Early characterization of reservoir heterogeneity in PRB coal seams

CASE STUDY 08-02 A GAS SENSING TECHNOLOGY CORP. SUCCESS STORY

[CASE STUDY]

Coalbed methane field under evaluation

Black Diamond Energy provides natural gas drilling programs for investor partners and specializes in coalbed methane plays in the Power River Basin in Wyoming. Black Diamond's CW field lies in the central portion of the greater Powder River Basin within Wyoming. Multiple coal seams converge and diverge within the area, exhibiting the lenticular nature of the coals. The coal seam characterized in this study is part of the Big George package of coals and is commonly called the Cook seam. A number of techniques are available for characterization of gas related properties of coalbed reservoirs. The traditional method, gas desorption from core sampling, and its lower cost version, gas desorption from cuttings, are both limited in their ability to represent the overall reservoir since they are highly susceptible to near wellbore variations in petrology. Additionally, they are tedious to employ and often disrupt a typical completion and production schedule. For this study, WellDog's downhole Raman spectrometer was used to analyze the coalbed reservoir properties. The spectrometer performs direct laser based interrogation of the solution gas content (GC) of reservoir fluids drawn into the wellbore. The effective methane partial pressure of the reservoir (equivalent to the reservoir's critical desorption pressure) is thereby determined, and the gas content and required drawdown can be calculated.

Finding the Gas

Black Diamond used WellDog's Critical Gas Content (CGC) service on seventeen wells in the field. The solution gas concentration in the wellbore fluids was profiled in each well. The magnitude of the solution gas concentrations, together with temperature, pressure and conductivity data collected simultaneously in each wellbore, were used to calculate the methane partial pressure (i.e. critical desorption pressure) of the reservoir around each wellbore. The critical desorption pressure was compared to the static reservoir pressure in order to calculate an initial gas saturation in the coal, as well as the drawdown required for gas production. The gas content of the reservoir around each wellbore was calculated by mapping the critical desorption pressure onto an adsorption isotherm representative of the average reservoir conditions in the field.

The results of the reservoir characterization are displayed in the figure below. At upper left, coal top elevations picked from gamma logs are plotted (in feet from sea level). The coal depth varies from about 2400 feet elevation in the southeast to 2900 feet elevation in the northwest. Conventional wisdom holds that the methane partial pressure (and gas content) should be higher in the portions of the coal located at greater depths.

Challenge

Evaluate and optimize gas content, critical desorption pressure and required drawdown for a coalbed natural gas field to plan further development of a coal seam and set appropriate expectations regarding the future production economics and timing for the field.

Solution

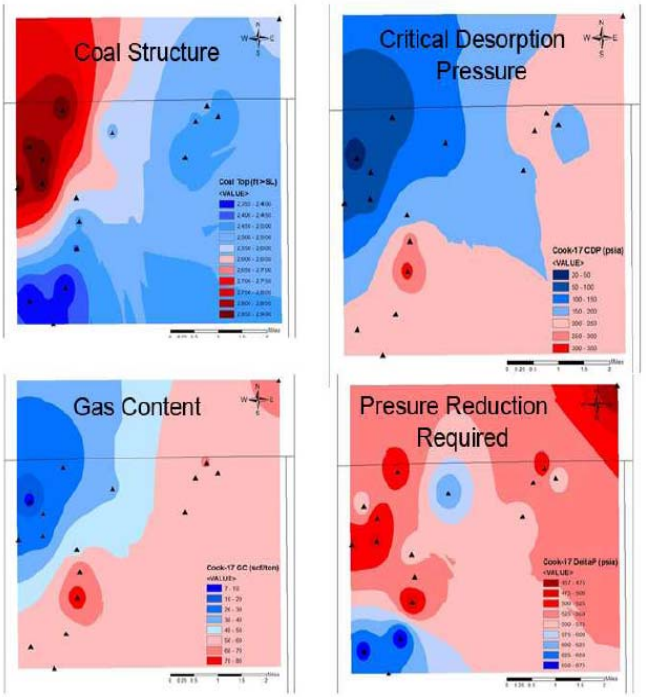
Employ Critical Gas Content™ from WellDog® to characterize the reservoir in order to direct further development. Additionally, compare CGC results to original core samples to establish correlation between WellDog services and traditional analysis method.

Results

Comparison of the original core results to WellDog's CGC service showed excellent correlation, so Black Diamond proceeded with collecting additional data. Using the CGC service saved in excess of 1M USD over employing traditional core sampling desorption processes. A further benefit was enhanced data accuracy due to WellDog's analysis of reservoir fluids rather than local wellbore entrained gas.

Most importantly, WellDog's measurement requires less than half a day per wellbore, and the resulting analysis can be completed in just a few days. This fast turnaround on data provides operators the opportunity to characterize their reservoirs and immediately adjust their development in response to the results.

At upper right, the critical desorption pressure in the field is plotted. In general, most of the gas is located in the deeper portion of this field. However, surprisingly, significant gas is associated with a subsurface feature (labeled “A”) at about 2450 feet elevation in the southwest. The critical desorption pressure varies from I greater than 200 psi in the southeast to less than 50 psi in the northwest. Desorption pressure peaks around the “A” well in quantities of 350 psi.



Likewise, distributions of the gas content (plotted at lower left) and required drawdown (plotted at lower right) in this field indicates areas of potential economic production and areas that are not acceptable targets. For example, well "A" shows both desirable gas content (of about 80 scf/ton) and some of the most manageable dewatering conditions (with a required drawdown of about 500 psi) in the field. Conversely, well "B" requires a similar drawdown for production, but gas content around that well is less than 10 scf/ton.

Conclusion

In a typical coalbed methane field, it is common to observe dramatic variations in gas production across the field. However, coals are commonly continuous and permeable, and operators regularly produce water from wells that do not show gas in order to reduce the overall pressure in the field. In many cases, this can help increase gas production in adjoining wells. By examining discontinuities in the distributions of reservoir properties across this field, it is possible to differentiate between wells that will contribute to overall drawdown in the field and wells that appear to be hydrologically disconnected from the targeted regions of the field. For example, for this field, it is unlikely that wells in the northwest will contribute substantially to dewatering the southeast area of the field (where most of the gas resides). Using the Critical Gas Content results, Black Diamond is able to focus their dewatering and production plan on the "sweet spot", avoid areas of high water production and/or low gas production, and decrease their overall water/gas production ratio in the field.