Geochemical tracing of groundwater pollution from unconventional gas production

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**Proposed funding:** NERC proposed CASE partnership with SEPA (in negotiation)

**Background:** Much of the controversy surrounding the exploitation of unconventional gas resources (shale gas and coal bed methane) is focused on the potential contamination of potable water supplies in shallow groundwater aquifers. This is particularly the case in the USA and UK, where there is growing public objection to unconventional gas exploitation, particularly around the “fracking” process. However, the evidence of groundwater contamination by produced gas is equivocal. Some studies find no direct causality between fracturing and groundwater contamination. Conversely, there is a developing group of work which suggests that contamination of groundwater1, or induced earth tremors2, certainly have resulted from gas exploitation activities.

In such a commercially active sector a very strong suite of evidence will be needed to enforce litigation, or prosecution of drilling companies. Rival claims can be made that the groundwater contamination is from drilling operations which predate gas exploration, or that observations of hydrocarbon content, including methane gas, in shallow aquifers are due to natural processes unconnected with shale gas exploration. The key aim of this PhD is to identify how different geochemical methods (stable isotopes, noble gases and radiocarbon content) can be used to unequivocally identify the pollution of shallow groundwaters by methane from unconventional gas extraction.

This study will establish a methodology to categorically resolve methane sources in groundwaters and hence determine if pollution by gas extraction has occurred. The work will establish the C and H stable isotope, noble gas composition and radiocarbon content of coal bed methane and shale gas from producing fields and backflow production waters in the UK and USA. These will be compared to the composition of natural shallow groundwaters in regions where pollution is thought to have occurred. Analysis of these samples will provide further understanding of the effectiveness of the different natural tracers in fingerprinting contamination of groundwaters. A similar approach has been successful with tracking natural CO₂ migration to the surface² and disputing allegations of the leakage of man-made CO₂³.

**Methods and Training:** The student will be trained in sediment basin and subsurface geology gas and water geochemical sampling methodology and laboratory analysis techniques for measuring C and H stable isotopes, radiocarbon content and noble gas analysis. Significant sample analysis will be undertaken using existing state of the art experimental equipment at SUERC. Mathematical mixing or diffusion models will reproduce the measurements. Fieldwork to the USA and UK to sample coal bed methane, shale gas and associated groundwaters will be required.

**Facilities:** The student will be based within the School of GeoSciences, at the University of Edinburgh. Facilities for analysis of noble gases and C stable isotopes within gases currently exist at SUERC. New equipment for measuring radiocarbon and H isotopes is planned.

**Industry Links:** This project has been driven by talks with SEPA. The student will be regularly encouraged to consider the economic and technical relevance of their work.

**Applications are invited from UK/EU graduates in Geology, Physics, Engineering, Maths, Chemistry, or similar.**

**References:**