



CSPG ROCK ANALYSIS WORKSHOP

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Mineralogy of Unconventional Reservoirs: Comparison of Rock Analyses from Different Analytical Techniques

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Summary

Determination of the mineralogy of unconventional reservoir rocks is paramount to the understanding of reservoir properties. Mineralogy and mineral fabrics are two of the parameters that petrophysicists rely on to determine these. Here we compare mineralogy data obtained from X-Ray Diffraction (XRD), X-Ray Fluorescence (XRF) and point counts.

XRD is the preferred method for most geologists working on unconventional reservoirs and there is a very large XRD data base. We find commercial XRD analyses to be intermediate in cost, preparation and analytical time compared to the other methods. There are different opinions as to whether XRD should be considered a quantitative, semi-quantitative or qualitative technique. Standard XRD powder diffraction was developed as a qualitative method for mineral identification and has been used as such for the last roughly 100 years. Reference intensity ratio methods, known amounts of minerals added to the sample, yield more quantitative results. The Rietveld method requires crystal structure information, generally unknown, may give more quantitative results. Rather than go through the scientific intricacies involved we choose a practical approach and compare sets of XRD mineralogy data obtained from the same samples by different labs. These data clearly demonstrate that commercial XRD mineral determinations are not reliable.

The development of portable XRF instruments over the last decade provides a means for rapid and inexpensive determination of the chemical composition of rocks. Determination of mineralogy from elemental chemistry was introduced by Cross, Iddings, Pirsson and Washington who developed the CIPW Norm in the early 1900s. It is based on typical minerals that precipitate from an anhydrous igneous melt at low pressure. Major elements in these igneous rocks are present in minerals as oxides and these are combined to determine mineral abundances. Sedimentary rocks are far more complicated chemically than igneous rocks; many are not composed of simple oxides and contain complex mineral assemblages. The CIPW Norm is not appropriate for determination of the mineralogy of sedimentary rocks. Normative mineral algorithms for sedimentary rocks such as MINLITH or SEDMIN are generally unsuccessful in determining mineralogy because mineral compositions are under constrained. The distribution of both major and



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trace elements in various minerals can be applied to arrive at mineralogy determinations by optimizing mass balances for each element.

Preparation of thin sections is somewhat time consuming; however, the total cost of preparation and obtaining point count data from conventional thin sections is low and the data quality is quite good. Unfortunately, the point count data base for unconventional reservoirs is relatively small. The fine grained nature of many unconventional reservoir rocks require higher resolution than possible using an optical microscope. Point counts from SEM images of these rocks provide not only reliable compositional data, but also fabric information. These analyses are quite valuable, but also quite time consuming and costly.

Comparison of the data from different instrumental methods point to the use of a combination of these in order to obtain reliable mineralogy information.