Risks of environmental contamination from proposed fracking in the Fylde, Lancashire

A short slideshow

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Introduction

Shale is a very common kind of rock, found in all sedimentary basins worldwide. One might consider that fracking shale to produce oil or gas has been a success in the USA. But the shale basins of the UK are very different from those in north America, so the experience from there cannot simply be transferred to here.

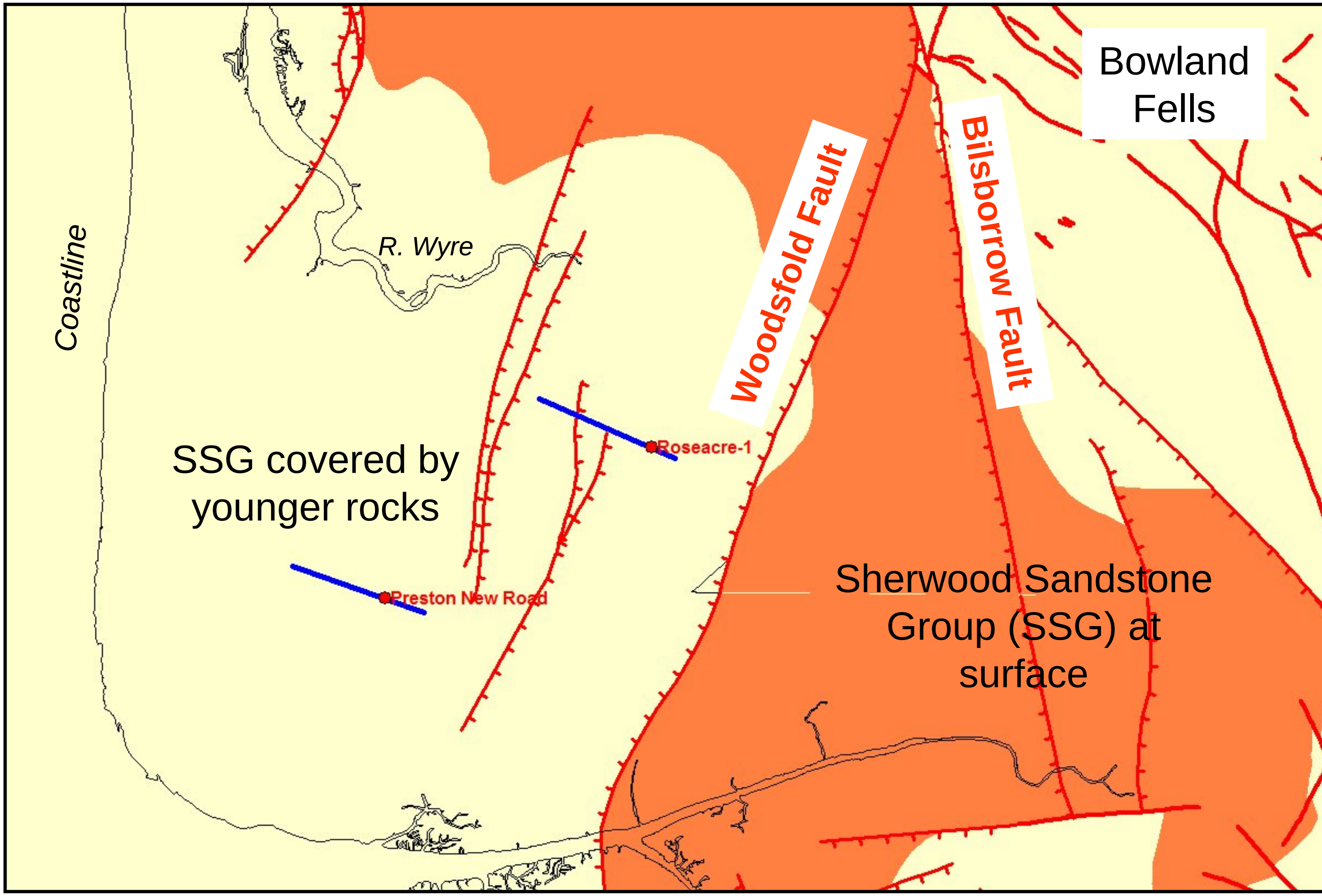
Here the shale is deposited very thickly in narrow faulted basins, often referred to as troughs. The Bowland Basin of Lancashire is an example. Many faults cut through the shale from the older rocks below right up to the surface.

In conventional oil and gas exploration faults are regarded with suspicion, because they may spoil a ‘prospect’ of finding hydrocarbons by acting as a leaky pathway.

The prevalence of faulting within and around the Bowland Basin means that there are many pathways for contaminated water or gas to escape upwards. The focus on the US experience, where faults extending from the shale layer up to the surface are effectively non-existent, is the reason why this problem has been ignored by study groups such as the Royal Society, which has declared fracking to be environmentally safe if ‘well regulated’.

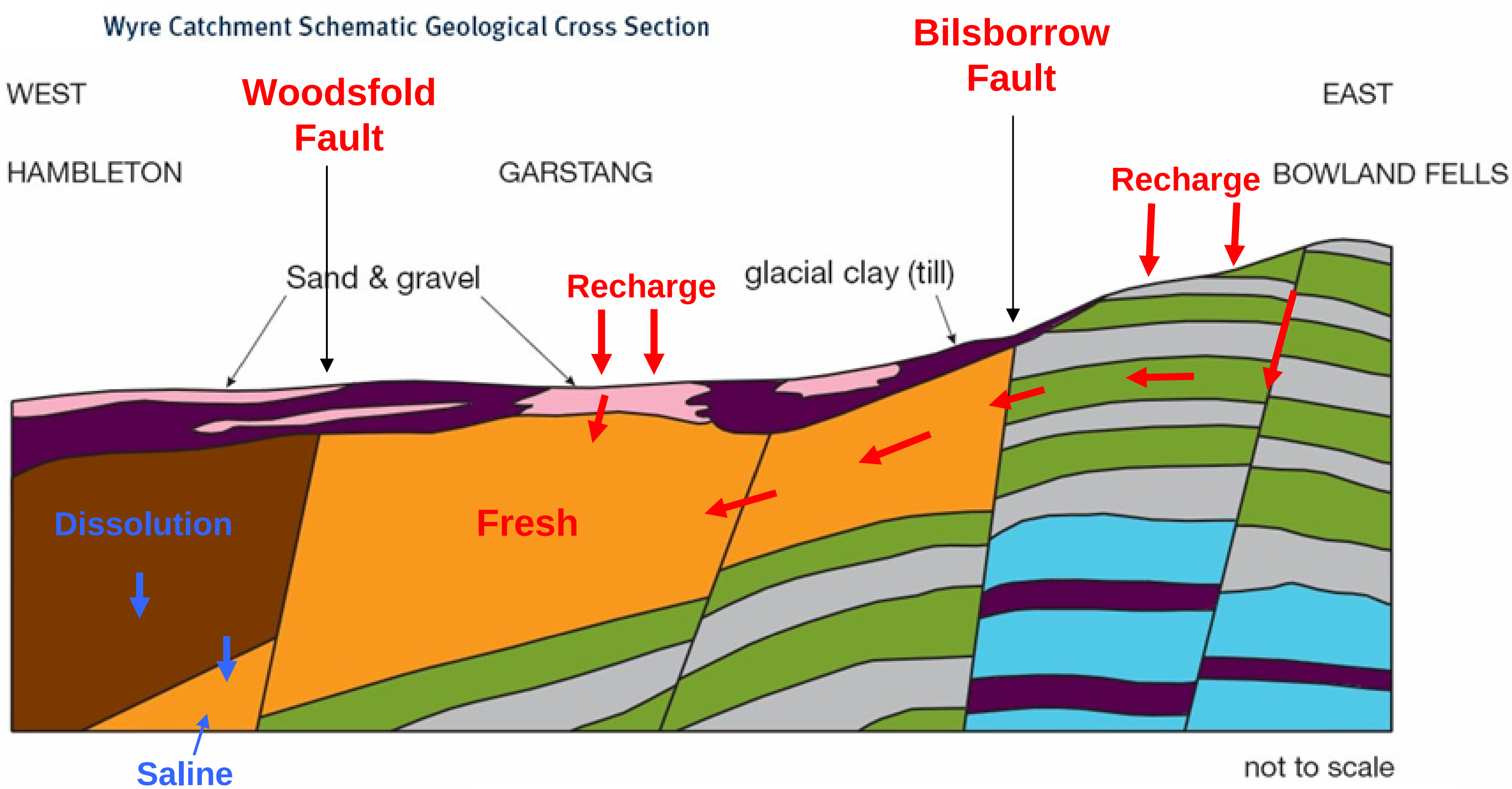
Other factors to consider include whether or not the rock layers overlying the fracked shale can act as a seal, or cap, even if faults are absent, and, not least, whether there exist drinking water aquifers which might be contaminated in the event of leakage.

This slideshow demonstrates that the faulting, together with the poor sealing qualities of the cap rocks, in the Fylde means that there is a real risk of contamination of the most important aquifer in the northwest of England.



Cuadrilla Bowland Ltd has applied to drill and frack for shale gas at Preston New Road and Roseacre Wood. The Sherwood Sandstone Group (SSG) at the surface (orange) is the most important groundwater aquifer in the north of England. Fresh water is fed into it by rainwater and by passage underground, driven by the head provided by the Bowland Fells to the east. But west of the Woodsfold Fault and south of the Wyre the SSG is covered by younger rocks, and the aquifer is highly saline.

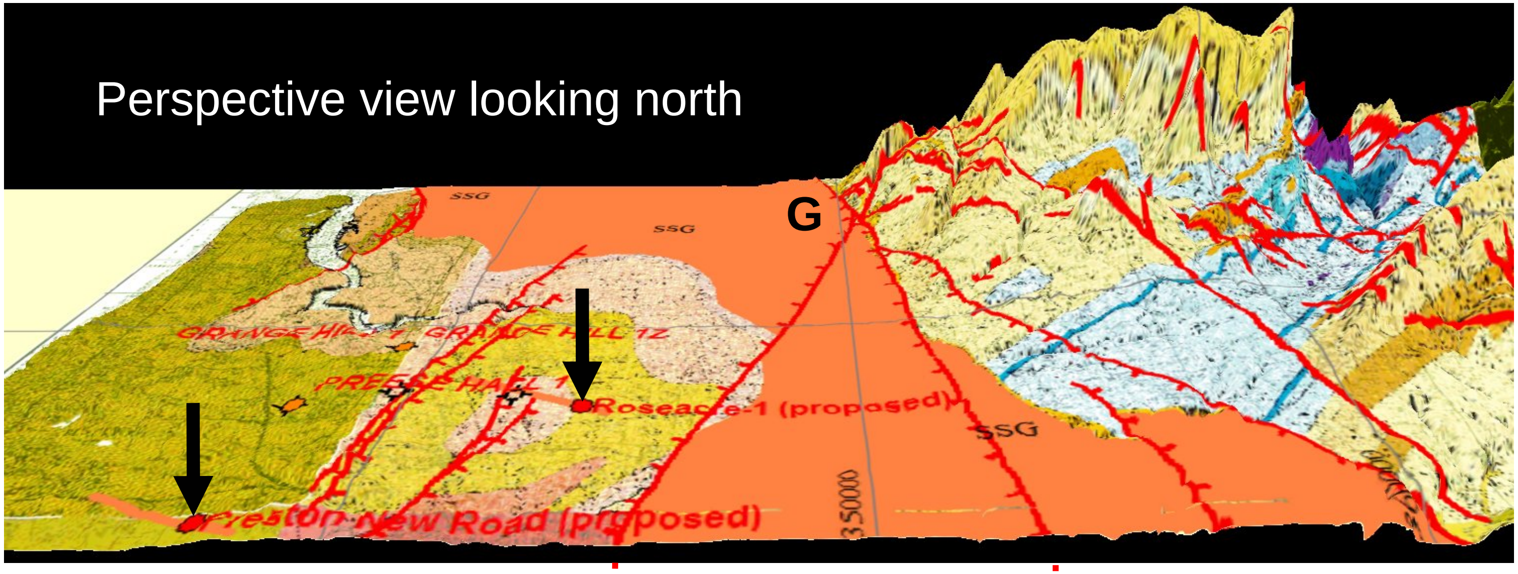
Faults are shown in red, with the teeth on the downthrown side. The Preston New Road drillsite is 7 km from the fault, and Roseacre Wood is less than 3 km from the fault.

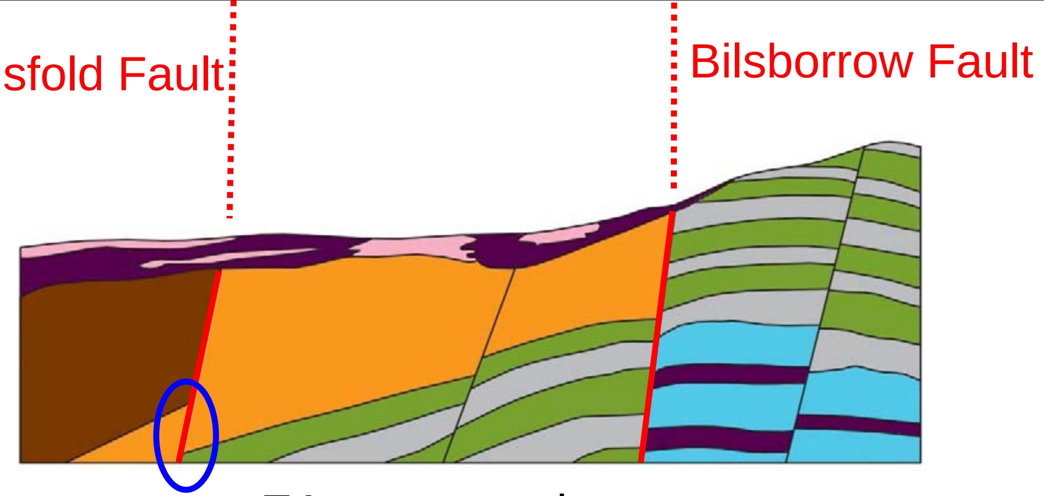


This is a schematic Environment Agency cross section, with additions, running east-west across the area. It shows how the SSG aquifer (orange layer) is recharged with fresh water (red arrows). Note how the Bilsborrow Fault is *transmissive* – water passes through it to recharge the SSG.

West of the Woodsfold Fault the deeper SSG is highly saline (blue arrows and legend). This is due to dissolution of the halites in the overlying Mercia Mudstone Group (brown layer). The EA assumes that the Woodsfold Fault is a barrier to flow, but this is not the case.

In West Cumbria, where the Sherwood Sandstone is at the surface, United Utilities has stated that it targets its water well drilling on the geological faults "*to give the best access to the yields*". In short, the faults are even more transmissive than the sandstone itself.



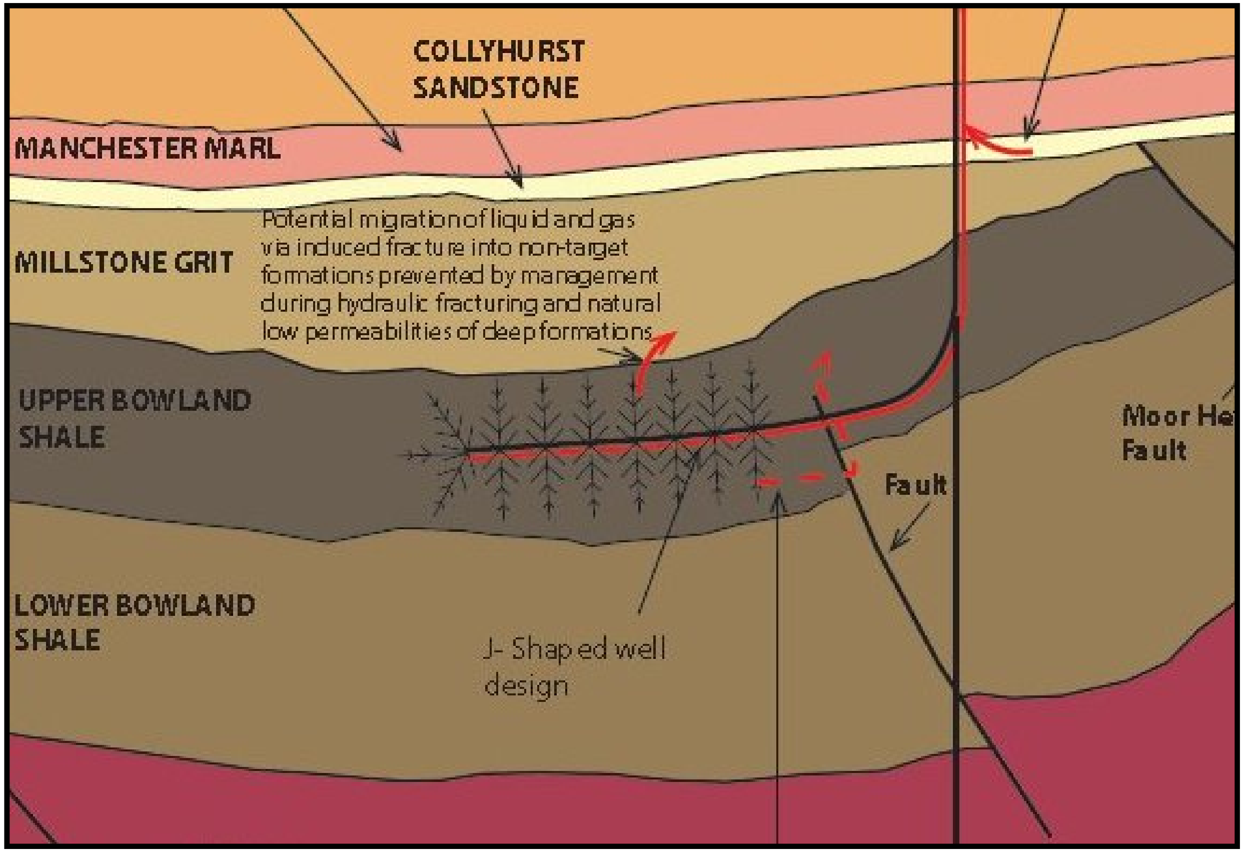


EA cross-section

The perspective view has exaggerated topography to illustrate the higher ground of older Carboniferous geology east of the Bilsborrow Fault. The two proposed well locations on the Fylde plain are shown by black arrows.

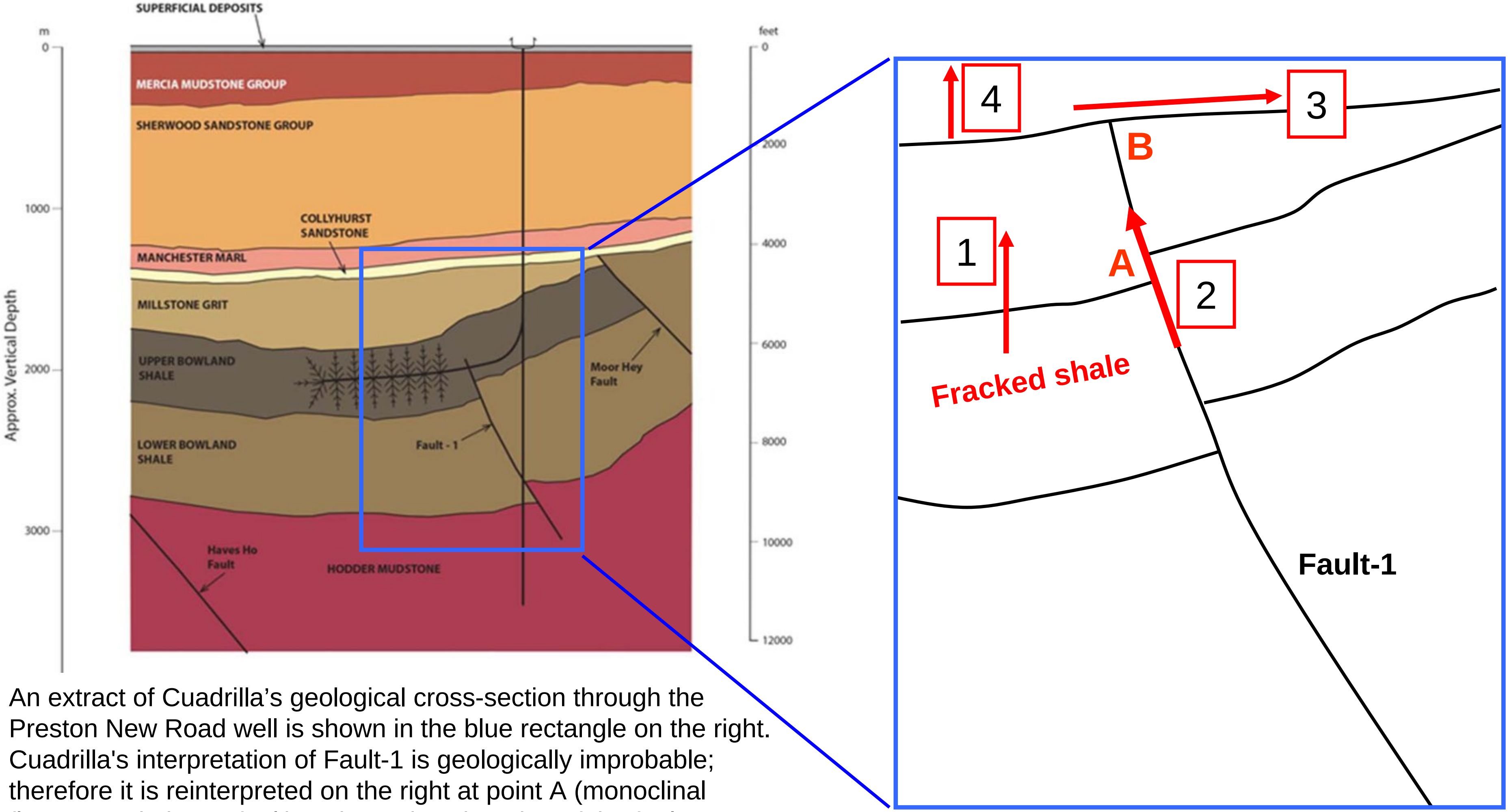
The Bilsborrow and Woodsford Faults diverge southwards from Garstang (G). Since the former fault is transmissive, it is highly unlikely that the latter is a sealing fault, especially in the blue-ringed zone where sandstone is juxtaposed against sandstone.

Preston New Road



This is a Cuadrilla cross-section (blue line in slide 3) purporting to show how potential upward migration of liquid and gas at the Preston New Road site will be "*prevented by management*" during fracking. The horizontal extension of the well is to be drilled through a fault, labelled above, which has been interpreted conveniently to die out upwards within the Upper Bowland Shale. Such an interpretation is unlikely and unconvincing; the seismic data on which this sketch is based have not been released.

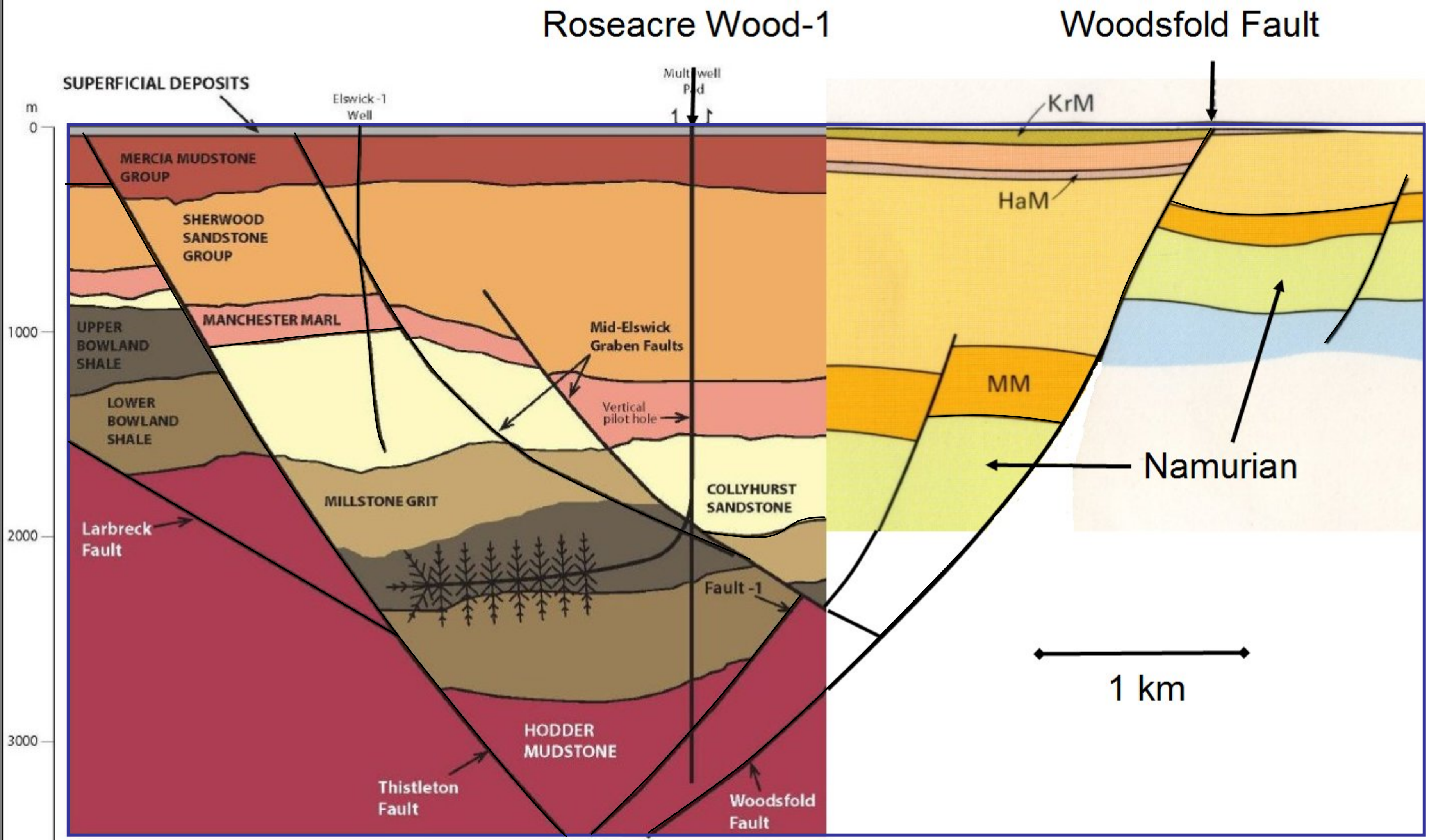
All the layers above the fracked shale, except the thin Manchester Marls, are very permeable. Potential migration pathways on a slightly revised interpretation of the fault geology are shown in the next slide.



An extract of Cuadrilla's geological cross-section through the Preston New Road well is shown in the blue rectangle on the right. Cuadrilla's interpretation of Fault-1 is geologically improbable; therefore it is reinterpreted on the right at point A (monoclinal flexure made into a fault) and at B (continuation of the fault up to the sub-Permian unconformity at the base of the Collyhurst Sandstone).

The numbers in red rectangles beside each arrow refer to likely fluid flow paths:

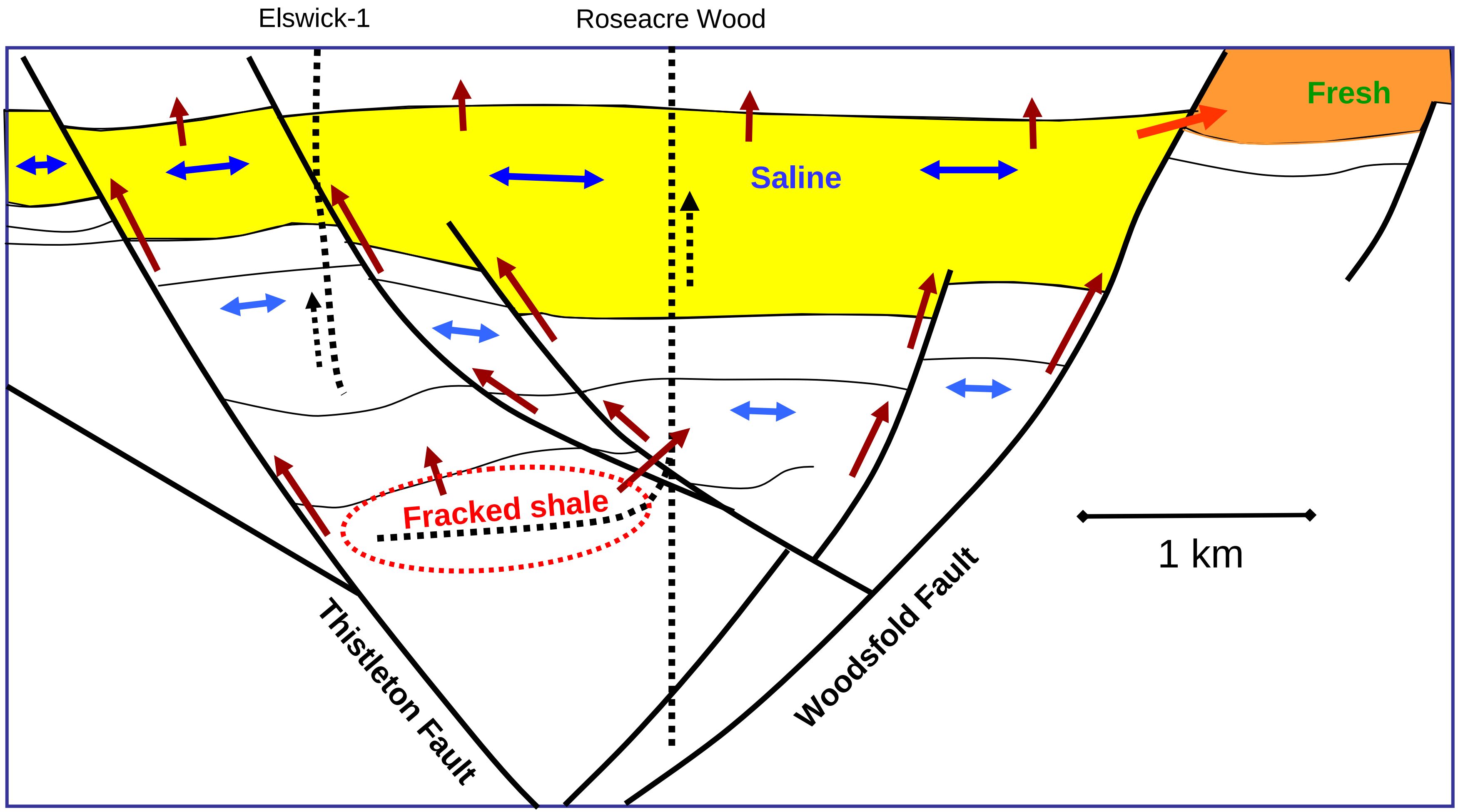
1. Directly upwards from the Upper Bowland Shale into the permeable Millstone Grit Group.
2. Up the transmissive fracture zone of Fault-1.
3. Along the highly permeable Collyhurst Sandstone, generally up-dip to the east, and only partially confined by the Manchester Marls.
4. Directly upwards from all the preceding sources through the Permian and superficial deposits to the surface.



Cuadrilla's interpretation of the geology and proposed fracking at Roseacre Wood (left; blue line in slide 3) extended eastwards using the cross-section from the BGS Garstang map sheet of 1990 (right). The latter is somewhat out of date, in that what the BGS has labelled as Namurian (Millstone Grit) should now be the Collyhurst Sandstone (cream colour). At 2000 m depth the well is only 1 km from the Woodsfold Fault.

The cross-section is clearly highly faulted. In other countries fracking would not be contemplated in such geology.

The next slide shows the potential pathways for contamination.



Potential contamination pathways from the fracked shale zone (red oval) are shown as follows:

- Long brown arrows: up fault zones.
- Short brown arrows: seepage upwards from the fracked shale into the permeable Millstone Grit, and also upwards from the saline Sherwood Sandstone Group (yellow) through the overlying partially permeable Mercia Mudstone Group to the surface.
- Dashed black arrows: passage up and around the margins of the boreholes.
- Double-headed blue arrows: free flow along highly permeable sandstones.

The most dangerous pathway is shown by the red arrow, crossing the transmissive Woodsfold Fault from saline Sherwood (yellow) into the important Sherwood aquifer (orange). Wastewater from fracking will naturally rise because it is less dense than the existing highly saline groundwater west of the Woodsfold Fault. The Mercia Mudstone at the top is today partially permeable because the halite layers, which would have helped to make a good seal, have been dissolved away.

Conclusions

The Environment Agency and Cuadrilla have got it wrong; the fact that the Sherwood Sandstone aquifer in the Fylde is highly saline does NOT mean that it is safe to frack the shales below. There are many connections and pathways for contaminated ‘flowback’ fluid (directly from the fracking process), or for ‘produced’ water (from gas production) to reach the Sherwood aquifer east of the Woodsfold Fault.

Such contamination may not happen overnight after fracking or subsequent shale gas production – it may take several years before it is observed. But once the fresh water aquifer has been polluted it can never be flushed clean again. Even minute quantities of benzene and other fracking by-products, to say nothing of NORM (naturally occurring radioactive material) are enough to render the aquifer permanently unsafe and undrinkable.

Fracking in faulted areas in Germany fracking is banned as a precautionary principle to avoid possible contamination; in the USA, the faults sometimes found at depth are avoided on economic grounds, because they reduce the efficiency of the fracking process. In France and Bulgaria, and in several states of the USA, fracking is simply banned altogether because of the environmental risks.

My technical submissions to Lancashire County Council provide all the detail to back up this summary. In my view the environmental risks of allowing even test fracking in the Fylde outweigh the alleged benefits.