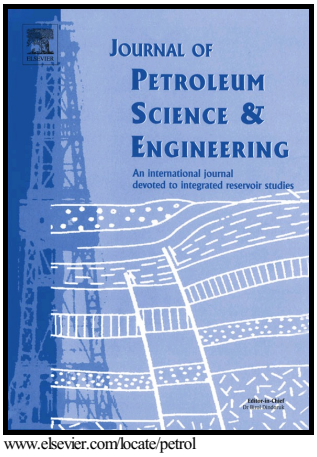
Multiscale Pore Structure Characterization of Middle East Carbonates

A.S. Gundogar, C.M. Ross, S. Akin, A.R. Kovscek



www.elsevier.com/locate/petrol

PII: S0920-4105(16)30280-7
DOI: http://dx.doi.org/10.1016/j.petrol.2016.07.018
Reference: PETROL3551

To appear in: *Journal of Petroleum Science and Engineering*

Received date: 16 December 2015
Revised date: 21 June 2016
Accepted date: 8 July 2016

Cite this article as: A.S. Gundogar, C.M. Ross, S. Akin and A.R. Kovscek, Multiscale Pore Structure Characterization of Middle East Carbonates, *Journal of Petroleum Science and Engineering*, http://dx.doi.org/10.1016/j.petrol.2016.07.018

Multiscale Pore Structure Characterization of Middle East Carbonates

A. S. Gundogar[1,2], C. M. Ross[1], S. Akin[2], and A. R. Kovscek[1,*]
[1] Stanford University, Energy Resources Engineering, Stanford, CA USA
[2] Middle East Technical University, Petroleum and Natural Gas Engineering, Ankara TURKEY
[*]Corresponding author: Kovscek@stanford.edu

ABSTRACT

This paper focuses on the measurement of pore-scale geometrical and topological properties of heterogeneous Middle East carbonates using scanning electron microscopy (SEM), image analysis, and mercury porosimetry. Quantitative pore network descriptors including porosity, pore body and throat sizes, coordination number (number of throats per pore), shape factor (pore area to perimeter ratio), aspect ratio (pore body to throat size ratio), and their distributions are determined from SEM-based images of thin sections at multiple resolutions as well as physical core measurements. Image analysis revealed pore bodies in 2D images whereas their connecting throat sizes are derived from mercury intrusion data. To compensate for pore sizes that vary over several orders of magnitude, SEM images are collected at 75X and 750X with pixel resolutions of 2.63 and 0.077 μm, respectively. Mosaics (75X) reveal abundant evidence of textural and structural differences within and between the carbonate samples. SEM pore-size distributions generated by merging data from both 75X and 750X images incorporate microporous features as small as 0.077 μm and macropores as large as 310 μm into a single multiscale pore system. A pore-throat classification method was developed relating mercury volume invaded through throats of a given size to the corresponding pore area as derived from SEM data. Four pore-throat classes were identified with unique pore- and throat-size distributions ranging from 0.077 to 310.34 μm and 0.007 to 23.703 μm, respectively. The average coordination number ranges mostly from 3 to 5, and irregular triangle-shaped cross-sections dominate the carbonate pore system. The pore to throat aspect ratio is generally large (> 3), indicating the potential for significant residual oil saturation. These pore system parameters and their distributions provide the basis for future pore network modeling studies and allow for improved understanding of pore structure and network framework and their influence on multiphase transport properties and, accordingly, secondary and enhanced oil recovery efficiency in carbonate reservoirs.

Graphical Abstract