Evaluation Of Different Technologies For Mudrock Porosity Measurement

Author block: A. Alnahwi, M. Boudjatit, Saudi Aramco; J. Chen, Aramco Service Company.

Abstract

Objectives/Scope: Porosity is a crucial parameter required to assess reservoir producibility and calculate resources in place. In mudrocks, however, measuring porosity is quite challenging because of the complex character of the pore network, low porosity, high content of organic matter, and ultra-low permeability. This paper is focused on comparing different porosity measurement methods of organic-rich mudrocks. The investigation includes 1) an evaluation of the controlling factors affecting each technique and 2) a comparison of lab-measured porosities to log-derived porosities.

Methods, Procedures, Process: Several laboratory methods were used to measure porosity which are 1) GRI (Gas Research Institute), 2) CNG (combined NMR and Gas porosimetry developed internally by Aramco), and 3) MICP (mercury injection capillary pressure). The GRI method was conducted on crushed particulate rocks while the CNG and MICP were performed on intact core plugs. Additionally, porosity was estimated from borehole well-logs including NMR, neutron, density and sonic. The log-derived porosities represent continuous records while the lab tests represent dispersed point measurements. The different measurements and estimations are compared and the more accurate lab measurements are upscaled to well-log level.

Results, Observations, Conclusions: The GRI method is often referred to as the industry standard for measuring porosity in mudrocks. Therefore, other measurements are compared and calibrated to GRI. The CNG porosity is the most comparable to GRI. The best fit trendline of CNG and GRI cross plot shows a slope of 1.06 and an R2 of 0.73. The second-best relationship exists between the NMR log and log-derived porosities with a slope of 0.92 with an R2 of 0.69. The MICP porosity is always lower than that of GRI and in this study we use the pore throat size to understand the different relationships. In this study, we assess and analyze each of the different factors that might be causing the difference in the porosity estimation. The cause of the different values by different porosity measurement methods could be attributed to (1) sample size, (2) sample preparation, (3) organic richness, (4) thermal maturity, and (5) pore size of investigation. Samples preparation and pore size of investigation are the main factors impacting the porosity measurements as well as the vertical heterogeneity of the samples.

Novel/Additive Information: Measuring porosity in mudrocks is challenging and requires an understanding of the various factors causing the lack of correlation between the different methods. In this study, the larger number of experimental porosity measurements allows for proper selection of the most applicable porosity measurement method that provides accurate mudrock porosities that are cost- and time-efficient. Additionally, the laboratory porosity measurements are upscaled to the wireline log resolution to calibrate the log-derived porosity values.