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Assessing kerogen maturity using laser Raman spectroscopy

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Vitrinite reflectance (VR) is considered to be the "gold standard" for assessing the maturity of petroleum source rocks, but it has long been recognized that it may produce unreliable results for dispersed organic matter in mudrocks, due to poor sample preparation, misidentification of primary vitrinite, and due to the suppression and/or retardation effect, caused by macerals with high hydrogen concentration (e.g. liptinites, amorphous organic matter and hydrogen-rich vitrinites), different lithologies, and overpressured basins. This project assesses the application of Raman spectroscopy to determine the maturity of organic-rich mudrocks by implementing a multidisciplinary approach combining VR, other petrographic thermal alteration indices, Rock-Eval pyrolysis and sedimentology. The novelty of the Raman method is that it can be used on all kerogen types and can be applied to pre-Devonian and deep-buried mudrocks with rare or absent vitrinite; analyses can also be performed on unprepared rock chips and drill cuttings. Our results show that several Raman parameters have great promise in determining the maturity of organic matter, and correlate extremely well with VR. Calibration curves constructed using well-characterised samples of Carboniferous shales from northern England and the Midland Valley of Scotland (the main targets for shale gas exploration in the UK), and old Torridonian shales from Scotland, have been successfully applied to determine the maturity of wells elsewhere in the areas, demonstrating the applicability of the tool. A fast and easy, automated method for Raman analysis will be presented that enables the acquisition of large data sets very quickly. Calibration curves are currently being refined and implemented on a wide range of sample sets of different ages in different basins. Overall, Raman spectroscopy provides a powerful additional technique in the geologist's tool kit to quantify the maturity of organic matter early in a field's lifecycle in order to help determine sweet spots. Analysis can be performed on-site or potentially even downhole during drilling, offering great potential for the rapid characterization and development of non-conventional petroleum reservoirs.