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Raman spectroscopy: a novel method for determining the thermal maturity of organic matter in sedimentary rocks

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Over the last decade, an increasing number of studies have demonstrated the effectiveness of Raman spectroscopy for estimating the thermal maturity of organic matter (OM) in sedimentary rocks. A number of Raman parameters display a strong relationship with maturity proxies commonly used in the oil and gas industry, such as vitrinite reflectance (VR) and Rock-Eval pyrolysis. The benefits of Raman spectroscopy are that it is a low-cost, fast, easy and non-destructive tool, that has potential to be deployed using a portable instrument in the field or at well site.

Nonetheless, there remains no consensus on the best methodology for Raman spectroscopy analysis, as many authors have developed unique techniques and methodologies for specific temperature ranges that are convoluted and create unnecessary bias. Henry et al. (2018) developed a rapid, easy and simple Raman method that does not involve complicated and biased deconvolution of spectra, and successfully applied this to the characterization of OM that had been heated to high enough temperatures to generate oil and gas (c. 60–250 °C).

Here, we present a suite of Raman results acquired using a desktop and a portable Raman instrument, employing Henry et al.'s (2018) method. Results are compared to VR and Rock-Eval pyrolysis data from the same or adjacent samples. Out of several Raman parameters tested, the G-band full-width at half-maximum (G-FWHM) is demonstrated to be the best Raman parameter to determine the thermal maturity of OM in the oil and gas windows, and has a strong correlation with VR and Rock-Eval pyrolysis results. Portable Raman results are more scattered than those generated by the laboratory instrument, but a clear trend is apparent and further work is being undertaken. Discrepancies in the desktop vs. portable Raman spectroscopy results may be due to multiple factors, such as the laser spot size (point vs. bulk analysis) and different instrumental conditions. A reliable portable Raman method will allow geologists to perform analysis on-site during drilling, offering rapid quantitative maturity evaluation, an important parameter for identifying "sweet spots" in shale gas/oil reservoirs.

Henry, D.G., Jarvis, I., Gillmore, G., Stephenson, M., Emmings, J., 2018. Assessing low-maturity organic matter maturity in shales using Raman spectroscopy: Effects of sample preparation and operating procedure methodology. International Journal of Coal Geology, 191, 135-151. doi: 10.1016/j.coal.2018.03.005.