UR04

Analysis of the Behavior between Mineralogical Composition and Porosity from X-Ray Diffraction Data

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Summary

The increasing interest in unconventional resources guides the need to characterize the pore networks of source rocks. Unlike conventional reservoir rocks, basin mudrocks rich in organic matter are more complicated to characterize due to its very fine allochemicals grain size (silty to clayish grain sized), causing a very small pore size and very low permeabilities. Petrographic descriptions, scanning electron microscope images, X-ray diffraction analysis, TOC determination and mercury injection porosimetry were performed on core samples and the results were compared as a function of depth. The results show that there is a direct relationship between mineralogical composition, TOC, porosity values and pore size.

Introduction

Laboratory analysis were performed on core samples that met the most representative characteristics of the oil-generating bodies within an unconventional reservoir. The tests performed were X-ray diffraction (XRD), scanning electron microscope (SEM) and determination of TOC content by the LECO technique. These tests were made to understand the relationship between mineralogical composition, pore size and TOC content in limestones.

If a relationship between these properties exist, it is expected to identify which are the mineralogical concentrations that directly affect the pore size.

Methodology

The study is based upon the workflow proposed by Slatt *et al*. [2012] (***Figure 1***) and the analysis made by Furmann *et al* [2016], which includes petrographic descriptions, scanning electron imaging, X-ray diffraction and geochemical analysis in core samples. This workflow has been very useful for the documentation of nanoporosities in the unconventional plays of Barnett and Woodford in the United States, and Belle Fourche and Second White Specks in Canada.

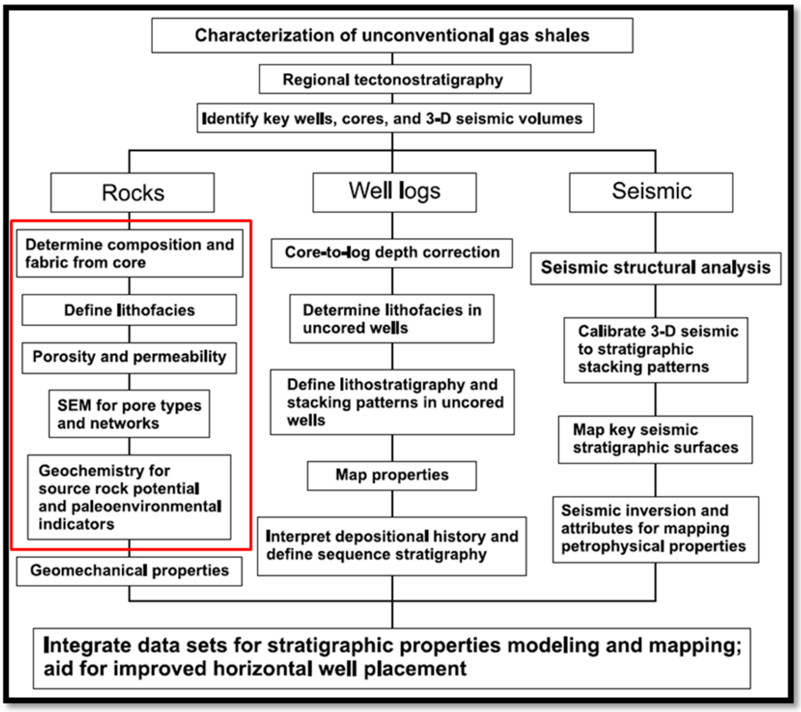

Figure 1 *Slatt et al. [2012] proposed workflow for the characterization of unconventional reservoirs. In red, aspects covered in this study.*

The samples were selected based upon: the position of the well within the Sweet Spot, its TOC content, the GR log pattern in the core depth and its lithofacies.

Results

The mineralogy determined via XRD revealed the presence of the following minerals in studied limestones: chlorite, kaolinite, illite and smectite (grouped as clay minerals); calcite, ankerite, dolomite and siderite (grouped as carbonates); quartz, potassic feldspars and plagioclase (grouped as silicates); as well as traces of pyrite, anhydrite, barite and heulandite.

These three major groups were plotted vs depth in ***Figure 2*** and compared with the TOC and porosity values. The distribution of ***Figure 2*** shows how low levels of clay allow relatively high values of porosity, this because clay minerals have a high influence on porosity distribution based on their ability to integrate water molecules inside of its structure, which could block access to hydrocarbons.

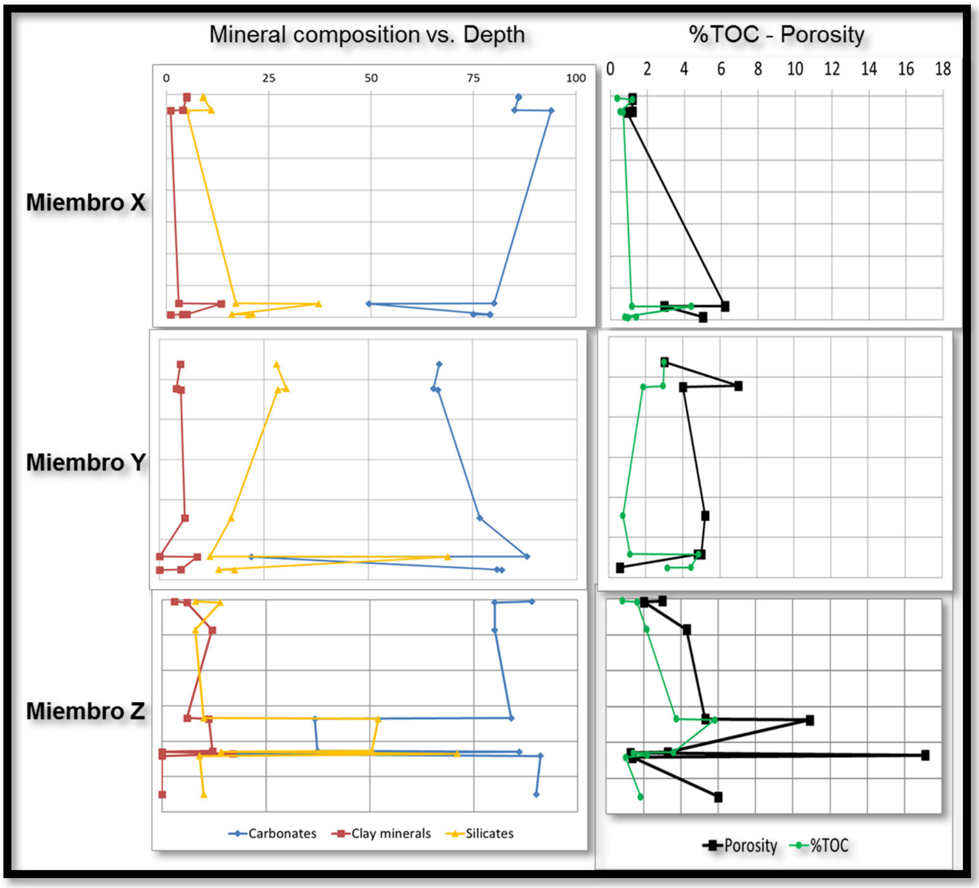

Figure 2 *Mineralogical composition, TOC content and porosity vs relative depth.*

By the other hand, the carbonate concentration shows a negative tendency as a function of porosity, which means, that at a higher concentration of carbonates the pore size is smaller, while at higher silicates concentration, pore size tend to increase (***Figure 3***).

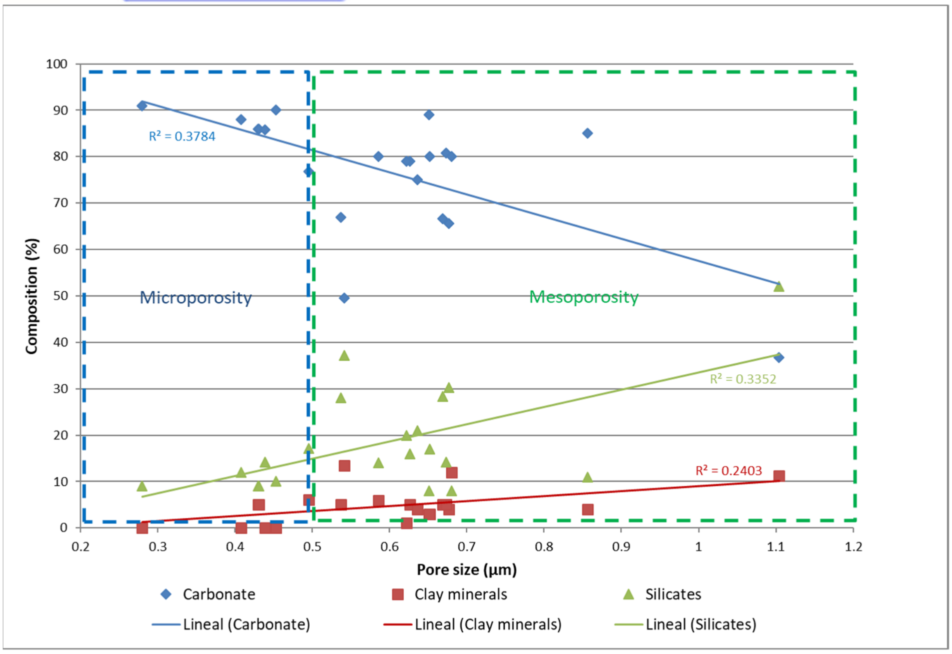

Figure 3 *Relationship between mineral composition and pore size.*

There is a high concentration of carbonates in relation to the clay minerals content (***Figure 4***). Unlike other unconventional reservoirs, this one is mostly carbonated and due to its low clay content it is unrelated with shales.

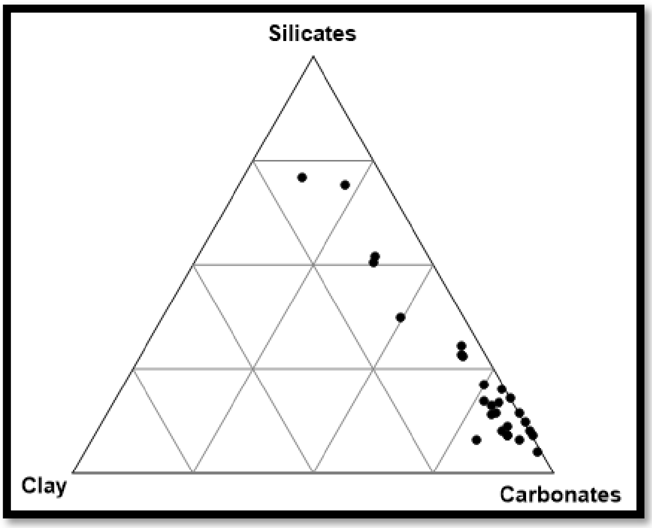

Figure 4 *XRD results.*

Conclusions

- It was found that limestones of the unconventional reservoir have a relationship between mineralogical composition and pore size, varying between micro- to mesoporosity.
- The carbonate contents have a direct influence on pore size: at higher carbonate concentrations, the pores are smaller and vice versa; while at higher concentration of silicates, the pore size tends to be higher.
- Variations in pore size of analyzed samples are primarily associated with mesopore sizes, rather than micro- or nanoporosity.
- The total clay content is below 13% in most samples, which suggests that unconventional reservoirs may not necessarily be from shales, but also from organic matter rich limestones.

References

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