THE IMPORTANCE OF PORE STRUCTURE ON THE VELOCITY OF DOLOSTONES

Ralf J. Weger, Gregor Baechle, Shouwen Shen, and Gregor P. Eberli

PROJECT OBJECTIVES

- Contrast and compare the sonic velocity and permeability of dolomite and calcite samples.
- Quantify pore structures of the measured samples using Digital Image Analysis (DIA) parameters and theoretically-derived parameters from the Extended Biot Theory.
- Assess the respective impact of mineralogy and pore geometry on acoustic velocity of carbonate rocks predominantly composed of dolomite and calcite.

PROJECT RATIONALE

Dolomite is acoustically faster than calcite but dolostones have a wide range of sonic velocities related to the different dolomite types that form during the transformation from limestone to dolostone (Ehrenberg et al., 2006). The purpose of this project is to quantitatively assess the internal pore geometry of various samples composed of both dolomite and calcite, together with their sonic velocity to evaluate the impact of geometry compared to that of mineralogy.

Transforming calcite to dolomite during diagenesis occurs either in a fabric-preserving or fabric-destructive manner. During this transformation a variety of crystal sizes, textures, and geometries are produced. Fabric-preserving dolomitization maintains to a large degree the limestone rock texture and pore types.

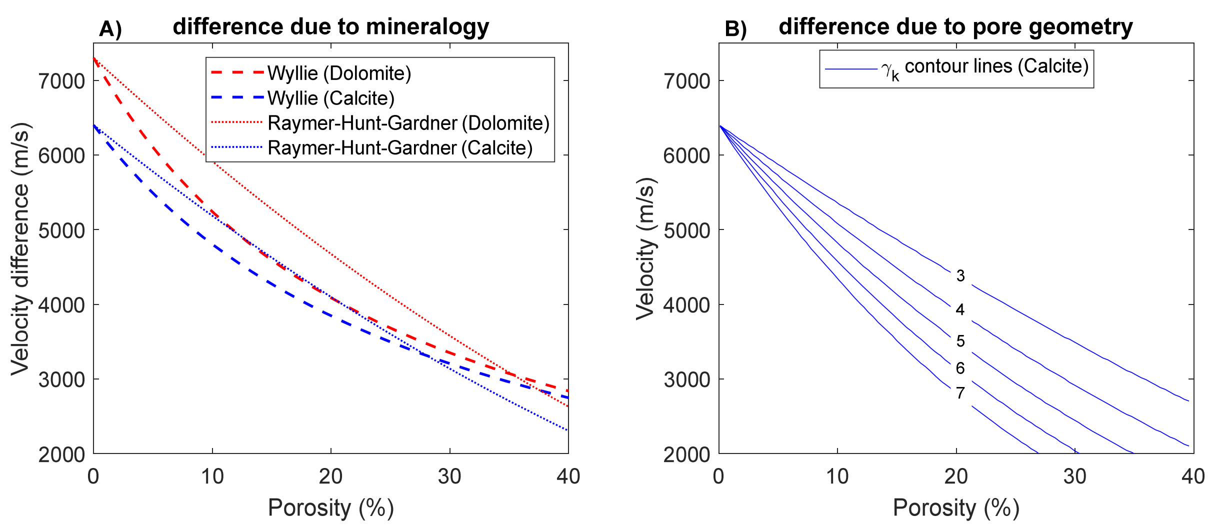

Figure 1: (A) Difference in acoustic velocity caused by variations in mineralogy (dolomite vs. calcite) as predicted by Wyllie time-average-equation and Raymer-Hunt-Gardner relationships (Wyllie et al., 1958; Raymer et al., 1980). (B) Variation in acoustic velocity caused changes in internal pore geometry at any given porosity as predicted by the Extended Biot Theory (Sun, 2001).

Original rock textures are largely destroyed and replaced by an intercrystalline rock fabric in fabric-destructive dolomites but the matrix velocity of dolomite remains faster than that of calcite.

With increasing porosity, the importance of mineralogical differences diminishes (Wyllie et al., 1958; Raymer et al., 1980) and the influence of internal pore geometry on acoustic velocity increases (Sun, 2001; Weger et al., 2009). Understanding these variations requires an assessment of sample mineralogy and the different rock fabrics with respect to their petrophysical properties.

WORK PROPOSED

For this study, we compiled 77 carbonate rocks (38 limestone core plugs and 39 dolomite core plugs) from two different locations, one from the Aptian (Shu'aiba Formation), and one from the Mississippian outcrops of the Madison Formation in Wyoming. Petrophysical properties (porosity, velocity, permeability) used for comparison of the samples have been measured at the CSL in the past. Digital image analysis of thin sections was performed using the method described by Weger et al. (2009) and geometrical parameters from the Extended Biot Theory are derived directly from the measured petrophysical properties.

We will compare the differences and similarities of dolostones and limestones to illustrate and quantify the impact of variations in mineralogy and internal pore geometry at different porosities. Our working hypothesis is that the pore structure is more important than (the calcite - dolomite) mineralogy for determining the velocity of carbonate rocks.

SIGNIFICANCE

The combined analysis of velocity, porosity, and permeability of samples from the Madison Formation and the Shu'aiba Formation with petrographic, digital image and mineralogical analyses will help to identify the controls each parameter exerts on the petrophysical behavior. This study will likely provide evidence that mineralogy is a minor factor on sonic velocity of dolostones.

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