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Molecular weight fractionation as a geochemical index; a new approach to predict the shale gas decline trend and estimated ultimate recovery (EUR) in unconventional gas reservoirs

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Efficient exploitation of shale gas reservoirs requires several key areas of understanding; how gas is stored within the shale, total gas in place (GIP) and location on the estimated ultimate recovery curve (EUR). Calculating gas extraction percent on an EUR curve early in well production history facilitates economic field appraisal including well spacing, refracking and use of infill drilling. Unconventional gas plays can thus be optimized in terms of economic analysis, risk mitigation and well lifecycle forecasting. We are testing the hypothesis that molecular weight fractionation between C1-C2 is a viable geochemical index to predict percent of total GIP extracted and thus location on the EUR.

In shale gas plays, gas is stored within a heterogeneous, organic and inorganic matrix and with tortuous networks of macro to nanoscale pores. Gas can be stored adsorbed onto pore surfaces or absorbed into the matrix of solid shale components. As such, determining total GIP for unconventional shale gas reservoirs cannot accurately be calculated using petrophysical techniques employed for conventional gas plays.

We hypothesise that molecular weight fractionation of C1 and C2 during depressurization can be used as a geochemical marker for gas stored in different sites within the shale, cumulating in both accurate total GIP calculation and EUR curve location prediction. We developed a custom-built sample cell and online gas chromatography – flame ionising detector (GC-FID) system to study C1-C2 fractionation during depressurization. Effects of shale mineralogy on molecular weight fractionation were explored using samples representing key shale constituents. Shale samples - Eagle Ford, Edale and West Lothian Shales and Oxford Clay at varying levels of maturation - were subsequently tested.

Results indicate that C1-C2 fractionation is almost completely controlled by organic matter, highlighted by pure constituents and replicated in real shale samples with varying TOC content. Kerogen type, content and maturity were shown to effect the C1-C2 ratio during depressurisation whilst inorganics have neglibile effects. As a result, if the TOC of a shale is know, a unique geochemical C1-C2 fractionation trend is expected with % gas extracted of the total GIP. Calculating the position on the EUR curve is thus possible which in turn guides field production assessment and economic analysis of the play. The source of the shale gas can also be deterimened; is the gas truly stored in shales or is it residing in fine sands/silts. This assessment mitigates economic risk and aids in field development planning especially in areas such as the UK where drilling localities are restricted.