Geophysical Research Abstracts
Vol. 18, EGU2016-15995-2, 2016
EGU General Assembly 2016

Characterizing petrophysical properties of carbonate rocks using nuclear magnetic resonance and spectral induced polarization

Fan Zhang, Chi Zhang, and Eugene Rankey
Department of Geology, The University of Kansas, United States (f001z459@ku.edu)

Unlike sandstones, with well-characterized correlations between porosity and permeability, carbonate rocks are well known for their highly complex petrophysical behaviors due to their intrinsically heterogeneous pore shape, pore size, and pore distributions and connectivity. The characterization of petrophysical properties of carbonate rocks, including rock properties and rock-fluid interactions, remains big challenges. This laboratory study focuses on integrating two geophysical methods: nuclear magnetic resonance (NMR) and spectral induced polarization (SIP) to determine porosity, pore size distribution, and permeability of carbonate rocks. NMR measures the relaxation of hydrogen nuclei at pore scale. Samples with different pore structures saturated by fluids have molecular relaxation responses to the external magnetic field which could generate various NMR signals. Permeability estimation from NMR in siliciclastic rocks is routine, however, is problematic in carbonates. SIP determines complex resistivity of a sample across a wide range of frequency and is sensitive to variations in the properties of solid-fluid and fluid-fluid interfaces in porous media. Previous studies investigated the relationships between permeability and parameters derived from SIP data, but are restricted to narrow lithology range. Our study used carbonate core samples from three depositional environments: tidal zone, shallow marine, and platform/reef margin of an atoll. Samples were fully saturated by water for T_2 relaxation measurements and complex conductivity measurements at low frequencies. We compare the pore volume to surface area ratio measured from NMR and SIP and assess the applicability of established petrophysical models to estimate permeability from NMR and SIP data. We hope to build a relationship between NMR signals, SIP responses and petrophysical properties in carbonate rocks. The results could also provide new data and help further understand the unique and complex pore structure of carbonates, which would lead to better constrained interpretation of field data.