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Analysis of the separation of aquifers and potential shale gas source rocks: a national-scale screening study from the UK.

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A number of potential pathways can be identified for the migration of methane and contaminants associated with the shale gas extraction process to aquifers. These include the possible movement of contaminants from shale gas reservoirs that have been hydraulically fractured to overlying aquifers. The risk of contamination of an overlying aquifer is a function of i.) the separation of the potential shale gas source rock and the aquifer, ii.) the hydraulic characteristics (e.g. hydraulic conductivity, storage and hydrogeochemistry) of the rocks in the intervening interval, and iii.) regional and local physio-chemical gradients. Here we report on a national-scale study from the UK to assess the former, i.e. the vertical separation between potential shale gas source rocks and major aquifers, as a contribution to more informed management of the risks associated with shale gas development if and when it takes place in the UK.

Eleven aquifers are considered in the study. These are aquifers that have been designated by the environment agencies of England (Environment Agency) and Wales (Natural Resources Wales) under the EU Water Framework Directive as being nationally important (Principal Aquifers). The shale gas source rocks have been defined on best publically available evidence for potential gas productivity and include both shales and clay formations. Based on a national geological fence diagram consisting of $\sim$80 geological sections, totalling $\sim$12,000km in length, down to >5km in depth, and with a typical spacing of 30km, the lower surfaces of each aquifer unit and upper surfaces of each shale/clay unit have been estimated at a spatial resolution of 3x3km. These surfaces have then been used to estimate vertical separations between pairs of shale/clay and aquifer units. The modelling process will be described and the aquifer, shale and separation maps presented and discussed.

The aquifers are defined by geological units and since these geological units may be found at depths far greater than the typical effective exploitable depth of the aquifers, the separation maps may show potential shale gas source rocks and overlying aquifers in relative proximity even though the exploitable aquifer is much shallower. Consequently, modifications to the mapped base of aquifer are considered and their effect on the separation mapping will be described.