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Application of Real Time Mass Spectrometry During Development Drilling, Qannik Field, North Slope, Alaska

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Direct, real-time mass spectrometry (1-140 atomic mass units (amu)) of formation fluids was used during 2008 horizontal development drilling of Qannik, a new field within the Alpine production and processing facility in the North Slope of Alaska. The DQ1000 tool, contracted by Fluid Inclusion Technologies (Broken Arrow, OK), was employed in order to 1) to predict and avoid the gas-oil contact (GOC), 2) differentiate lithologies from laminated, fine sands to coarser sand bodies and 3) detect isolated sand bodies which are below-seismic resolution, but typical of shallow marine progradational facies. Using the atomic mass unit data alone, a partial least squares (PLS) regression model was developed to predict the distance from the gas-oil contact, using a data subset (30%, n= ~2,200) from well CD-466, an injector drilled specifically to intercept the GOC. The PLS model developed from this training dataset was then used to predict the distance (in feet) for subsequent wells. First, the model was tested against the entire well CD-466 dataset. The predicted distance from the GOC clusters around the 1:1 line; 90% of the predicted data fall +/- 7.4 ft from the GOC (Figure 1). The predicted distance from the GOC using the model accurately predicted the approach to the gas cap at ~16,800 ft, and also detected the traverse through the gas cap at 18,000 feet (Figure 2).

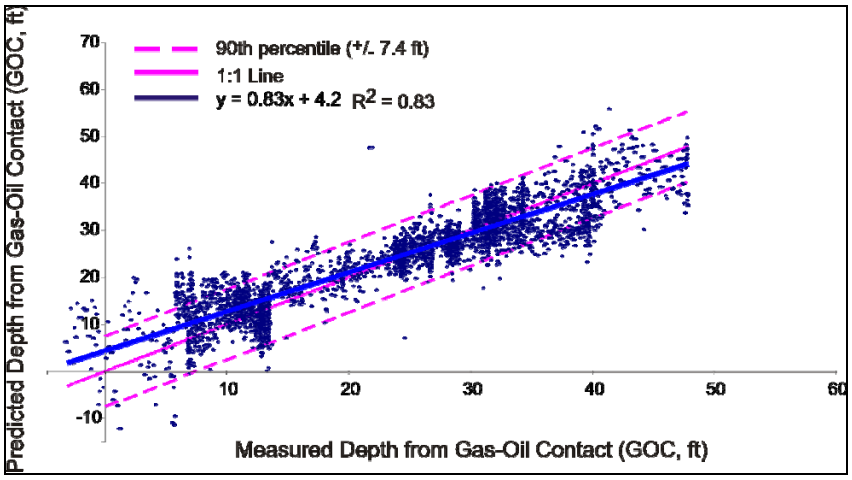

Figure 1. Predicted v. calculated distance from the GOC in well CD2-466 (n = ~7,500) using Partial Least Squares model based on DQ1000 mass spectrometry data points (n=~2,200).

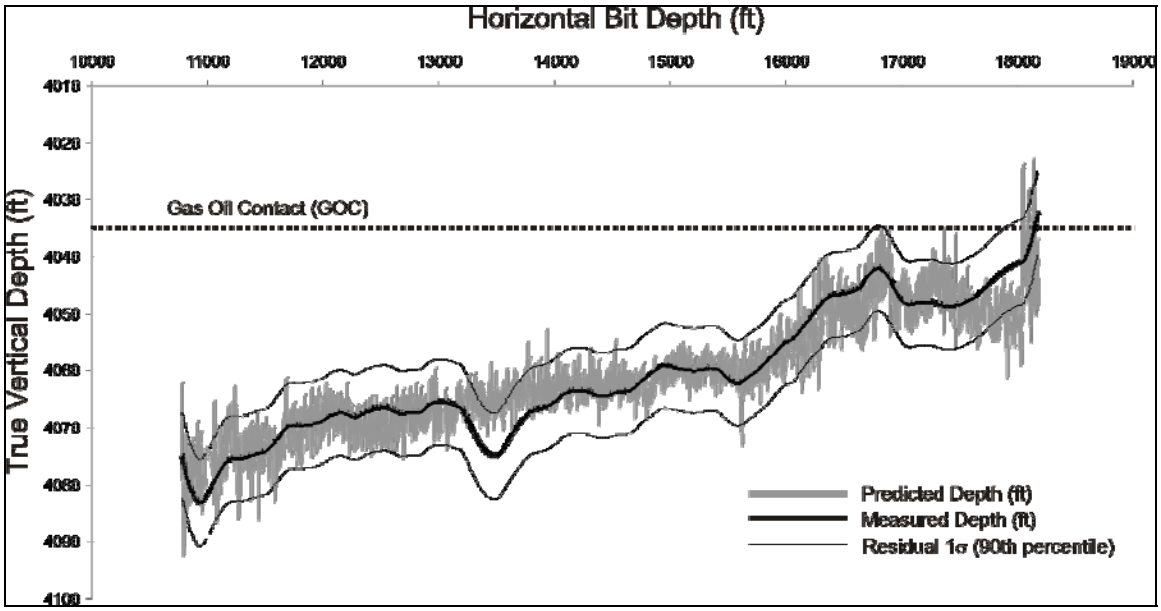

Figure 2. Comparison of predicted and measured depths below the GOC.

Applying the PLS equations to the other wells in the drilling programs indicates that the GOC was consistently avoided. Analysis, done after the drilling program, shows that one subsequent producer in particular, well CD-465, which was drilled short to avoid losing the well by intercepting the GOC, was within 25 ft of the GOC, but no closer.

The DQ1000 data was also interrogated for the identification of lithological variability and isolation of sand bodies. The lithology and sand connectivity was classified based on a full suite of well log data (GammaRay, Resistivity, Neutron/Density) and geologic insight. The geologic interpretation was then compared to the DQ1000 dataset. The DQ1000 He/methane ratios were useful in discriminating the coarser/cleaner sands from the more silty/shaly intervals. Principle component analysis of the atomic mass unit data also identified variations through preferential clustering by lithology. Additional calibration work will further increase the confidence of using the DQ1000 data to discriminate lithology variations and sand body isolation, especially in very thin, depositionally complex, fine-grained reservoir.