independent but identical systems using Dual FID gas chromatographs for reading gas components from C1 to nC5, and the two results were compared.

The drilling fluid was sampled using a standard CVD on the shale shakers; while on the LP line to the MGS a Self Cleaning Probe was utilized in order to reduce the pressure inside the LP line and allow the gas to be extracted from the drilling fluids at ambient pressure, at constant volume and temperature.

Results

The gas data extracted from the GeoMPD showed a high degree of resolution across all formation gas components, with prompt and accurate response to variations of formation gas content.

In the interval from xx70.0 m to xx10.0 m (Fig 3), GeoMPD recorded gas peaks of 46.9% (xx61.5 m), 33.9% (xx89.5 m) and of 37.6% (xx22.5 m); gas peaks above the background gas which was 11%. At the shale shakers the gas readings were notably lower and the peaks not clearly visible above the background gas due to the gas-depletion effect of the MGS, particularly lighter alkanes. The background gas recorded from the shale shakers was 2% and the gas readings at the peaks were respectively: 3.5%, 3.7%, 3.7%, demonstrating that the concentration of gas in mud measured after the MGS is strongly reduced.

While drilling a sand interval in the 10 ⅝" section the gas recorded by GeoMPD system was always higher than that from the shale shakers. With a background gas of about 4.0% on the GeoMPD, the gas recorded from the shale shakers was at about 1.3%. Gas peaks were observed at 7.1% (xx47.0 m, 2.7% at the shale shakers), at 8.5% (xx71.5 m, 2.4% at the shale shakers) and at 4.5% (xx77.0 m, 1.2% at the shale shakers). It is worth noting that in these intervals the sensitivity of the gas system to the variations in penetration rate, e.g. during drilling breaks, is much easier to observe at the GeoMPD, due to the more consistent and unadulterated sampling, as can be seen in (Fig. 5).

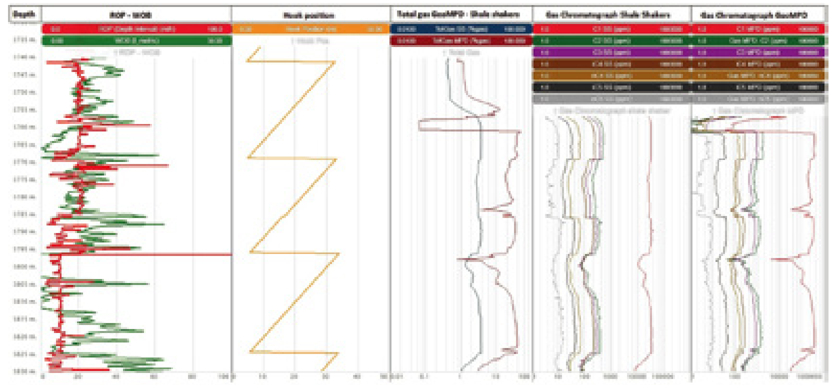

Fig.3: GeoMPD recorded higher gas concentrations as compared to the gas readings of the drilling fluid sampled at the shale shakers; in addition, the relative gas component breakdown is better preserved in the GeoMPD sample compared to shaker sample which is affected by selective gas phase evaporation.

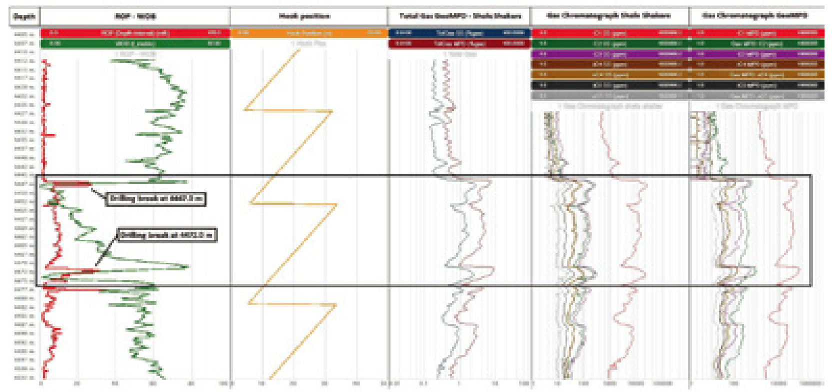

Fig. 4: in the sand interval from xx45.0 m to xx77.0 m a higher gas reading is observed on the GeoMPD.

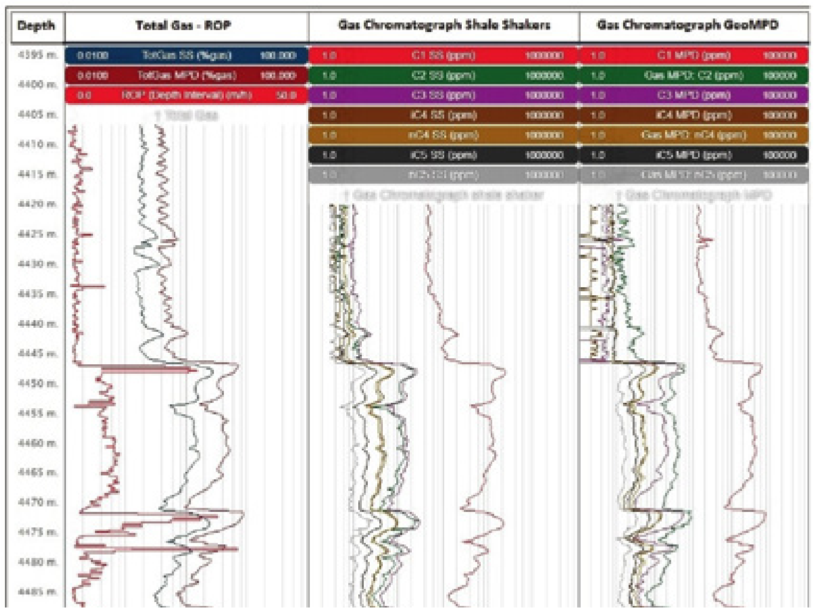

Fig. 5: in the same sand interval, two drilling breaks were observed - the resulting gas from each showed a prompt response on the GeoMPD compared to the readings taken at the shale shakers. This is due to the partial loss of gases at MGS, and the extra air dilution at the shale shakers.

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Another consideration is the time delay between the GeoMPD and the shale shakers readings. This delay is due to the location of the GeoMPD closer to the well head, compared to the position of the CVD on the shale shakers. On average, gas from the GeoMPD has approx. 40 seconds less lag than that from the gas from the shale shakers. This time offset has been measured in the field and can be observed when the gas curves are plotted on the chart (Fig. 8). At xx47.0 m the drilling break is observed and the corresponding gas is seen on the GeoMPD earlier than on the shale shakers, the measured time delay is used for Time-to-Depth synchronization.