3-D Visualization of the Internal Structure of Tyndall Limestone using Magnetic Resonance Imaging and Petrography

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ABSTRACT

Sedimentary rocks are ideal candidates for Magnetic Resonance Imaging (MRI) because their pore space can be imbibed with fluid or gas to image porosity distribution and porosity-permeability networks. In this study, a water-saturated sample of Tyndall Limestone (Red River Group, Manitoba) was imaged using MRI analysis. This technique, if coupled with petrographic observations, is ideally suited for investigating millimeter- and centimeter-scale heterogeneities in bioturbated calcareous sedimentary rocks.

The data presented addresses the potential of spin-echo imaging technique as a tool for mapping the porosity of heterogeneous sedimentary media. Magnetic resonance images are analyzed in conjunction with petrographic data to evaluate the textural characteristics of carbonate rocks dominated by texturally selective dolomitization. Moreover, the images reveal the three-dimensional geometry of the ichnofossils that influenced dolomitization and porosity development. *Planolites*, *Palaeophycus*, *Chondrites,* and rare *Taenidium* are present within the sample. The ichnofabric is manifest in the distinctive distribution of patchy dolomite. High intensity MR images are calibrated to high porosity regions by integrating petrographic data with MR data, and low intensity images are calibrated to low porosity regions. Numerical reservoir modeling demonstrates the impact of the tortuous flow paths on the overall flow network. The implementation of improved MRI techniques offers the technology to advance geologists' understanding of the three-dimensional nature of carbonate rocks and the influence they may have on the overall resource-quality of the sedimentary media.