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ReFINE Briefing Note

How far from faults to avoid fracking earthquakes?

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This research is based on the article "Fracking: How far from faults?" by Miles Wilson, Fred Worrall, Richard Davies and Sam Almond. The article was published in *Geomechanics and Geophysics for Geo-Energy and Geo-Resources* and is available for free download at www.refine.org.uk.

What are geological faults?

Geological faults are cracks or fractures in the Earth's crust that form when tectonic forces force layers of rock to slide against each other. Faults vary in length, depth and width, from small faults with millimetres of movement to those at large tectonic plate boundaries with kilometre scale movements accumulated over thousands to millions of years.

What is fracking?

Fracking, or as it's more scientifically known 'hydraulic fracturing', is a process in which rocks are deliberately fractured by high pressured injection of fluids. The hydraulic fractures created allow fluids to flow through the rock more easily. This can be beneficial for the recovery of oil and gas from rocks which don't normally allow oil and gas to flow through them at commercial rates, for example shales. The distance hydraulic fractures extend away from the injection point in the well depends on the injection parameters, the rock type, and the tectonic forces present.

Why should fracking avoid faults?

The sliding movement of rocks along geological faults can result in earthquakes. This sliding movement commonly occurs naturally due to tectonic forces, but in some cases it may be induced by human activities. For example, the 2011 Blackpool, UK, earthquakes were induced by injected fluid reaching a previously unknown geological fault at the Preese Hall fracking site. Induced earthquakes, if they are large enough, could damage buildings and put the public's safety at risk. Furthermore, because some faults allow fluids to flow along them, there are also concerns that if injected fluids reached a geological fault they could travel upwards and may contaminate shallow groundwater resources such as drinking water (Figure 1).

Both of these environmental hazard scenarios require that fracking fluids reach geological faults. Because hydraulic fractures could provide fluid pathways to faults, it is important to understand how far hydraulic fractures extend horizontally and consequently create regulations that minimise the risk of hydraulic fractures reaching geological faults.

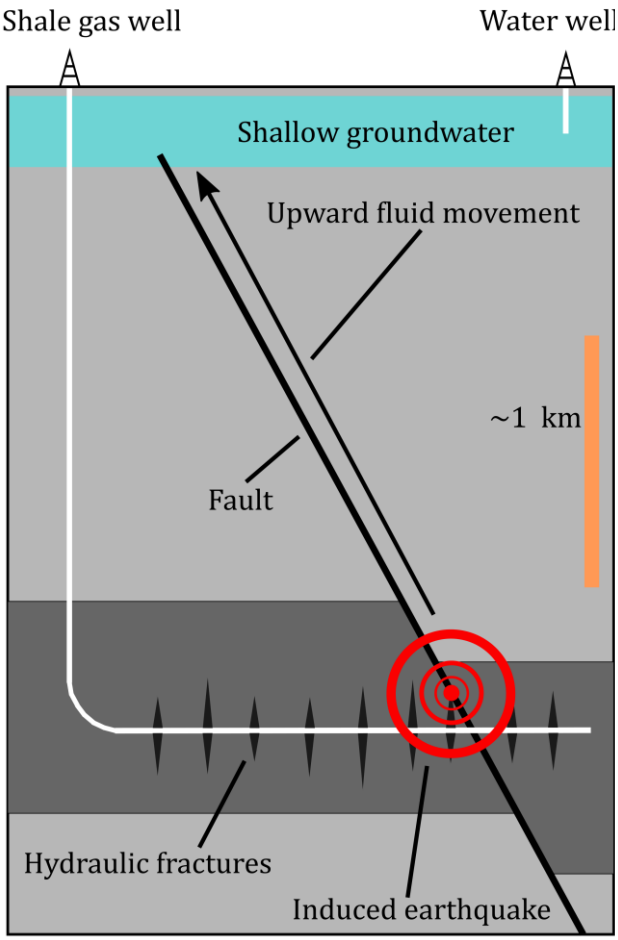

Figure 1: Schematic diagram showing a shale gas well with hydraulic fractures connected to a fault. The interaction of injected fracking fluid with the fault might lead to an induced earthquake or the movement of fracking fluid upwards, where it may contaminate shallow groundwater resources such as drinking water.

How can we predict the extent of fractures from fracking operations?

In 2017 ReFINE researchers used computer software to model the extent of hydraulic fractures from a theoretical fracking operation ('Horizontal respect distance for hydraulic fracturing in the vicinity of existing faults in deep geological reservoirs: a review and modelling study' by Westwood et al., 2017). The results suggested a horizontal distance of 433 m should be maintained between injection points and faults to reduce the risk of the hydraulic fractures reaching faults. Whilst this result is useful, the model was limited by parameters that were kept constant and not varied, for example the amount of fluid injected. Changing these parameters might lead to a different horizontal respect distance. We took a different approach by using hydraulic fracture lengths from documented real-life fracking operations.

How far can hydraulic fractures go horizontally?

For the 109 fracking operations we found documented in scientific literature, the horizontal extent of hydraulic fractures ranged from 59 to 720 m. There were 12 examples of fracking operations where hydraulic fractures extended beyond the 433 m proposed by Westwood et al. (2017). We find that the chance of a hydraulic fracture extending beyond 433 m in shale is 32% and beyond 895 m is 1%. We therefore propose that a horizontal distance of 895 m should be maintained between injection points in fracking wells and geological faults (Figure 2).

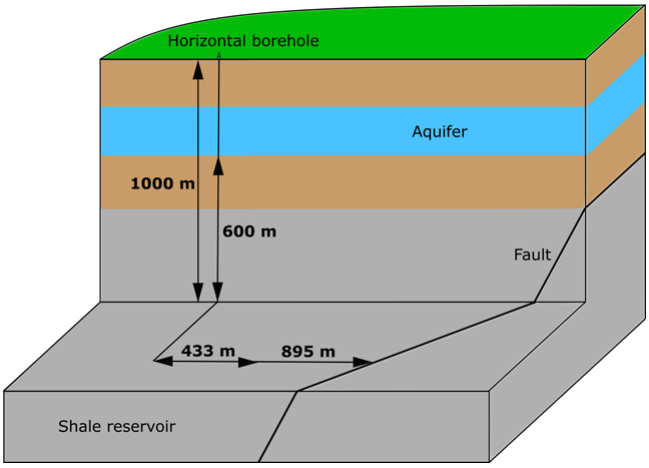

Figure 2: Schematic diagram illustrating: the 1000 m below surface Infrastructure Act (2015), a 600 m vertical respect distance to aquifers, the 433 m horizontal respect distance of Westwood et al. (2017), and the 895 m horizontal respect distance of this study.

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