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Mud Gas Analyses as a Useful Tool in Differentiation of Fluid Types and Aid in Stratigraphic Correlation

S. Jovanovic* (Australian International Petro-Consultants PTY LTD) & A. Mendoza (Exxon Neftegas Limited)

SUMMARY

Analyses of mudlogging gas data can be a useful tool in clarifying ambiguous formation evaluation results and identifying fluid differences. Two different gas data sets were analyzed from the Chayvo and Odoptu fields.

Raw mudlog data require two stage filtering to remove noise and lithology effects. The resulting filtered data sets from carefully selected wells (Z-44ST1 and OP-7), were used as referenced data for all other wells.

Gas data were plotted using various gas ratio cross-plots to identify the most useful ratio cross-plots, to answer particular problems and questions.

The gas ratio cross-plot of WH (wetness) and BH (balance) for Zone XVI wells aligned well with the fluid contacts obtained from LWD data.

Filtered mud gas data can provide a quality gas data set that can be used as an aide in differentiating between different reservoir fluid types. This type of analysis can be used in clarifying ambiguous formation evaluation results, such as fluid contacts in a reservoir, reservoir compartments, effects of pressure depletion etc.

SCOPE

Analyses of mudlogging gas data may be a useful tool in clarifying ambiguous formation evaluation results and identifying fluid differences. Two different gas data sets were analyzed from the Chayvo and Odoptu fields, off the northeast coast of Sakhalin Island, Russia. The techniques employed produced a useful correlation and differentiation of different fluid types.

OBJECTIVES

Objective of this study was to find the most suitable gas ratios to differentiate fluid types and that can be used for between wells correlation.

METHODOLOGY

Two different gas data sets were analyzed, one each from the Chayvo and Odoptu fields. The first from Odoptu (Zone XXI) was collected using Geoservices' GFF (Geo Fast FID) gas detection system, with a variable volume gas trap extraction system (located in the possum belly). The second from Chayvo was collected using Geoservices' RESERVAL gas detection system, with a constant volume gas extraction system (Zone XVI). The first gas data set yielded more scattered data compared with the second gas data set.

Data processing and analyzing started with two QC "filtering" steps; Gas Quality Ratio (GQR) and a cross-plot of C1 versus C1/TGeqv, where $TGeqv = C1 + 2C2 + 3C3 + 4(iC4 + nC4) + 5(iC5 + nC5)$.

The first criterion was applied to check for data reliability. Reliable data can be qualified as being in the ratio range of $1 \pm 20\%$. Ratios of TG to TGeqv should be in the range of 0.8 to 1.2. If the data ratio is less than 0.8, the data are believed to be unreliable due to incorrect calibration of the equipment. In the case where the data ratio is greater than 1.2, there should be additional checks performed, as this ratio is dependent on several issues:

- presence of the heavy HC fraction, which is detected by Total Gas (but not by Chromatograph)
- presence of the organic matter in the surrounding formation
- presence of water in the surrounding formation, or a HC/water transition zone, taking into the account that the heavier HC fractions are more soluble in the presence of water (aromatics)
- presence of isomers, as the chromatograph is calibrated only for two isomers (iC4 and iC5)

Second filtering consisted of plotting C1 values versus C1/TGeqv. The cut-off point used presents the inflection point, and eliminates the lithology effect on the data. All further gas ratio analyses were performed using these "filtered" values.

After performing these filtering stages, gas data were plotted using different gas ratio cross-plots to identify the "best" (most useful) gas ratio cross-plot, and to define the most discriminatory ratio for a particular problem.

The following gas ratio cross-plots were found to be the most useful: C1 vs. C2; C1 vs. iC4; C1/C3 vs. C2/C3; C1/SC4 vs. C1/SC5; C3/SC4 vs. $\Sigma C4 / \Sigma C5$ and $(\Sigma C4 + \Sigma C5) / (C1 + C2)$ vs. $(C1 + C2) / C3$.

Scales for Wetness (WH) and Balance (BH) ratios in the traditional gas ratio plot (Haworth, *et al.*) were modified and adjusted to suit local field conditions.

RESULTS

The Chayvo Z-44ST1 was used as the reference well for Zone XVI fluids, as it was the first and only well to penetrate the water, oil and gas leg. Z-44ST1 was the first well to have a clearly distinguished separation between different fluid types on gas ratio plots.

Mudgas data from the Odoptu OP-7 well was used as the reference well for Zone XXI. Odoptu OP-7 had more scattered data, as it was influenced by a different gas trap system. It and produced a smaller data set after filtering.

The gas ratio cross-plot of WH and BH for Zone XVI wells aligned well with the fluid contacts obtained from LWD data.

CONCLUSIONS

Filtered mudgas data can provide a quality gas data set that can be used as an aide in differentiating between different reservoir fluid types. This type of analysis can be used in clarifying ambiguous formation evaluation results, such as fluid contacts in a reservoir.

Figure 1 - C1 vs. C2 cross-plot for Z-41ST1 well showing clearly differentiated fluid types in Zone XVI. If subsequent wells are drilled into Zone XVI, the mudgas ratios could be useful in determining reservoir fluid type if log data are absent, poor or ambiguous.

REFERENCES

- Haworth J.H, *et al*: Interpretation of Hydrocarbon Shows Using Light (C1-C5) Hydrocarbon Gases from Mud-Log Data, AAPG Bulletin V 69. No.8, 1985.
- Kandel D., *et.al*: Improved Integrated Reservoir interpretation using the Gas While Drilling (GWD) data, SPE 65176, 2000.