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Pore system characterization and petrophysical rock classification using a bimodal Gaussian density function. (English) Zbl 1321.86037

Math. Geosci. 45, No. 6, 753-771 (2013).

Summary: This paper introduces a bimodal Gaussian density function to characterize pore-size distributions in terms of incremental pore volume versus logarithmic pore-throat radius. An inverse problem is formulated and solved to reconstruct mercury injection capillary pressure curves by enforcing a bimodal Gaussian pore-size distribution. The bimodal Gaussian model generates six petrophysically interpretable attributes which provide a quantitative basis for petrophysical modeling and rock typing. Correlations between these attributes and their associated petrophysical properties are investigated to verify interpretations. In the field case, the correlation coefficient (R^2) between absolute permeability, end-point gas relative permeability and the mean value of large pore-throat size mode are 0.93 and 0.715, respectively. Correlation ($R^2 = 0.613$) is also observed between critical water saturation and pore volume connected by small pore-throat sizes. Petrophysical modeling based on the bimodal Gaussian pore-size distribution with sufficient core data calibration predicts static and dynamic petrophysical properties that are in agreement with laboratory core measurements. The quantitative pore-system description underlies a new petrophysical rock typing method that combines all relevant pore-system attributes. Verification of the method was performed with field data from two key wells in the Hugoton carbonate gas field, Kansas.

MSC:

86A32 Geostatistics
86A60 Geological problems

Keywords:

bimodal Gaussian density function; inverse problem; pore-size distribution; petrophysical modeling; rock typing

Full Text: DOI

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