

ANALYTICAL UNCERTAINTY IN TOC AND ROCK-EVAL MEASUREMENTS OF ORGANIC-RICH ROCKS – INSIGHTS FROM RECENT ROUND ROBIN TESTS

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Introduction

To gain quantitative understanding of analytical uncertainties associated with data used for source rock screening, organic carbon analysis and Rock-Eval pyrolysis were performed on nine rock samples of different ages and from different geographic areas at six geochemical laboratories worldwide. Each sample was carefully homogenized before aliquots were sent to the laboratories. Each sample was analysed twice under coded names at each laboratory several months apart. Analytical uncertainty associated with laboratory selection and analytical precision at each laboratory was assessed using results from these analyses.

Results

TOC measurements from most of the laboratories are reliable and comparable. The analytical uncertainty associated with laboratory selection are typically <0.5% TOC, when measured TOC is less than 5%, and are <1% TOC when measured TOC is between 5-10%. Analytical precision at a single laboratory is generally within $\pm 0.5\%$ TOC or $\pm 5\%$ of the measured TOC.

Rock-Eval pyrolysis results are more laboratory-dependent. S1 values should generally be used with caution. Large uncertainties (100-200% of measured S1) are typically associated with these data, both between laboratories and in single laboratory analytical precision.

S2 measurement also appears heavily laboratory dependent. Errors associated with using different laboratories are typically 40-55% of the measured S2 values. Analytical error in data from a single laboratory is relatively small, often on the order of $\pm 10\%$ of the measured S2 values independent of organic richness. As a result, relative oil- and gas-proneness of a series of samples analysed by the same laboratory can still be established with reasonable confidence.

S3 analysis results indicate that S3 values generated by different laboratories are hardly comparable and often carry large differences (50-100% difference). However, S3 values generated on different samples within a single laboratory should still be useful for comparative study. The errors associated with a single laboratory analytical precision are less than 1mg/g or <50% of the measured S3.

Tmax data generated by different laboratories on the same sample differ commonly by 10 to 25°C. Analytical precision at a single laboratory is often within $\pm 10^\circ\text{C}$. For samples with S2 < 1 mg/g, the error range is greater. Tmax data is recommended to be used only qualitatively or as a tool to establish a trend. Quantitative interpretation based on individual data points is not supported by analytical precision, especially for samples that are marginally mature to mature.

Derived source rock parameters such as hydrogen index, oxygen index and production index compound the errors in S2, S3 and TOC.

Hydrogen index values generated by different laboratories for the same sample can be significantly different and are not directly comparable in many cases (typical error 35-40% of the calculated average HI). Analytical precision at each laboratory, although often between 50-100mg/g on average (or $\pm 10-15\%$ relative error), does not appear to prohibit source rock characterization most of the time.

Oxygen index values produced by different laboratories may also have large errors depending on the laboratory used ($\sim 50\%$ to $\sim >100\%$ of the average calculated OI). OI data generated by a single laboratory for the same samples are fairly repeatable ($\pm 10-20\text{mg/g}$ absolute error or $\pm 50\%$ relative error most of the time). In both cases, the analytical uncertainties do not impose a serious threat to data interpretation.

Production index values calculated using S1 and S2 carry uncertainties in the range of 0.05 – 0.10. Analytical precision at a single laboratory are within ± 0.05 in most cases. The analytical uncertainties should not be a concern most of the time, but should not be used alone for maturity assessment when the reported PI is in 0.15 – 0.25 range.

Conclusions

Based on results from this study, TOC analysis can be performed in most geochemical laboratories precisely and with little variation between laboratories. Because Rock-Eval pyrolysis is more sensitive to the analytical laboratory used, we recommend having Rock-Eval pyrolysis performed only at one laboratory for any given batch of samples or project, if possible, to avoid introducing large analytical uncertainties related to the mixing of data from multiple laboratories.

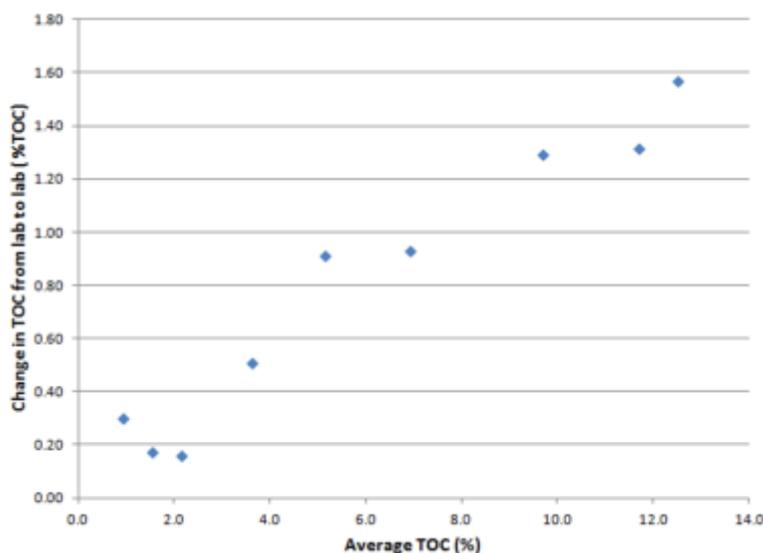


Figure 1 Change of TOC associated with laboratory selection. The y-axis is calculated as maximum TOC minus minimum TOC for a single sample analysed at the 6 different laboratories. The x-axis is the average TOC for a single sample calculated using the data from the 6 different laboratories.

References

Weiss, H.M., Wilhelms, A., Mills, N., Scotchmer, J., Hall, P.B., Lind, K. and Brekke, T. (2000): NIGOGA: The Norwegian Industry Guide to Organic Geochemical Analyses [online], Edition 4.0, May, 2000.