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CALIBRATING NMR RESPONSE TO
CAPILLARY PRESSURE CURVES
IN FINE GRAINED LITHOLOGIES:
PRETTY HILL FORMATION,
OTWAY BASIN

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ABSTRACT

Nuclear magnetic resonance (NMR) tools are commonly used in formation evaluation. NMR T2 distribution data have been used by previous authors to build down-hole pseudo capillary pressure curves in reservoir quality rocks. The objective of this study is to generate NMR-derived down-hole pseudo capillary pressure curves in very fine grained lithologies in order to determine whether it is possible to estimate capillary displacement pressures and thereby sealing capacity.

NMR T2 relaxation time distributions of flood plain facies at Redman-1 well in Otway Basin, SE of South Australia, were converted to pseudo capillary pressure curves. The generated curves were compared to mercury injection capillary pressure (MICP) curves. The petrophysical properties and mineralogy of 11 flood plain samples were analyzed using the following measurement techniques: MICP, Scanning Electron Microscopy (SEM), core porosity and permeability, X-Ray Diffraction (XRD), optical microscopy of thin section and X-Ray Fluorescence XRF.

Displacement pressures were calculated from pseudo capillary pressure curves and compared with actual MICP curves at different saturations percentages of non-wetting phase. The best percentage in displacement pressure estimation is the 20% saturation with correlation coefficient of 0.59. Statistically, the correlation coefficient of the 20% saturation is too low for meaningful calibration.

The reason for the lack of robust calibration is related to the actual properties of the rock: the Redman-1 flood plain samples have high iron contents (Fe_2O_3 content ranges between 5.21-7.16 wt%) with correspondingly increased magnetic susceptibility and elevated internal field gradients. The iron is mainly associated with chlorite and biotite in the samples studied. The NMR T2 response is affected significantly by the internal magnetic field gradient which depends on the magnitude of the

magnetic susceptibility. Surface relaxivity changes and high pore to throat size ratio also contribute to the difference between the two measurements.

Study conclusions are that T2 response in high iron content rock is affected by many factors such as magnetic susceptibility, surface relaxivity and aspect ratio. Therefore, using the NMR response to estimate capillary displacement pressures in iron-rich, fine grained rocks is not recommended. However, further studies in rocks of low magnetic susceptibility might yield more significant correlations.

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