The Maturity of Organic-Rich Shales Using Micro-Impedance Analysis

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Organic-rich shales (ORS) are the common source rock for most clastic reservoirs. The processes that are involved in how these shales generate extractable hydrocarbons from kerogen are fairly well understood. The maturity level of kerogens in organic-rich shales is presently determined by geochemical analysis of core samples. The maturity of shales at insitu conditions may be inferred from relationships between shale pressures, and downhole measurements from resistivity and sonic logs. The ability to determine maturity by the use of indirect measurements such as seismic is still the subject of research.

The study focus area is the Bakken formation in the Williston Basin, North America whose organic-rich shales are proven hydrocarbon source rocks. Further study in the remote detection of maturity would be help in reducing exploration and development costs.

This study focuses on a method of predicting maturity of organic-rich shales by evaluation of their impedance micro-structure. Scanning acoustic microscopy is used to map the impedance of shale components. The impedance of these components is related to their elastic properties, and these components vary with maturity in the shales. Previous studies have been successful in relating shale velocities to porosity, and in detecting textural changes with maturity. In this study, direct qualitative relationships are shown between the impedance of shale samples, shale rock properties and maturity indicators, TOC and Transformation Ratio.

This study adds to current understanding of the maturity-based variations by using analysis from scanning acoustic microscopy, integrating measurements from geochemical analysis, and observations from downhole sonic measurements to develop relationships for relating impedance information from seismic data to organic shale maturity.