DETECTING PORE TYPES USING VELOCITY AND RESISTIVITY

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PROJECT OBJECTIVES

- Discriminate connected interparticle from separated moldic porosity using petrophysical properties.
- Combine resistivity and velocity to discriminate samples with simple pore geometries and connected pores from samples with simple pore geometries and disconnected pores.

PROJECT RATIONALE

Carbonates with high porosity can yield high velocity if they contain a stiff frame that allows the acoustic wave to travel with high speed. These high-velocity, high-porosity rocks can have either interparticle or separated moldic porosity, reflecting the contrasting stiffening process. In fast rocks with interparticle pore space the stiff frame is produced by cementation of grain-grain contacts while in separated moldic rocks the frame is basically the completely cemented pore space. Both processes result in high velocity but because of the pore type the permeability is different. Moldic rocks have low permeability while high velocity rocks with interparticle pore type have a high permeability (Fig. 1).

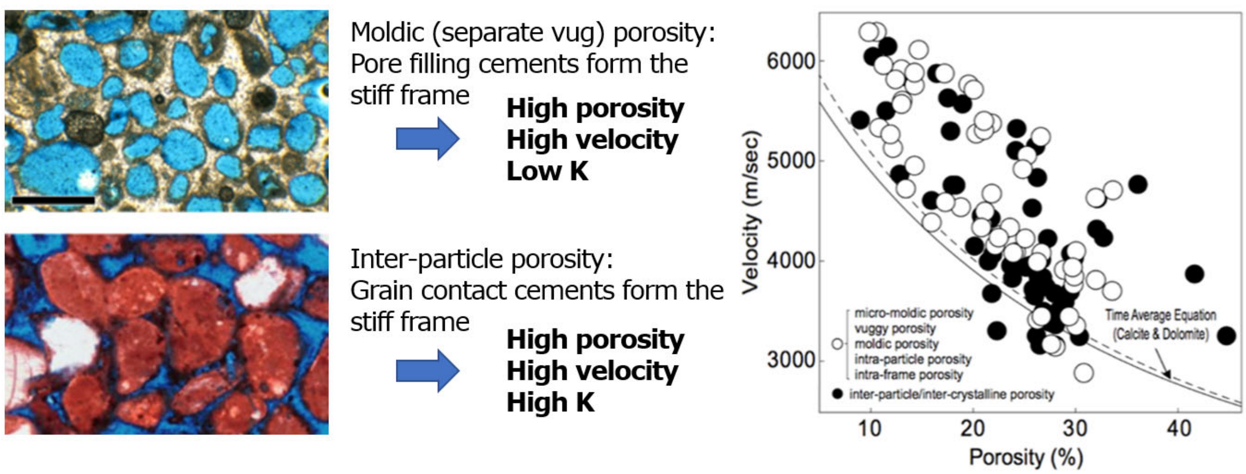

Figure 1: Left: Illustration of the two pore types and their petrophysical characteristics. Right: Velocity-porosity plot of carbonates separated into interparticle/intercrystalline and different types of separate vug porosity. Both can have very high velocity at any given porosity (from Weger et al., 2009).

It is difficult to distinguish between these two pore types using Digital Image Analysis (DIA) because both yield large, simple pores (Weger et al., 2009). Resistivity also relates to pore type but is also strongly dependent on pore connectivity and the number of pores (Verwer et al., 2011; Norbisrath et al., 2015). As a result, resistivity is lower when the pores are more connected in contrast to separated pore networks that usually show higher resistivity measurements (Fig. 2). This project tests how accurately these two pore types can be distinguished using laboratory measurements of acoustic velocity and electrical resistivity (Fig. 2).

APPROACH

Compare samples with simple internal pore geometry that are either connected (high K), or isolated (low K) to evaluate and quantify how resistivity will discriminate connected from unconnected simple pore networks.

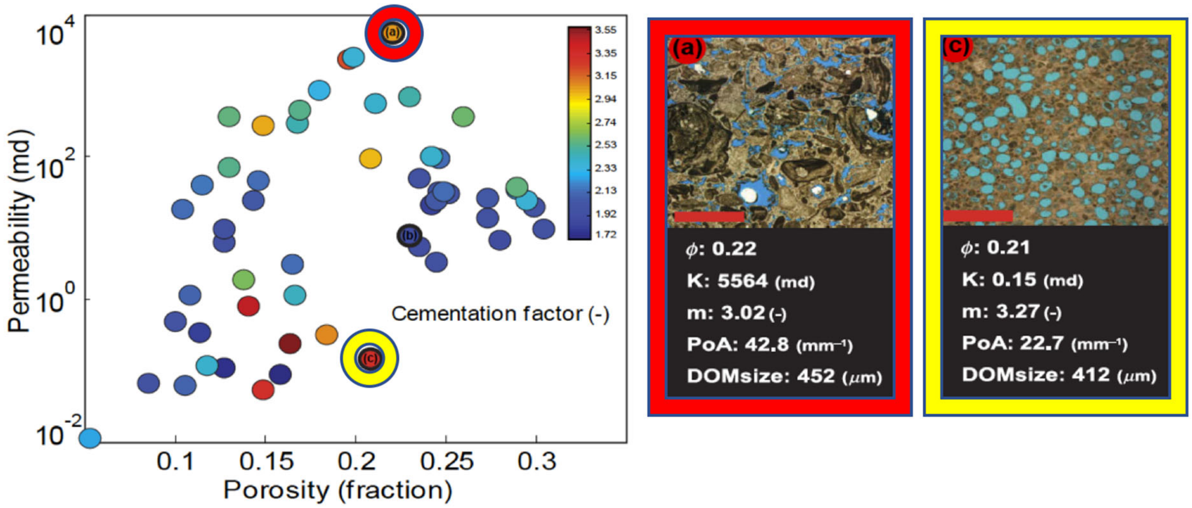

Figure 2: Permeability-porosity cross plot showing resistivity derived cementation factor (m) superimposed in color. High velocity samples with similarly simple pore networks and DIA parameters (a and c) show subtle differences in resistivity.

WORKPLAN

The CSL has measured several hundred samples for velocity, resistivity, porosity, permeability and related their values to quantitative pore geometry parameters determined using DIA. We plan to mine this data base for samples of similarly high velocity and simple and large pores, as documented by the DIA parameters of low perimeter over area (PoA) and high dominant pore size (DomSize), and then assess the resistivity differences in these samples. It is expected that the velocity in each sample is relatively high while the resistivity will be "high" in samples with separate vug porosity and "low" in samples with interparticle porosity. Samples that do not follow this expected trend will be further examined to determine the cause of the indiscriminate behavior.

REFERENCES

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