Deciphering the Isotopic Code: A New, Online Technique for Measuring Carbon Isotope Fractionation in Shale Gas

Ruth J. Davey[1], Mark Sephton[1], and Craig Smalley[1]

[1]Earth Science and Engineering, Imperial College London, LONDON, United Kingdom.

ABSTRACT

Various aspects of the exploitation of shale reservoirs, whether for hydrocarbon extraction or carbon storage, depend strongly on understanding how the gas is situated at a pore scale within the shale: for example in (isolated) macropores, micropores, adsorbed onto the surfaces of pores or absorbed into the matrix of solid shale components. We are testing the hypothesis that gas compositional and isotopic fractionation during depressurization can be used as a marker for gas stored in these different sites within the shale. One aspect of this is investigating how variables such as the composition or shale organic and inorganic constituents, thermal maturity and the size distribution and tortuosity of the pore system influence carbon isotope fractionation during shale gas production. We developed a custom-built sample cell and online gas chromatography – combustion – isotope ratio mass spectrometer (GC-C-IMRS) system to study methane isotope fractionation during progressive depressurization. The effects of shale mineralogy on methane carbon isotope fractionation of shale gas was explored using artificial samples designed to represent key shale constituents; measurements on kaolinite, montmorillonite, calcite, quartz and anthracite are reported here. Matrix mineralogy was identified as a key control on isotopic fractionation. Each specific mineral group produces its own distinct carbon isotope fractionation trend. For example, high surface-are minerals such as clays display significantly greater isotope fractionation during depressurization than calcite. These preliminary findings demonstrate the ability to generate high-quality data (± 0.5 ‰ 2σ), as well as illustrating the potential of this method for understanding gas-shale interactions of importance for industrial applications. This method will be used in future work to investigate independently each variable that may affect carbon isotope fractionation in shale gas reservoirs.