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Groundwater vulnerability to onshore unconventional and conventional hydrocarbon activities in England

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In the last five years there has been a renewed interest in onshore oil and gas in England as new extraction technologies and continued energy demand have allowed for the development of less accessible resources. Until now, shale gas has received most attention in England although exploration licences have also been granted for coal bed methane and mine gas in addition to more conventional hydrocarbon resources. While there is some interest in underground coal gasification there are currently no licences granted.

Potential impacts on groundwater from shale gas operations have been well publicised. Hazards include contamination from spills or leaks of frack-fluids and returned water, at the surface, through leaky wells or via subsurface pathways from the source rock, and the availability of water resources. Groundwater is an important resource in England, providing an average of 31% of water resources in England and Wales, and up to 100% in some areas of south-east England. In its role as the environmental regulator the Environment Agency must manage the risks associated with these hazards, and those associated with other onshore oil and gas activities, so that they are minimised.

Here we focus on the groundwater contamination risk from source rocks though subsurface pathways. Despite the abundant literature emerging from the North American continent there remain great uncertainties as to the risk. These uncertainties are amplified when translated to Europe due to significant policy and geological differences.

Research from North America indicates that risk is influenced by the exploitation and well completion methods and the geological setting, including: pre-existing fracture and fault networks; stress regime; petrological and rheological properties of the rock between the source and groundwater receptor and the distance between the source and receptors. A joint British Geological Survey/ EA project – iHydrogeology (http://www.bgs.ac.uk/research/groundwater/shaleGas/iHydrogeology.html) – identified key shale units and Principal Aquifers (http://apps.environment-agency.gov.uk/wiyby/117020.aspx) in England and Wales. The BGS GB3D model (Mathers et al., 2014) was used to produce maps of these and the separation distance between aquifer-shale pairs. The latter maps show large variations across the country and even within basins for the aquifer-shale pairs. For example, the separation distance between the Bowland shale and Triassic sandstone aquifer varies between < 200 m to > 1,500 m. However it is not yet clear what constitutes a safe separation distance.

Due to the geological variability across England a current project (3DGWV) will address the need to assess risk and uncertainties both conceptually and on a more site-specific scale. The method above will be extended to other onshore hydrocarbons. Conceptual models of these source releases and pathways will be compared in the context of English geology. Another important outcome of the ihydrogeology project was the recognition that the definition of groundwater bodies with respect to the Water Framework Directive might need to be redefined in a UK context, taking into account these new, 3D risks.

In addition to this work the BGS and EA are also conducting one of the first comprehensive baseline monitoring studies in potential shale gas areas and a project looking at the impacts of abandoned wells.

Reference:
Mathers, et al. (2014). GB3D–a framework for the bedrock geology of Great Britain. Geoscience Data Journal, 1(1), 30-42.