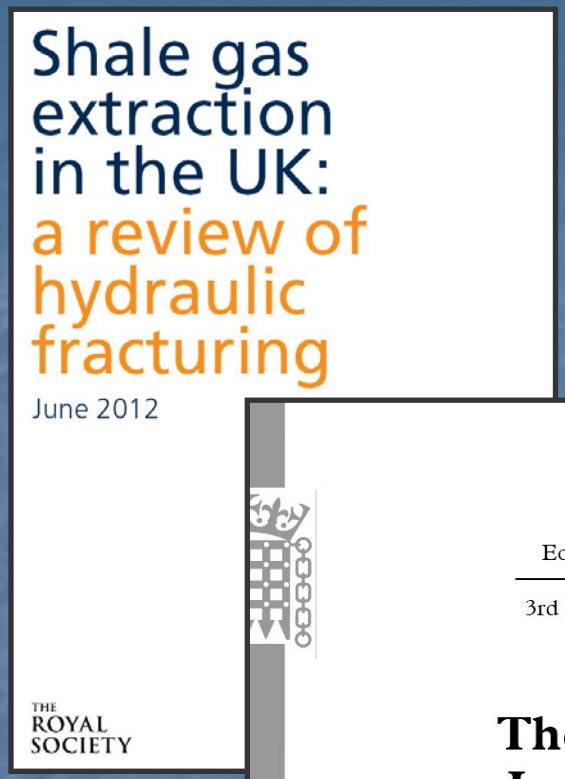
Planning application no. LCC/2014/0101 by Cuadrilla Bowland Limited to drill at Roseacre Wood, Lancashire:

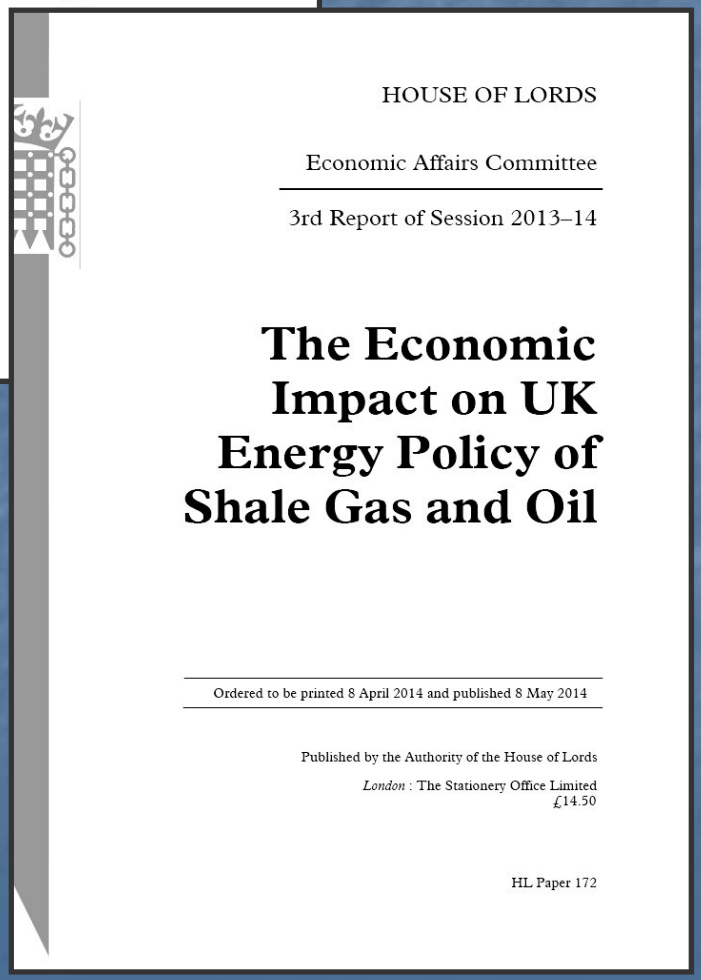
Objection on grounds of geology and hydrogeology

by

Professor David Smythe

Emeritus Professor of Geophysics, University of Glasgow





House of Lords

Unelected committee included Nigel Lawson; heavily loaded towards pro-frackers.

My submission criticised the Royal Society report (Chair Prof Robert Mair).

Committee found time to interview:

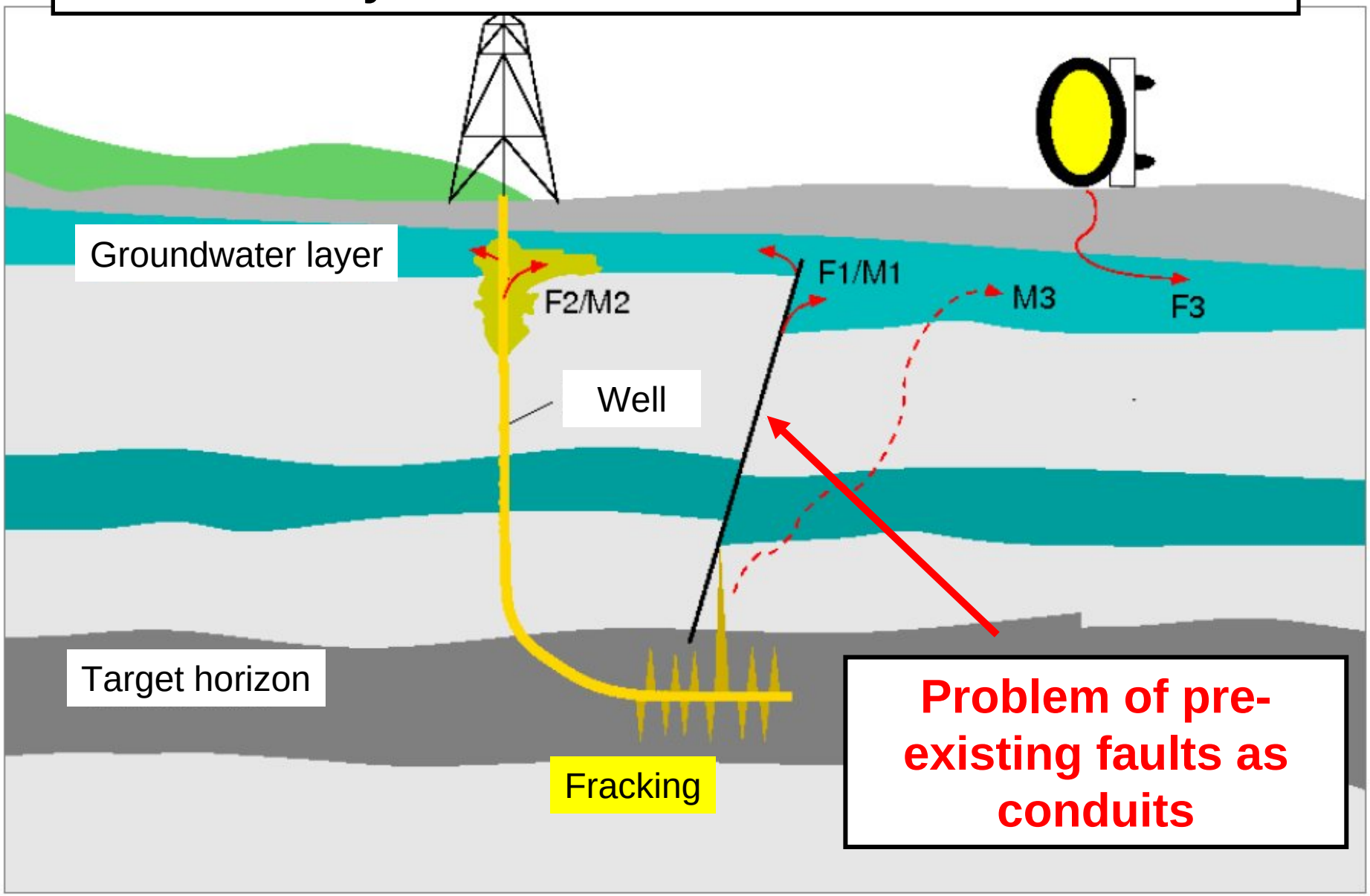
Nick Grealy – pro-fracking pundit
Viscount Ridley – climate-sceptic journalist
Phelim McAleer – pro-fracking film-maker

- but there was "*no time*" for me.

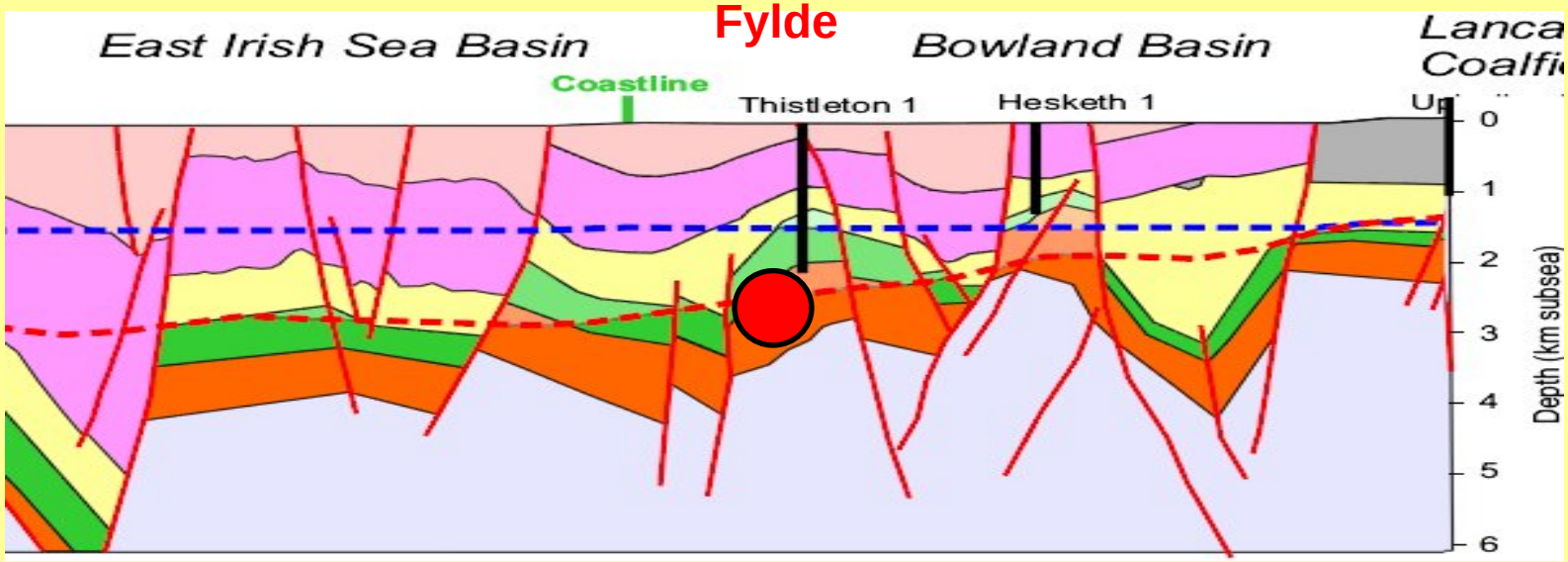
Result:

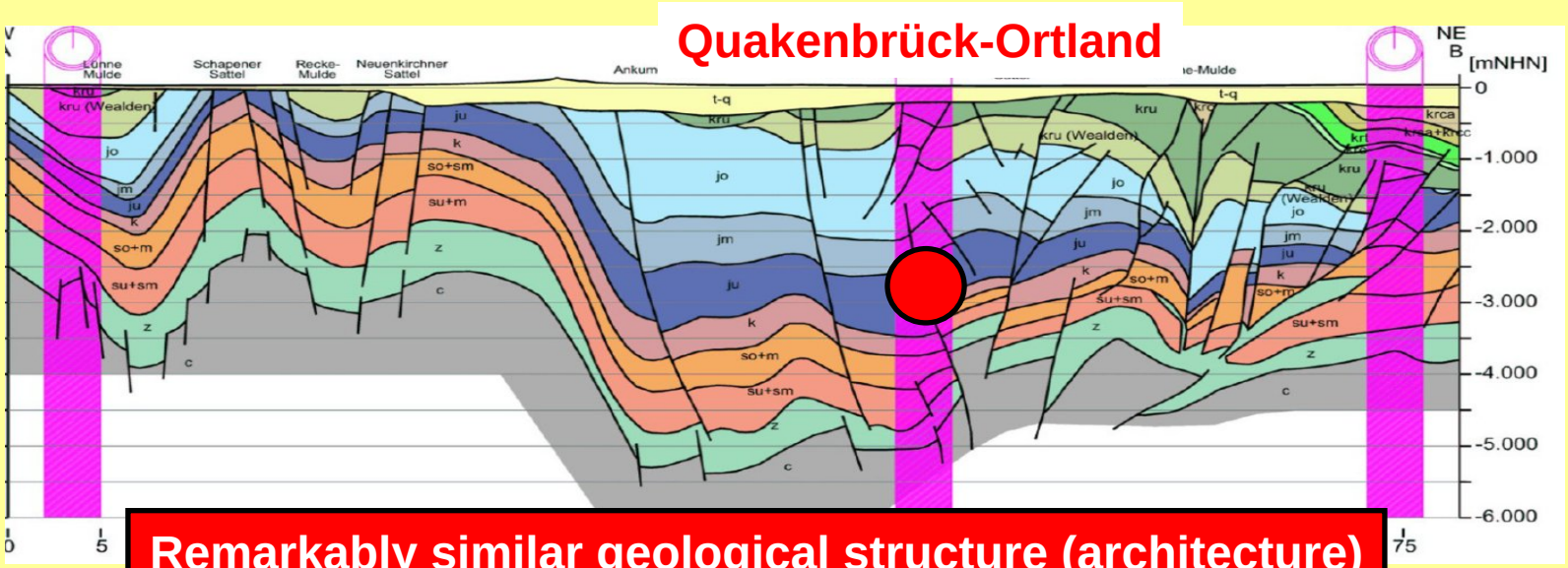
The *"report does not reflect Professor Smythe's fears. … Professor Mair told us that the risk was "<u>very low</u>" ".*

German study 2012: concern about faults as conduits



German shale basin compared with Irish Sea - Bowland Basin





Remarkably similar geological structure (architecture)

75 km

Computer modelling studies of time for contaminants to migrate up a fault

Myers 2012
Marcellus shale, Pennsylvania **'A few years'**

German study 2012
7 localities modelled
Scenario 2 – regional models **30 years**
Scenario 3 – methane migration to atmosphere **100 years**

Caveat: "*A scenario on which these simulations are based is, however, very unlikely to be envisaged, because in principle no frack activities should be performed near a through-going fault zone*."

Canadian study 2013
Quebec, Utica shale **1000 years**

"… contaminants from the shale unit reach the shallow aquifer in less than 1000 years following hydraulic fracturing, at concentrations of solutes up to 90% of their initial concentration in the shale"

Lessons from modelling

Myers – criticised (by industry) as over-simple.

German study – not widely known (132 pages in German).
English summary does not show modelling, but says:

"The following hydrofracking fluid transport barriers are crucial:
…
>>*The absence of faults or fault zones, i.e. underground areas that are more porous owing to fractures in geological materials."*

Canadian study – very long travel time because:

- low permeabilities assumed
- buoyancy effect of fracking fluid ignored

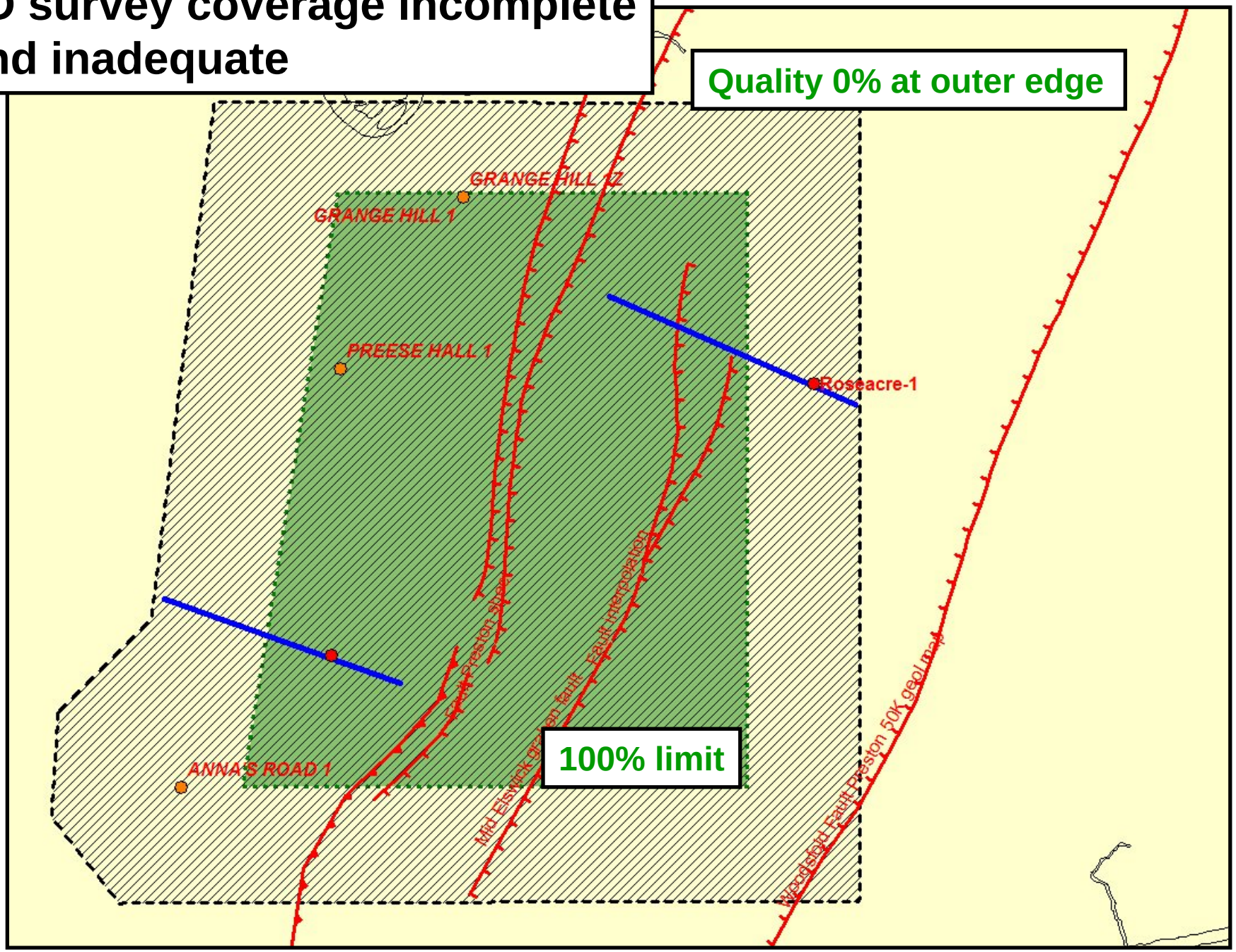
My conclusion – **migration upwards in 1-2 generations likely**

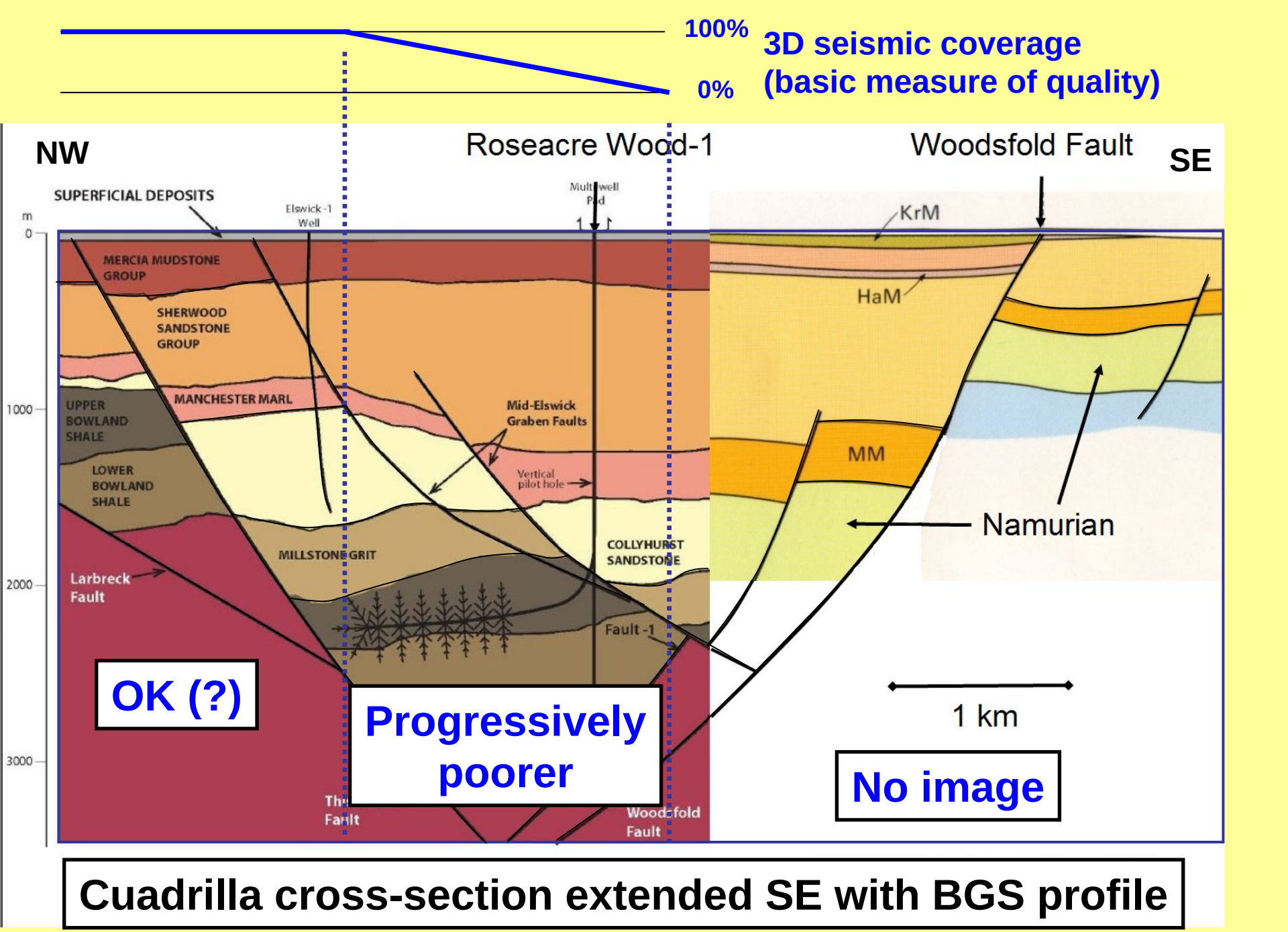
Questions

Why is fracking even being contemplated in a faulted area like the Fylde?
Where are the UK fault modelling studies before any drilling starts?

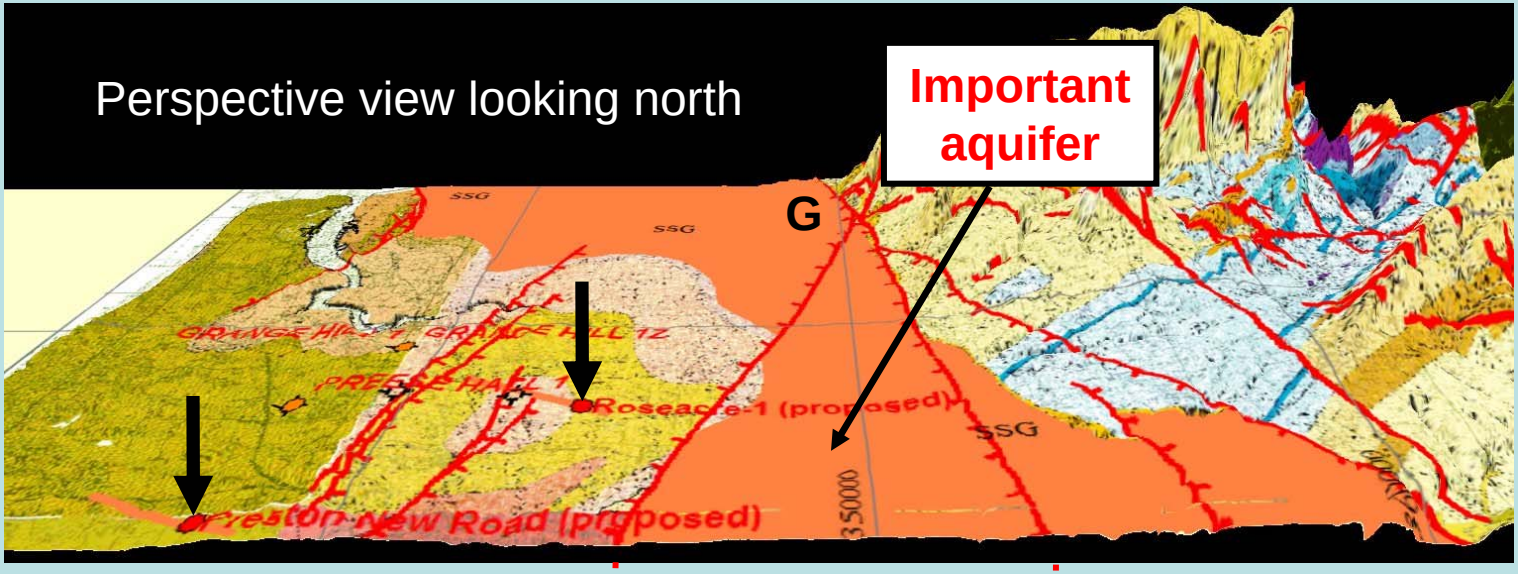
NB funding: Cuadrilla spends £3 million per annum on PR.

3D survey coverage incomplete and inadequate



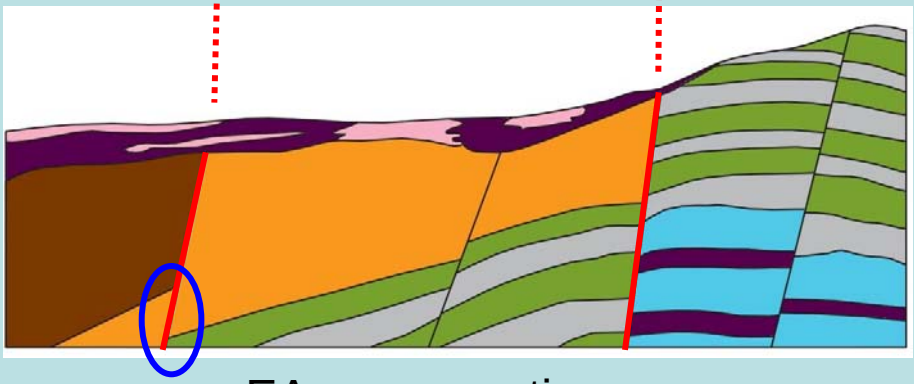


Cuadrilla cross-section extended SE with BGS profile



Woodsfold Fault

Bilsborrow Fault



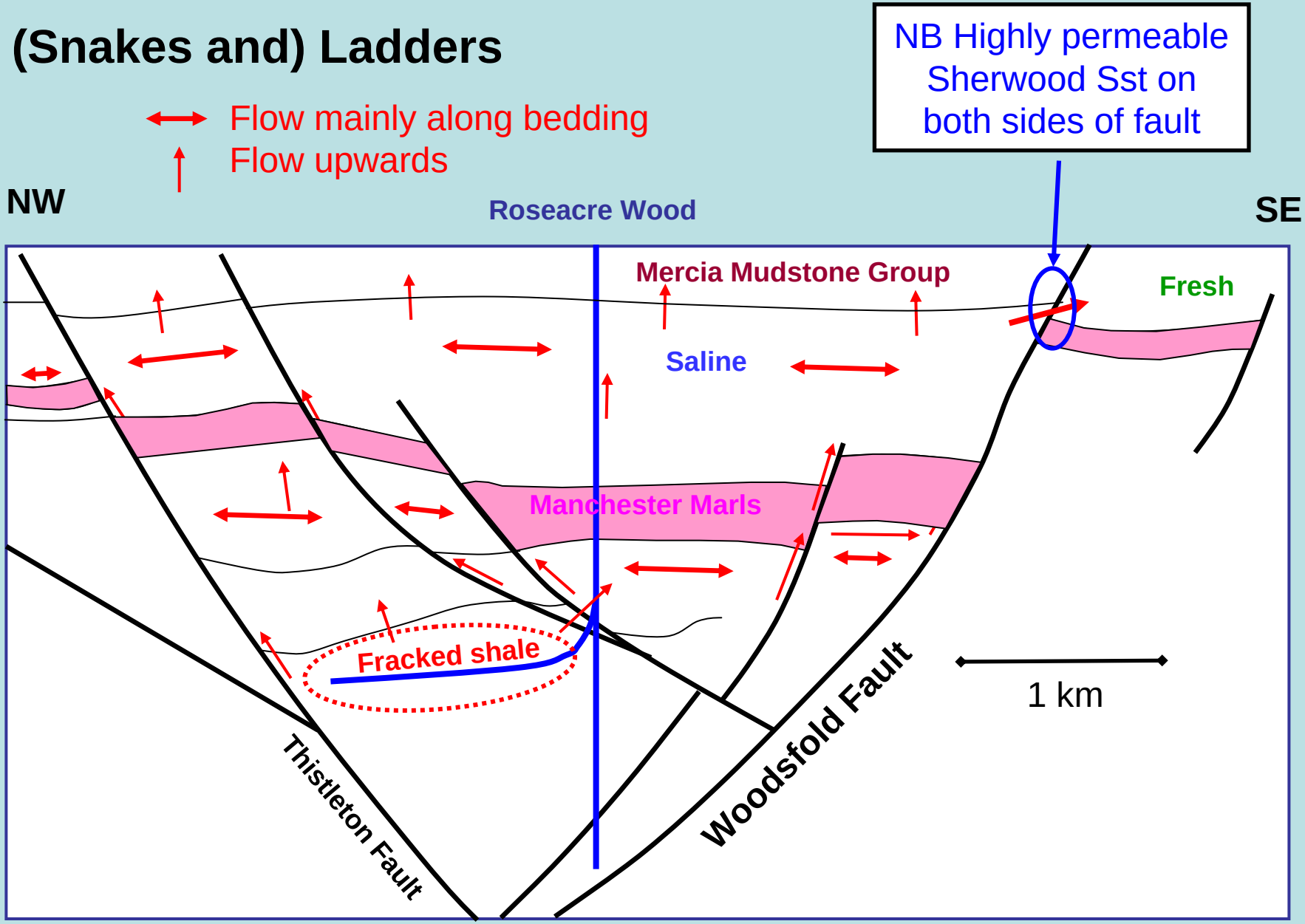
EA cross-section

Faults are proven conduits:

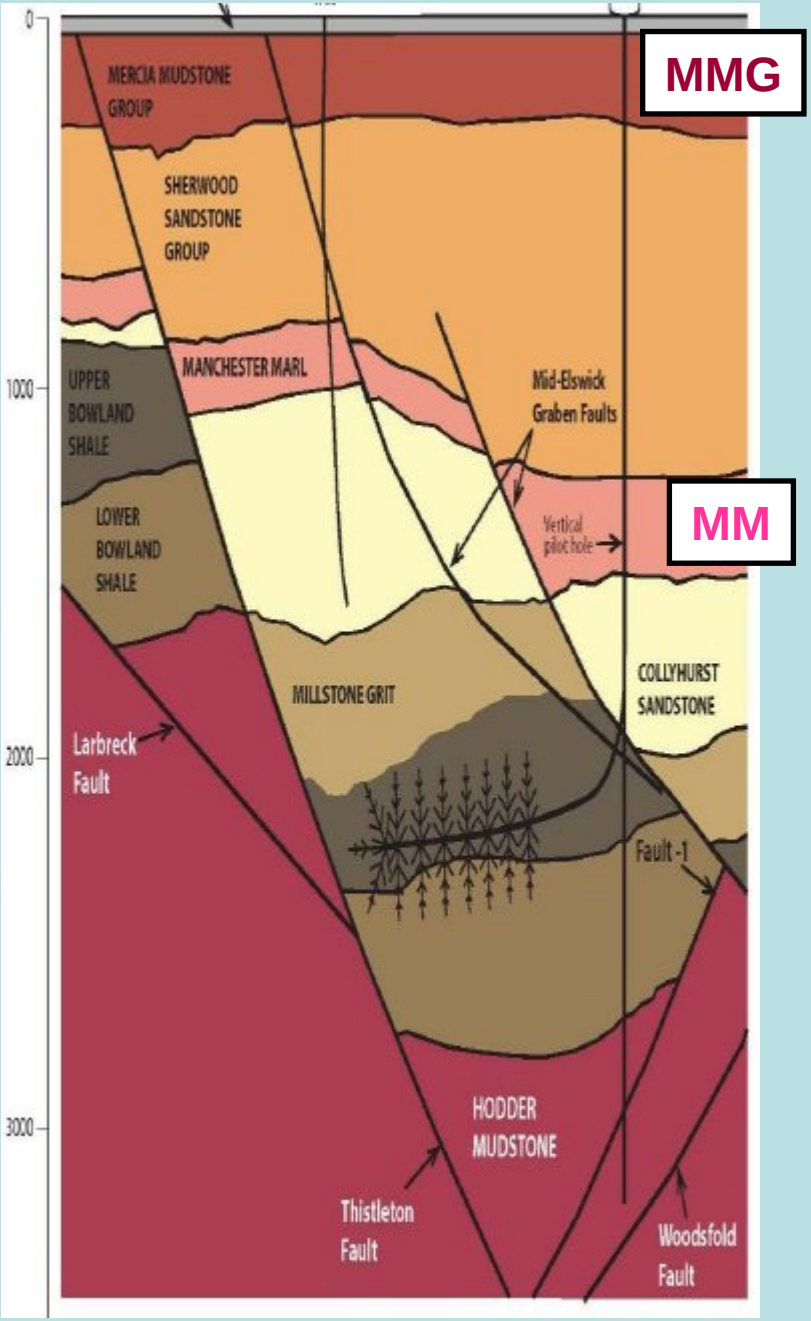
Transmit water (including Woodsfold Fault)

Drilled for water

(Snakes and) Ladders



But EA argues that Mercia Mudstone Group and Manchester marls are sealing rocks



Recent EA rebuttal comments (on PNR , but will apply to RW)

Several arguments involving:

1. Faults are sealing, not transmissive
2. Circulation of groundwater decreases with depth
3. Water gets mineralised with depth
4. Deep saline water hardly flows
5. No mechanism for upward flow
6. Impermeable marl bands within Sherwood Sandstone
7. MMG and MM are impermeable

My response: the EA misunderstands several issues

EA concedes that there could be **flow across Woodsfold Fault**, but then argues that thin impermeable layers within the Sherwood Sandstone will prevent upward migration.

EA fails to grasp that simple **buoyancy** will cause upward upward flow:
(a) Fracking fluid is much less dense than saline groundwater.
(b) During production, methane dissolved in saline groundwater will greatly reduce its density.
(c) Methane gas as a separate phase will rise.

EA's picture does not explain why the shallow aquifer under the Fylde is **highly saline** (very unusual).

EA thinks that **absence of hydrocarbon migration** proves that the Manchester Marls are an effective seal.

EA seems to be bending over backwards to permit the application(s).

Contamination: the polyacrylamide question

The *slick* in slickwater fracking
The only chemical used by Cuadrilla
Declared non-hazardous by the EA

Made from highly toxic acrylamide
– carcinogenic, nerve damage, etc.

Safe limits for acrylamide in drinking water:

EPA	**0.0 (i.e. no safe limit)**

Guidance limits:

EPA, WHO	**0.5 parts per billion**
Minnesota	**0.2 ***

*** "*based on protecting Minnesotans from cancer*"**

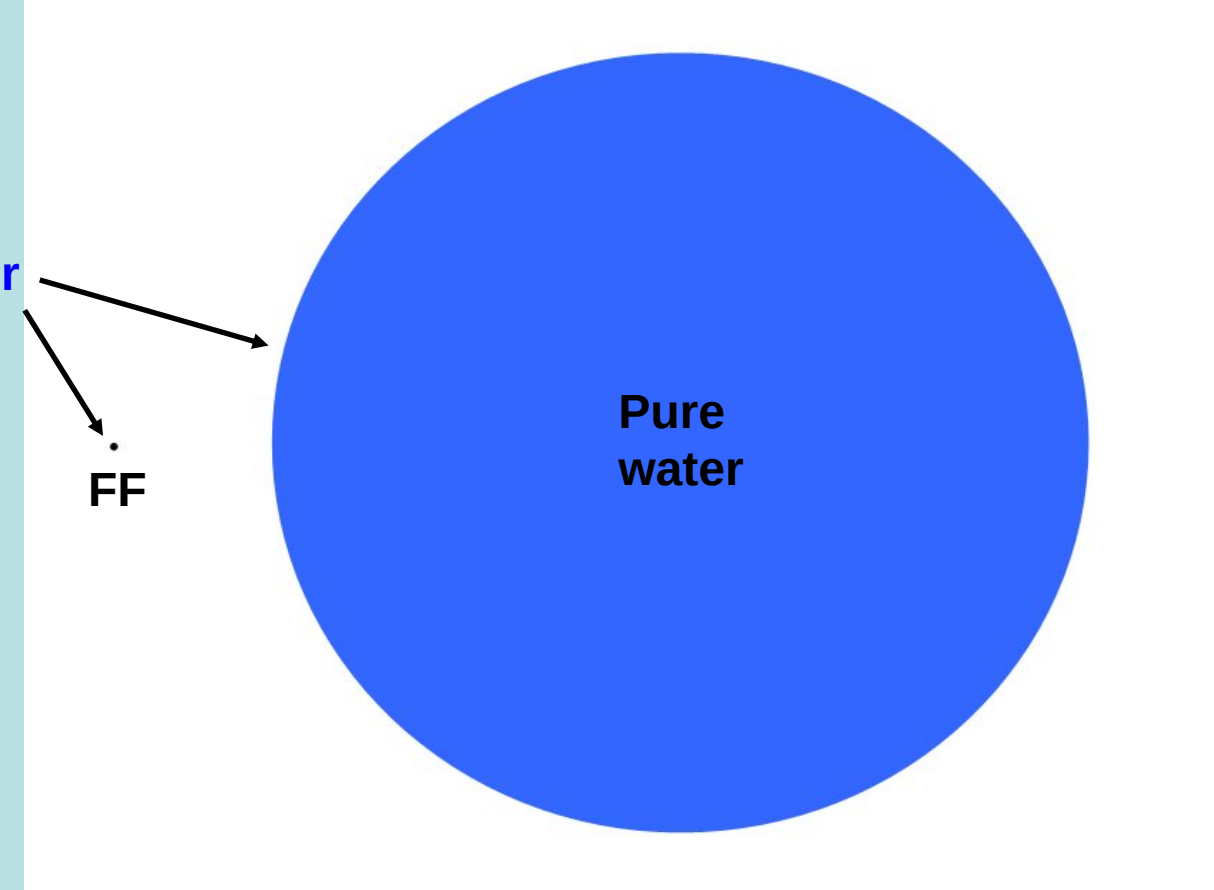
BUT residual acrylamide remains in polyacrylamide

A potential problem?

Acrylamide in frack fluid - the sums:

Amount of polyacrylamide in slickwater	0.05%
Residual acrylamide (AA) in polyacrylamide	0.1%
Proportion of AA in frack fluid (FF)	0.00005%
Minnesota upper limit of AA in drinking water (DW)	$2 \cdot 10^{-8}$
Proportion of FF in DW to be at safe limit	0.04% (1/2500)

So neat fracking fluid is safe to drink (!) as long as it is diluted by at least 2500 times with pure water



Acrylamide - conclusions

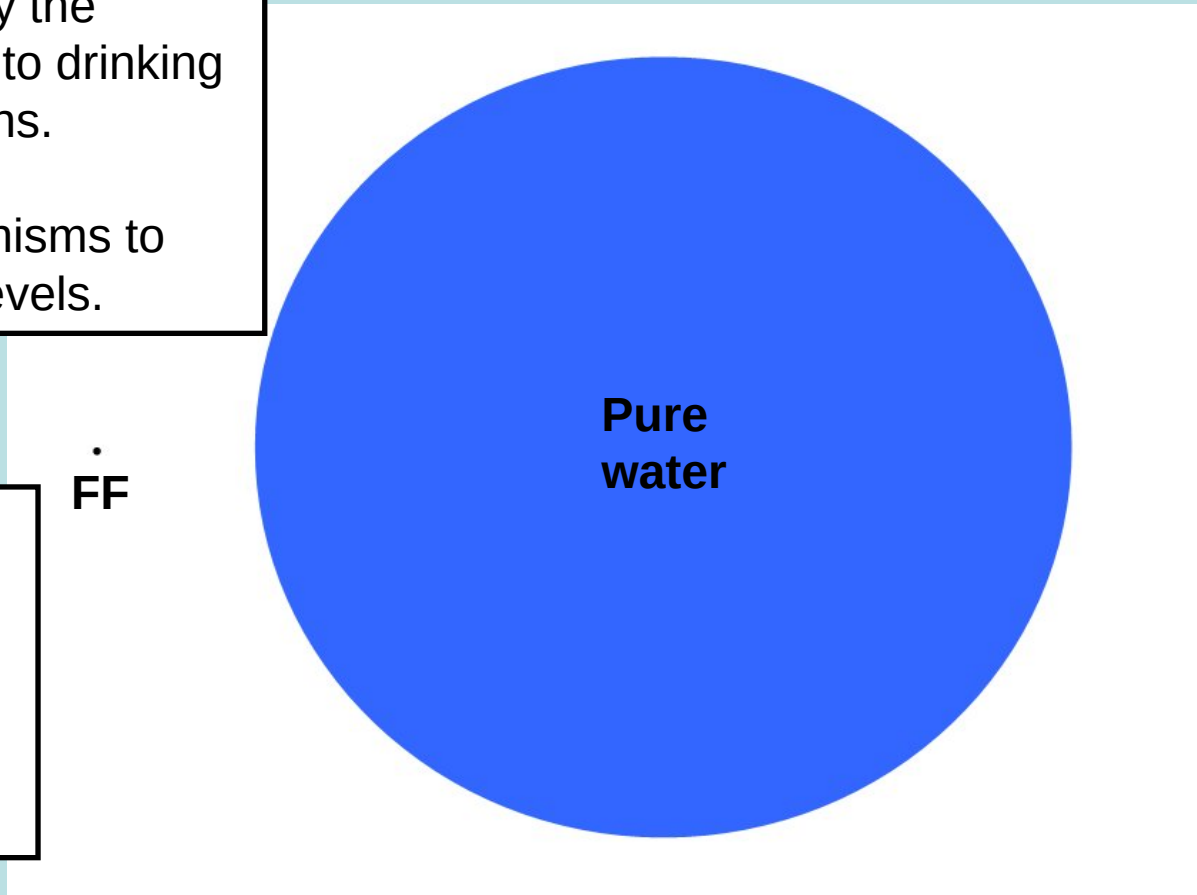
Recall Canadian fault migration study:

- up to 1000 years (but this could be too long by x10 or more)

- at 90% concentration of original solutes

Polyacrylamide injected into fracked rock in the quantities used by the fracking industry could get into drinking water within a few generations.

There are no natural mechanisms to guarantee dilution to ‘safe’ levels.



So the EA is wrong: Polyacrylamide used in fracking is a hazardous chemical, even though safe in everyday use, including water filtration

Summary of geology and hydrogeology of the Fylde

- Heavily faulted, no adequate cover (sealing rocks)
- Multitude of fluid pathways for contamination
- Lack of adequate 3D imaging
- Complete lack of computer modelling
- No similarity with any US shale basin
- Similar structure to NW German shale basin

So what is a sensible approach?

Fracking shale in other countries and states

Germany – moratorium on safety grounds
- completely banned in any faulted area

France – existing licences cancelled and complete ban on environmental grounds, 2011
- confirmed as legal by Contitutional Court

Bulgaria – banned

New York State – banned on public health grounds 2014

Conclusions

- US shale experience is no guide to UK
- Faulting important in Bowland Basin
  - faults often act as conduits for fluids
- Cuadrilla PH-1 drilled a fault in 2011
  - (just like Balcombe, Sussex)
- 3D seismic survey mediocre quality
- Cuadrilla fault interpretation unreliable
  - (just like Balcombe, Sussex)
- EA self-contradictory, too industry-friendly
- Rocks above shales poor fluid barrier
- More earthquake triggering likely

Applying the precautionary principle to the risk of contamination by fluids and methane -

the application should be refused