Oil-water exchange, degassing, and cracking of oil traced by noble gases in the Eagle Ford Shale

D. J. BYRNE[1], P. H. BARRY[1], M. LAWSON[2], S. BECKER[2], D. J. HILLEGONDS[1], C. J. BALLENTINE[1]

[11] Department of Earth Sciences, University of Oxford, UK
*Correspondence email: david.byrne@earth.ox.ac.uk
[2] ExxonMobil Upstream Research Co., Spring, TX, USA

Unconventional hydrocarbon resources are organic rich source rocks that have retained a significant portion of their hydrocarbon inventory post generation. As such, they provide an opportunity to characterize the geochemical properties of hydrocarbons prior to migration, accumulation or alteration. However, fluid flow within these low permeability systems is poorly understood. This is applicable to both hydrocarbons generated within these rocks and potentially to any fluids that are migrating up from greater depths.

The regional stratigraphic dip of the Cretaceous Eagle Ford shale gives rise to a range in thermal maturity of the formation from main stage oil window to dry gas. We present here stable isotope and noble gas data (n=10) to investigate the physical behaviour of hydrocarbon fluids during generation and storage at these different stages of maturity [1, 2].

Atmospherically derived [^{20}Ne] and [^{36}Ar] correlate with the δ^{13}C of co-existing methane, a typical indicator of source rock maturity. Using a Rayleigh-distillation model of the evolution of δ^{13}C with methane production [3], we show that the dilution of the atmosphere-derived noble gases is coupled with the maturity of the samples. Atmospheric ratios cannot be explained by hydrocarbon-water partitioning alone. Instead, noble gas concentrations and both atmospheric and radiogenic elemental ratios appear to reflect oil-water exchange, degassing of oil and the progressive dilution of the initial inventory of atmosphere-derived noble gases during the cracking of oil to gas.

[1] Ballentine et al., 1996, *GCA* **60:5**, [2] Barry et al., 2016, *GCA* **194,** [3] Rooney et al., 1995, *Chem Geol* **126:3**

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