A New Generation Magnetic Resonance Logging Tool

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ABSTRACT

A new generation wireline nuclear magnetic resonance (NMR) logging tool has recently been commercialized. The Magnetic Resonance eXpert (MRX) has a depth of investigation (DOI) that is deeper than previous designs resulting in improved performance in rugose boreholes and increased oil signal for hydrocarbon characterization. In addition to the deeper DOI, the tool has multiple DOI's that simultaneously probe the formation at various depths. The geometry of the investigation volume is hemi-cylindrical arcs or crescents in front of the antenna. Since the tool is of an eccentered mandrel design, these crescents are maintained at a fixed distance from the borehole wall and are independent of hole size or shape. These DOI's are widely spaced and cover a range of values so that changes in fluid type across the invasion profile can be detected. During field-testing the multiple DOI's were found to be valuable in determining fluid type as well as detecting and quantifying environmental effects such as whole mud invasion. A novel instrumentation feature is the multiple antennas placed along the length of the pre-polarizing magnet. This design circumvents the compromise of high vertical resolution versus deep depth of investigation and allows the tool to achieve both in a single logging pass. The effective polarization time between the antennas can be varied as a function of logging speed, direction, and acquisition cycle. Comparisons between fully polarized antennas yields a continuous and simultaneous repeat section for data quality confirmation while comparisons between fully and partially polarized antennas yields fluid type information based on T1 properties. New acquisition sequences have been developed for the tool and new inversion algorithms yield comprehensive fluid characterization including quantitative gas and oil saturation as well as oil viscosity. The tool has demonstrated the ability to differentiate hydrocarbon from water and even the difficult task of discriminating oil-based mud filtrate from native oil.