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The Importance of the Integrated Approach to Evaluate Tight Gas and Liquid-rich Plays

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Summary

Standard analysis of rock samples has not significantly changed in the past, despite drastic changes in our reservoir rock. The focus has shifted from macro to micro details. The amount of testing required has shifted from few to multiple data sets. This shift in paradigm has been embraced in some ways but largely not accepted in industry today. The majority of testing performed is basic and the level of detail is insufficient to properly characterize the rock. An integrated approach is proposed to properly investigate the rock and take advantage of multiple tests required. The collaboration of multiple data sets is a powerful tool that must be used to investigate the fine-grained rock samples that comprise our reservoirs today.

Introduction

Traditional reservoirs of 20 years ago had porosity values of 5% to >15% with permeability values of 5 to >100 md. This is no longer the case for the reservoirs explored today. Cuttings analysis and/or basic petrology were the standard for studying and understanding conventional reservoirs. This standard suite of tests proved effective for describing high porosity, coarse-grained samples but is inadequate when confronted with low porosity, fine-grained rock samples. The micro-textures of these fine-grained rocks require detailed analysis just to attain the basic information. New factors have also arisen in these rocks (e.g. fracability, etc.) that require attention, along with older well know issues (e.g. water-sensitive clays, etc.). The commutative amount of data that is required to understand these samples at a basic level demands more and higher detailed testing.

Theory and/or Method

Over years of study, it has become apparent those variations in micro-textures, and their proper identification, play a critical role in proper reservoir characterization. Important features such as microporosity, nanoporosity, micro-fractures, fracability, etc. require a different suite of tests that is a departure from the standard testing of the past. The majority of testing that was done, and is still done today, is still somewhat basic (mainly visual petrographics with occasionally x-ray diffraction and/or porosity/permeability data) with the more detailed testing reserved after formation damage has occurred (to mitigate losses) or if another problem has arisen.

These critical micro-features cannot be understood using basic analysis and requires integrating these data sets with petrology: x-ray diffractometry(XRD), scanning electron microscopy (SEM), porosity/permeability (CMS-300 or TRA), backscatter electron microscopy (BSE), mercury injection capillary pressure (MICP), elemental mapping, TOC and Rock Eval. The collaboration of these tests

with petrographic analysis creates a powerful analytical tool, useful for identification of water-sensitive clays and their distribution, natural micro-fractures and their distribution, effective sealing pressure of micro-fractures, percentage of microporosity vs. fracture porosity, micro-compositional changes, distribution of pore throat sizes, maturation state of the rock samples, etc. and most importantly how they affect each other. Each test has specific limitations and weakness which must be understood to gain proper and useable data. The advantage of integrating the data sets is that the strengths can be used together to minimize individual weakness. Each data set can be overlayed and cross-checked and therefore interpretations can be verified. The types of tests listed are not new in the industry but, surprisingly, are not regularly used and especially not integrated.

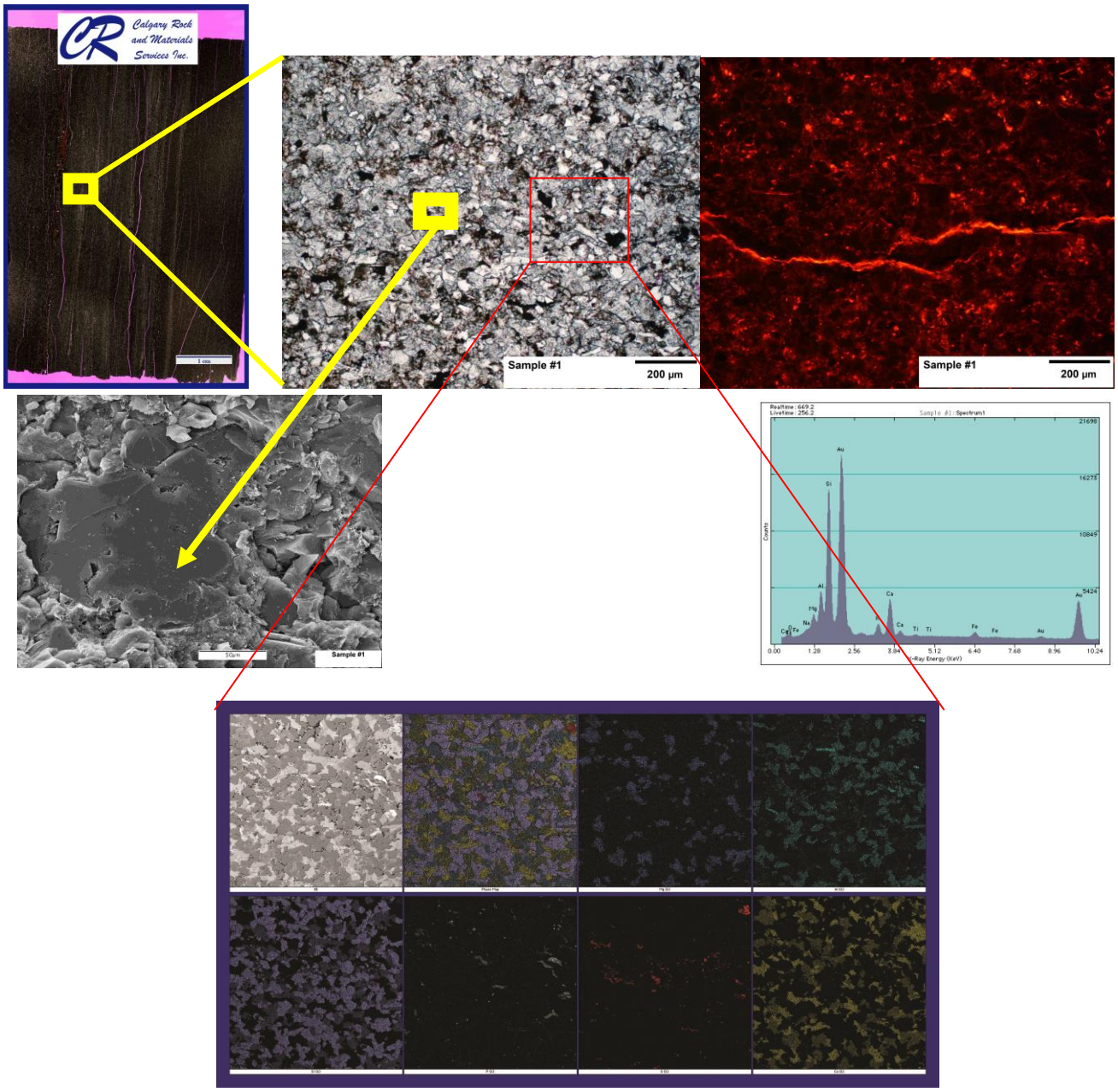

Figure 1: The integrated approach of thin section microscopy, SEM with EDS analysis, and elemental mapping.

Conclusions

The rocks tested today and the data required from them are far more complex and detailed when compared to the rocks tested in the past. An integrated approach will reduce technical risk and further understanding of fine-grained rocks. The additional testing comes with higher costs per sample, however will there is also cost that comes with unnecessary expenses and/or failed production. The collaboration of multiple tests ensures the confidence to understand the rock and make the appropriate decisions. Always bring to bear the tests required to answer the questions that are posed.

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