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The Noble Gas Fingerprint in a UK Unconventional Gas Reservoir

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In the last decade, there has been an unprecedented expansion in the development of unconventional hydrocarbon resources. Concerns have arisen about the effect of this new industry on groundwater quality, particularly focussing on hydraulic fracturing, the technique used to increase the permeability of the targeted tight shale formations. Methane contamination of groundwater has been documented in areas of gas production[1] but conclusively linking this to fugitive emissions from unconventional hydrocarbon production has been controversial[2]. A lack of baseline measurements taken before drilling, and the equivocal interpretation of geochemical data hamper the determination of possible contamination.

Common techniques for "fingerprinting" gas from discrete sources rely on gas composition and isotopic ratios of elements within hydrocarbons (e.g. $\delta^{13}C_{CH4}$), but the original signatures can be masked by biological and gas transport processes. The noble gases (He, Ne, Ar, Kr, Xe) are inert and controlled only by their physical properties. They exist in trace quantities in natural gases and are sourced from 3 isotopically distinct environments (atmosphere, crust and mantle)[3]. They are decoupled from the biosphere, and provide a separate toolbox to investigate the numerous sources and migration pathways of natural gases, and have found recent utility in the CCS[4] and unconventional gas[5] industries.

Here we present a brief overview of noble gas data obtained from a new coal bed methane (CBM) field, Central Scotland. We show that the high concentration of helium is an ideal fingerprint for tracing fugitive gas migration to a shallow groundwater. The wells show variation in the noble gas signatures that can be attributed to differences in formation water pumping from the coal seams as the field has been explored for future commercial development. Dewatering the seams alters the gas/water ratio and the degree to which noble gases degas from the formation water. Additionally the helium and neon isotopic signatures exhibit a small but resolvable mantle input previously unseen onshore in the United Kingdom. We will outline the potential sources of this mantle input.

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