Assessing Geochemical Tools to Resolve Origin and Trace Migration of Unconventional Gas in the U.K.

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A number of environmental concerns have been raised by the rapid development of unconventional gas resources worldwide, particularly over contamination of groundwater resources potentially induced by the hydraulic fracturing process. Elevated methane concentrations in groundwater have been reported in areas of gas extraction [1], however categorically connecting this to fugitive emissions directly from gas production has been problematic [2].

This issue is compounded by the presence of naturally occuring gases in the shallow subsurface, limited baseline measurements, and equivocal interpretations of limited geochemical data. Traditional techniques for assessing the sources of hydrocarbon contamination rely on bulk composition and isotopic ratios of hydrocarbons (.e.g. $d^{13}C_{CH4}$), but these original signatures can be masked by gas transport and microbial processes.

Radiocarbon is able to resolve between recent and fossil sourced gases in shallow groundwaters. Noble gases (He, Ne, Ar, Kr, Xe) are chemically inert and only affected by physical processes, thus uncoupled from the biosphere. The unique elemental and isotopic composition of their natural sources has been utilised to successfully trace the movement of gases and reveal transport mechanisms in the subsurface [3]

We will present a critical analysis of the effectiveness of $d^{13}C_{CH4}$, radiocarbon and noble gas fingerprints in detecting the migration of gases from both conventional and unconventional hydrocarbon sources in the U.K., including conventional natural gas, coal bed methane, abandoned mine methane and shale gas to the shallow subsurface.

Further, we combine these fingerprints to resolve the origin of methane originating from a natural intertidal seep, and a regional aquifer which is naturally high in CH_4. This allows assessement of how these techniques can be effectively used to monitor for unplanned migration of CH_4 related to future UK unconventional gas exploitation.

[1] Osbourn et al., (2011), PNAS 108, 8172–8176, [2]Baldassare et al. (2014), AAPG Bull. [3] Darrah et al. (2014), Nat. Acad. Sci. v.111, No.39.