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Resolving fingerprints of unconventional gas sources and methane-rich groundwaters in the Vale of Pickering, UK

REBECCA M CHAMBERS[1], STUART M V GILFILLAN[1], CHRISTOPHER I MCDERMOTT[1], PAULINE SMEDLEY[2] AND ROB WARD[2]

[1]University of Edinburgh
[2]BGS

Presenting Author: Rebecca.Chambers@ed.ac.uk

With the increasing development of geoenergy technologies, including unconventional gas, interest in the constraint of the origin of methane gas, and how its geochemical fingerprint evolves through the subsurface has increased. This renewed interest stems from the potential risk of contamination of potable water sources within shallow groundwater aquifers[1]. Hence, it is key to establish whether deep gas that is released by changes to the subsurface from such technologies can be categorically identified at shallow depths; and distinguished from shallow biogenically derived methane sources.

The Vale of Pickering was identified as a potential target for exploitation of unconventional gas resources. Whilst such exploration has ceased within the UK at present, groundwater and gas samples collected from the region provide an opportunity to establish how geochemical tracers, such as stable isotopes and noble gases, can be used to distinguish hydrocarbon source rocks and identify potential migration of deep gas to shallow aquifer bodies.

Several shallow groundwater and deep gas samples were collected in internally polished refrigeration grade copper tubing in 2019 and 2020. Geochemical analyses of these samples consisted of bulk concentration analysis using gas chromatography to determine gas concentrations, $\delta^{13}C$, δD stable isotope analysis, and noble gases. The aim of these analyses is to establish the source of the methane, and to develop a rigorous and dependable methodology to robustly identify the migration of deep methane to the shallow groundwater.

Our initial results indicate that the dominant gas in all samples is methane, with trace quantities of ethane and propane found in both the deep gas and shallow groundwater samples. Methane from the deep gas samples is predictably of thermogenic origin, with the preliminary methane data obtained from the groundwater samples indicating a biogenic origin.

Using this data we will present a methodology outlining how the migration of deep sourced methane to the shallow groundwaters in the Vale of Pickering can be resolved using geochemical fingerprinting tools, incorporating the likely evolution of gas signatures through migration.

[1] Darrah, Vengosh, Jackson, Warner, Poreda (2014), *Proceedings of the National Academy of Sciences*, 111(39), 14076-14081