Characterizing Secondary Porosity and It's Connectivity in Carbonate Reservoirs Using Electrical Borehole Images

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Historically, the correlation between hydrocarbon production and neutron-density derived porosity in many carbonate reservoirs has been inconsistent. One of the major reasons causing this inconsistency is the difficulty in characterizing the secondary porosity system in carbonates with a dual pore system based on open hole logs alone due to their complex nature. Primary intergranular porosities are less abundant in most limestones. There is generally secondary porosity in the form of vugs, molds and factures. The vuggy porosity, produced by diagenesis and secondary recrystallization occurring in the rock due to water influx, is usually present particularly in dolomites.

This paper describes a quantitative formation evaluation technique using electrical borehole image data to determine both primary and secondary porosity. Borehole images provide both high resolution and whole well bore coverage to quantitatively resolve the heterogeneous nature of the vuggy porosity. It is assumed in this technique that the micro-resistivity data from the electrical borehole images is measured in the flushed zone of the borehole. These electrical images can then be converted into a porosity map of the borehole. Automated analysis of this porosity map, windowed over short intervals, provides a continuous output of the primary and secondary porosity components.

In this case study, an attempt has also been made to apply a borehole textural analysis on FMI/FMS* images to characterize connectivity between vugs through a conductivity mapping technique. A quantitative secondary porosity connectivity value can be derived and used as a rough permeability indicator for the studied reservoirs. It is understood that recognizing secondary porosity components and their connectivity in carbonates with dual pore systems is very important to predict production performance. Therefore, the techniques described in this paper utilizing borehole image data provide solutions to complex carbonate reservoir problems which are not well addressed by conventional open hole log interpretation.