

## Review of

### **Hydraulic fracturing in thick shale basins: problems in identifying faults in the Bowland and Weald Basins, UK**

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#### **General comments**

My review deals with the overall structure, style and presentation of the article. I am not an expert on seismic interpretation so I leave comments on the scientific quality of this part of the article to other reviewers.

What I can say is that the article is a mixture of science, insinuation and review – most of it the latter. The new research is minimal. The article isn't about what the title says; and the conclusions don't reflect the content of the article either. The piece is not a research or science article, more a detailed magazine article. However it is well written and interesting and probably would be fine as an opinion piece in a specialist magazine, or with suitable editing, in a newspaper.

I recommend rejection.

#### **Detailed comments**

My first reservation is simply that the paper isn't about what the title says it's about: 'Hydraulic fracturing in thick shale basins: problems in identifying faults in the Bowland and Weald Basins, UK.'

Much of the paper is about regulation and other aspects that are irrelevant. The paper contains many unsubstantiated assertions and irrelevant statements - and comments completely inconsistent with the style of an academic paper. Here are but a few:

*'...In addition, the CBL that was run on the production casing proved that the cementing was inadequate, and that DECC knew this but tried to hide it...'*

*'...EA funding was cut by more than 20% between 2011 and 2015...'*

*'...Celtique also submitted a misleading diagram in each application...'*

*'...However, below the Mercia Mudstone Group the SSG is alleged by the UK Environment Agency to be hypersaline, but may in fact be fresh down to 500 m depth...'*

*'...The Minister of State at the Department of Energy and Climate Change, the UK licensor, wrote to Lord Browne, Chairman of Cuadrilla Resources Ltd., the operator, on 11 May 2012 (Hendry, 2012) to express his concern that the wellbore deformation, which might be linked to the fracking, had been concealed from his officials...'*

*'...Regulation of unconventional energy is split across four main separate agencies or authorities...'*

*'...Guidance for councils on unconventional hydrocarbon planning applications was provided, not by any of the agencies mentioned above, but by the Department for Communities and Local Government (2013). This document was only available on the government website from July 2013 until March 2014. It was then archived with a website redirection to a new website; but the latter (<http://planningguidance.communities.gov.uk/>) contains no equivalent information...'*

*'...The committee recommended that the disparate regulatory bodies be brought under one central overseeing body, but this has not come to pass...'*

*'...The current UK regulatory system is over-complex and not fit for purpose. Its government has adopted a laissez-faire approach...'*

*'...Central government is currently calling in applications, i.e. to make the final decision itself, on the basis that shale development is part of the so-called 'National Infrastructure', and therefore too important to be left to county councils...'*

All these comments may or may not be true, but they have no place in a scientific paper which should recount research, data, hypotheses and conclusions. With these statements the paper reads more like a piece of investigative journalism or an opinion piece. It might be perfectly good as such. The article would perhaps be better published in a specialist magazine, or with suitable editing, in a newspaper.

Second. The amount of new research or data presented is minimal. With a paper purporting to be about something as important as faults and leakage, some new data and conclusions following modelling or research would really be welcome. The paper is almost entirely a review, and a partial review at that. It could easily be about a quarter of its present length and concentrate only on faults as the title suggests.

Third. The author is right to consider the paper by Llewellyn et al. (2015). In the paper he says '*...Llewellyn et al. (2015) prove beyond reasonable doubt that contamination of drinking water was caused by passage of frack fluid and/or produced water in part through the geology'*. In fact Llewellyn et al. (2015) were much more circumspect than this in their conclusions. Here is a paragraph from the paper:

*If HVHF fluids did contaminate the water wells, it would be surprising if such contamination were due to fluids returning upward from deep strata, given that (i) this has never been reported (6), (ii) the time required to travel 2 km up from the Marcellus along natural fractures is likely to be thousands to millions of years (31), and (iii) Fig. 6 shows that the Cl:Br ratios in the drinking waters indicate the absence of salts that would be diagnostic of fluids from the Marcellus Shale (e.g., flowback/ production waters). The most likely way for HVHF fluids to contaminate the shallow aquifers would therefore be through surface spillage of HVHF fluids before injection or by shallow subsurface leakage during injection.*

(p. 6329 of Llewellyn, G.T., Dorman, F., Westland, J.L., Yoxtheimer, D. Grieve, P., Sowers, T., Humstone-Fulmer, E. Brantley, S.L. 2015. Evaluating a groundwater supply contamination incident attributed to Marcellus Shale gas development. Proceedings of the National Academy of Sciences).

Finally, in the same way that the title does not reflect the contents of the paper, the conclusion does not reflect what has been examined in the paper either. Taking the first few sentences of the conclusions, for example....

Sentence one. *The USA experience of fracking in shale basins cannot be applied to the UK shale basins, or, for that matter, shale basins anywhere in western Europe, because the geometry of the basins is completely different.* There is no examination of the *geometry of the basins* in the paper at all beyond a few sentences. An examination of this would be interesting and worthy of a paper – and such a paper would have to be substantial to cover

such a lot of ground. But the present paper can't pretend to have shown that the  
'...geometry of the basins is completely different...'

Sentence two. *The major normal faults which cut through the shale to the surface, a universal feature of the UK extensional basins, but absent in the US shale basins.* There is no serious examination of this topic in the paper. It may be true, but has the author really surveyed the huge US basins enough to establish such a point? Where is all the evidence?

There are other statements and sentences in the conclusion that could not be said to have been established through the research or discussion presented in the paper.

End of review