A Novel Technique for Formation Evaluation in Fractured Basalts by Integration of Elemental Capture Spectroscopy, Nuclear Magnetic Resonance (NMR) and Dipole Sonic Logs

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This paper presents an innovative approach for enhanced formation evaluation of fractured basaltic reservoirs. The study was based on integration of high-tech logs, i.e., Elemental Capture Spectroscopy, Dipole Sonic and Nuclear Magnetic Resonance and calibration with special core analysis data. The main interpretation challenge in basalts is the lack of matrix response data due to the complex mineralogy. Using conventional logs, i.e., neutron, density, resistivity and sonic, often leads to questions, such as, where is the hydrocarbon, is porosity correct, where should I perforate, will it flow? For example, porosity estimation using neutron-density logs is often inaccurate due to matrix-density uncertainty. Moreover, permeability in basalts is of vital importance in selecting the best zones for perforation and deciding the optimal completion strategy. We used the conventional logs in conjunction with the elemental dry weights (iron, silicon, calcium and sulfur)from elemental capture spectroscopy and NMR porosity logs as inputs in a multimineral petrophysical evaluation, which was calibrated with available core porosity, X-Ray diffraction and petrography data, in order to derive an accurate mineralogical model across the basaltic sections. Cross-plots of P-wave and S-wave velocity vs. Poisson's ratio exhibited a distinct response over the weathered basalts and thus assisted in facies characterization. Moreover, NMR and Stoneley logs were used for estimation of intrinsic and fracture permeability, respectively. This synergistic approach assisted in deriving more accurate reservoir properties and delineating the high productivity pay zones. The well was tested across the altered basaltic zone and flowed more than 2,000 BOPD.