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## Abstract


**Objectives/Scope:** The Downhole Reservoir Raman System (DRRS) is a wireline conveyed Raman spectrometer and physical sensor platform that is used to evaluate the resource potential of hydrocarbons in unconventional reservoirs. This robust tool can measure low ppm levels of hydrocarbons dissolved in well water plus discriminating in real time between the presence of dissolved methane, free methane and other light hydrocarbons. Results of two successful field trials using DRRS have been conducted in evaluation of the Marcellus shale Formation in the Appalachian basin in PA. The technical objective of both field trials was to identify and quantify hydrocarbon resource density as well as the most favorable location(s) for the placement of a lateral.

**Methods, Procedures, Process:** Field trial-1 was conducted in an uncased well. In this well, the Marcellus is only ~30 ft. thick but the results of several logging runs established the clear presence of methane entering the well bore to a resolution of better than ~2 ft. Field trial-2 was conducted in a cased well where the Marcellus shale is almost 100 ft. thick. Based on Spectral Gamma Ray logging, the Marcellus in this part of PA is composed of three distinct lithofacies (Basal, Middle and Upper zones), easily recognized by their petrophysical rock properties such as Spectral Gamma Ray response (Uranium), TOC, bulk density, porosity and gas saturation.

**Results, Observations, Conclusions:** Logging was conducted in three separate stages, progressing vertically from the Basal zone. Each zone was ~10 ft. in height and perforated with a high shot density. After perforation, the interval was logged using the DRRS in both dynamic and static modes. After logging, the perforated interval was sealed off using packers.

DRRS data provide a real time estimate of plume formation in the well, allowing for an estimate of the mass of methane entering the well per unit time. This flux measurement provides, in real time, an estimate of the composition and relative richness of different stratigraphic intervals within the Marcellus shale. The results of field trial-2 showed that the most productive interval was the Upper zone, producing gas at a considerably faster rate than the more TOC rich and higher porosity Basal zone. These results challenge an established paradigm of unconventional resource evaluation which is focused mostly on high Uranium and TOC intervals for completion of laterals.

**Novel/Additive Information:** Based on measured plume concentrations in both field trials, the estimated resource density i.e., the mass of methane per volume of rock, is highest in the Upper Marcellus. Based on DRRS results, prioritization was on the completion of the Upper zone with a lateral in this well. The findings demonstrate that this technique can be transplanted to other unconventional resources in China and globally.