

# Use of Variograms to Quantify Distribution of Barriers to Flow in Incised Valley-Fill Newcastle Sandstone, Wyoming: Abstract

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## ABSTRACT

The objective of this paper is to quantify the distribution of potential flow units within valley-fill outcrop deposits by utilizing geostatistical parameters, especially variograms. The Newcastle (Muddy) Sandstone, which is a prolific producer in the Powder River Basin of Wyoming, is the subject of our outcrop reservoir characterization analysis which compares the relationships of detailed geological (sedimentological) interpretations of facies, detailed in situ permeability measurements, and outcrop gamma-ray log surveys. Much of the Newcastle (Muddy) Sandstone, which crops out near Newcastle, Wyoming was deposited by tidal currents backfilling valleys formed during a Lower Cretaceous sea level drop. The Skull Creek Shales which underlies and is lateral to the Newcastle sandstone forms lateral and bottom seals.

We concurrently measured the permeabilities and gamma-ray responses of beds on three vertical transects with a grid extending normal to the bedding and three lateral grids which are as nearly parallel to the bedding as possible. We generated geostatistical parameters from these data sets. In all cases, Dykstra-Parsons coefficients are in the neighborhood of 0.35 for the single-unit data and above 0.8 for the multi-unit measurements. Coefficients of variation are below 0.5 for single units and above 0.8 for multi-unit data sets.

Multi-unit variograms show hole effect and often strong trend, while single unit variograms always indicate nugget effect with a weak trend. The correlation between the plots generated from measured permeability and gamma-ray responses are impressive. Permeability and gamma-ray variograms are similar. The variograms in the vertical and horizontal directions are quite different. Therefore, they cannot substitute one for another. We also concluded that relative semi-variograms are a better way of presenting formation heterogeneities. We observed that abrupt variations in outcrop gamma-ray values are also excellent indicators of bed contacts.

We used the generated geostatistical parameters in a simulated annealing program to predict permeabilities of lateral profile A, and concluded that variogram, mean and standard deviation are required but not sufficient parameters to predict the distribution of reservoir heterogeneity.

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