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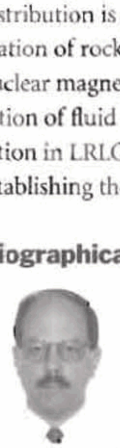
Low-Resistivity, Low-Contrast Pays

Major hydrocarbon accumulations have been produced over the past 40 years in low resistivity, low contrast (LRLC) sands in the Gulf of Mexico basin (GOM). LRLC reservoirs were commonly considered wet, tight, misidentified as shale, or completely overlooked because of logging tool resolution limitations, but are being re-evaluated now in other basins. Low-resistivity pay has been typically defined at or below the 1.0 ohm-meter resistivity level, yet many productive reservoirs are found in the 0.3 to 0.5 ohm-m resistivity range. The interpretation of seismic response, the analyses of drill cuttings, sidewall and conventional cores, the interpretation of log response with the application of appropriate petrophysical models, along with wireline and production testing, provide an integrated LRLC evaluation. In addition to many U.S. basins, LRLC sands are found in basins in Canada (Alberta), North Sea, Egypt, Nigeria, Malaysia, Indonesia, Australia, Philippines, Italy, Mexico, Trinidad, Venezuela, Ecuador, Argentina, and Russia.

Geological causes of LRLC pay include: laminated clean sands with shales; silts or shaly sands; clay-coated sands; glauconitic sands; sands with interstitial dispersed clay; sands with disseminated pyrite or other conductive minerals; clay-lined burrows; clay clasts; altered volcanic/feldspathic framework grains; very fine-grained sands; microporosity; or sands with very saline formation water. LRLC depositional systems include deepwater fans with levee-channel complexes, delta front and toe deposits, shingle turbidites, and alluvial and deltaic channel fills. The lack of high-resolution logging across intervals containing reservoir sands that are below the tool resolution is frequently the "cause" of the LRLC.

Geological and petrophysical models developed in the GOM for the evaluation of LRLC pay are applicable to other basins. A conventional Archie clean sand or Waxman-Smits shaly sand model is commonly used to evaluate LRLC log anomalies. Often, shaly sand models are not necessarily suited for LRLC evaluation. The Archie lithology exponent (m) and saturation exponent (n) for many LRLC reservoirs can range from 1.4 to 1.85, and from 1.2 to 1.8, respectively. In thinly laminated LRLC reservoirs, net sand distribution is identified with high resolution logging tools, examination of rock samples, and interval testing. Recent application of nuclear magnetic resonance logging has provided a better identification of fluid type, grain size distribution, and hydrocarbon saturation in LRLC sands. Resistivity forward modeling can also aid in establishing the "true" resistivity in laminated sands.

Biographical Sketch



John T. Kulha is a Houston-based engineering consultant with over twenty-five years experience in petroleum engineering and geoscience studies related to exploration, development, reserve determination and property acquisition. In association with other engineering and geoscience consulting firms, John is a key member of multidiscipline project teams working with energy companies worldwide. As a recognized authority in the identification and evaluation of low-resistivity, low-contrast pay zones, John has presented LRLC pay evaluation, petrophysics, and reservoir characterization seminars world-wide to energy companies, professional societies, and academe. He has also provided expert witness testimony to the Texas Railroad Commission and for other judicial boards. He previously worked for Shell Oil Company and Loren and Associates, Inc.

John received a B.S. degree in petroleum engineering from the University of Pittsburgh and an M.S. degree in petroleum engineering from the University of Houston. He is a member of the Houston Geological Society, Society of Petroleum Engineers, Society of Professional Well Log Analysts, and the American Association of Petroleum Geologists. John worked with the editorial committee on the Houston and New Orleans Geological Societies' joint publication *Productive Low-Resistivity Well Logs of the Offshore Gulf of Mexico* (1993). □

HGS Dinner Meeting • Monday, May 10 • Westchase Hilton, 9999 Westheimer • Social 5:30 p.m., Dinner 6:30 p.m.