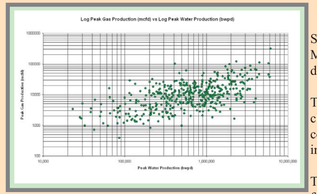
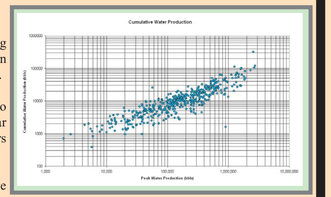
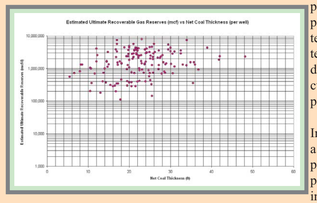
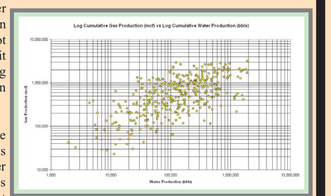
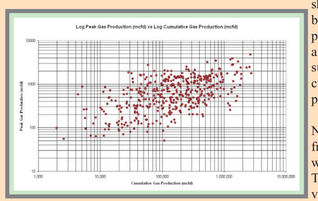
Scatter Plot Analysis

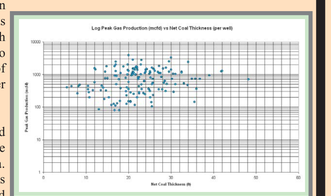


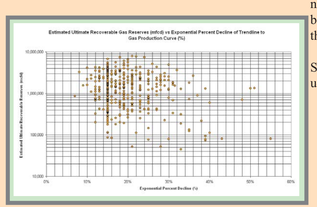












Scatter/Cross plots were created using Microsoft Excel from the production data set created from decline analysis.

These plots were mainly created to classify any type of log-linear correlations from any two parameters in the data set.

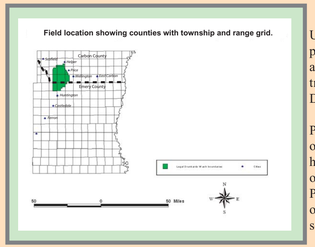
The most obvious correlation came from plotting the cumulative water production to the peak water production rate as seen to the right. In terms of gas production, this does not tell us much information. However, it does provide a model for predicting cumulative water production based on peak water production levels.

In terms of gas production, we do see a correlation between log peak gas production rates and log peak water production rates. Based on this information, we infer that wells that show high initial water production can be predicted to ultimately be good gas producers in the Drunkards Wash area. This suggestion is also supported by the cross plot of cumulative gas and cumulative water production levels as seen to the right.

Net coal thicknesses were recorded from density logs for several of the wells in the Drunkards Wash area. The cross-plot of net coal thickness versus peak gas production rates did not display an obvious correlation between the two parameters as seen to the right.

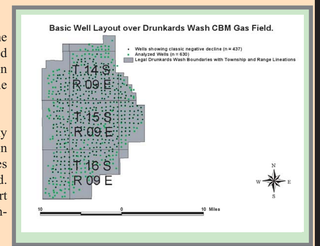
Several other plots were created, however, they displayed a wide array of scatter and were not useful in determining correlations between production parameters.

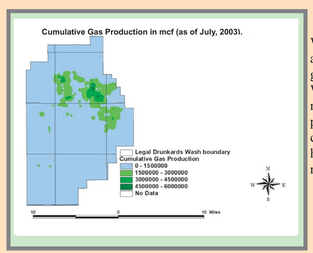
Spatial Analysis



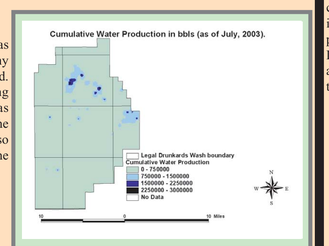
Using ArcView GIS 3.2 software, the production data was spatially plotted and analyzed for possible production trends and sweet spots in the Drunkards Wash field.

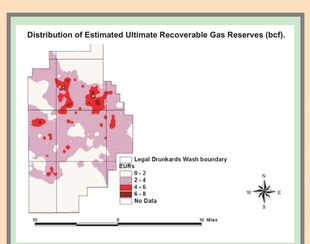
Plotting well locations showed many of the wells with immature production histories were located along the edges of the field boundary as expected. Production began in the northern part of the field and has extended south-southwest.





We next plotted the cumulative gas and water production data to see if any general trends occur across the field. We noticed an east-west trending region of high cumulative gas production as seen to the left. The cumulative water production was also high in this same area, although the regions are not exactly the same.

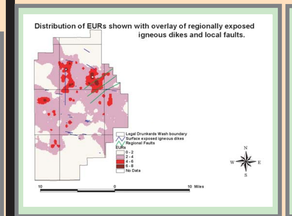




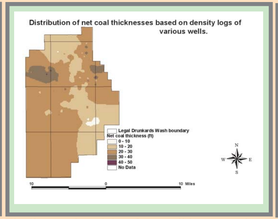
A similar east-west trending region was also noticed when we plotted the spatial distribution of the predicted EURs.

As noted earlier, thrust faulting occurs in the Drunkards Wash field and may have created a structural trapping component to the Ferron CBM deposit in this field. We note that the EUR "sweet spot" is located near structurally faulted areas which may have enhanced gas producibility because of increased fracturing.

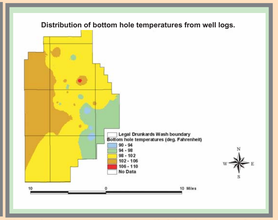
By generating this plot, we were motivated to research local geologic features outside of structures that could also influence the high producing region.



Production values were mapped along with other local geologic features to view spatial correlation of features. The locations of exposed igneous dikes across the field were mapped, and wells located adjacent to the long N-S trending dike show higher production rates than most wells in the field. Other clusters of dikes trend northwest to southeast, and these clusters are also often close to high production wells. The presence of igneous dikes appears to correlate with high gas production areas in the Drunkards Wash field. Detailed correlations relating dike characteristics and adjacent production were not completed in this study.



Finally, we plotted data from well logs to notice any other spatial correlations with production. The location of the thickest net coal areas show the same correlation with areas of gas production rates.



Though sparse, the available bottom hole temperature data recorded during initial well logging also showed similar north - south regions of local highs. Higher bottom-hole temperatures would provide reservoir conditions leading to faster desorption of gas from the coal upon depressuring of the reservoir. Thus, in wells with high bottom-hole temperatures, higher gas producibility would be expected to be better over the life of the well, and more gas might be expected to be present in such wells.

Conclusions

Tabular, graphical, and spatial distribution studies of factors affecting gas production rates in the Drunkards Wash field led to the following conclusions:

1 - The average exponential decline rate for coal bed methane gas wells in the Drunkards Wash field is 19 % with a standard deviation of 7 %;

2 - The approximate time from well completion to peak production was highly variable, but was commonly found to be three years;

3 - Wells that show high initial water production can be predicted to ultimately be good gas producers in the Drunkards Wash area;

4 - The average estimated ultimate recoverable reserves per well were calculated to be 1.75 bcf with a standard deviation of 1.43 bcf;

5 - Gas and water production rates for the selected wells experienced a rapid increase between 1998 and 2000, an increase believed to be due to changes in stimulation practices;

6 - Areas near local dikes and faults in the Drunkards Wash field are likely to have greater fracturing and permeability, resulting in better gas and water producibility.

7 - The Ferron coalbed gas deposit has some structural trapping component to its location. Structurally high areas have better gas producibility because of conventional trapping of migrated gas.

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Ron Blakey, Northern Arizona University

References

Armstrong, R. L., 1968, Sevier orogenic belt in Nevada and Utah: Geological Society of America Bulletin, v. 79, p. 429-458.

Blakey, R. J., 2004, Website; http://jan.ucc.nau.edu/~rcb7/crepaleo.html.

Burns, T. D. and Lamarre, R. A., 1997, Drunkards Wash project: coalbed methane production from Ferron coals in east-central Utah: Proceedings of the International Coalbed Methane Symposium, University of Alabama, Tuscaloosa, paper 9709, p. 507-520.

Conway, M. W., R. D. Barree, J. Hollingshead, C. Willis, and M. Farrens, 1997, Characterization and performance of coalbed methane wells in Drunkards Wash, Carbon County, Utah: Proceedings of the International Coalbed Methane Symposium, University of Alabama, Tuscaloosa, paper 9736, p. 195-212.

Gardner, M. H., and T. A. Cross, 1994, Middle Cretaceous paleogeography of Utah, in M. V. Caputo, J. A. Peterson, and K. J. Franczyk, eds., Mesozoic systems of the Rocky Mountain region, USA: Rocky Mountain Section SEPM, p. 471-503.

Hale, L. A., and F. R. Van de Graaff, 1964, Cretaceous stratigraphy and facies patterns - northeastern Utah and adjacent areas: Intermountain Association of Petroleum Geologists 13th Annual Field Conference Guidebook, p. 115-138.

Montgomery, S. L., Tabet, D. E., and Barker, C. E., 2001, Upper Cretaceous Ferron Sandstone: Major coalbed methane play in central Utah: AAPG Bulletin, v. 85, No. 2, p. 199-219.

Ryer, T. A., 1981, Deltaic coals of Ferron Sandstone Member of Mancos Shale - predictive model for Cretaceous coal-bearing strata of Western Interior: AAPG Bulletin, v. 65, p. 2323-2340.

Stutz, H. L., Victor, D. J., Fisher, M. K., Griffin, L. G., and Weijers, L., 2002, Calibrating coalbed methane fracture geometry in the Helper Utah field using treatment well tiltmeters: Society of Petroleum Engineers 77443, presented at the Society of Petroleum Engineers Annual Technical Conference and Exhibition held in San Antonio, TX, 29 September - 2 October 2002, 10 pp..

Willis, C., 1995, Drilled core holes key to coalbed methane project: Oil & Gas Journal, 6 Mar, p. 73-75.