

Interactive comment on “Hydraulic fracturing in thick shale basins: problems in identifying faults in the Bowland and Weald Basins, UK” by David K. Smythe

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Mercifully, the ‘discussion’ phase for Smythe’s (2016a) manuscript is now almost at an end. In my view this journal has given him far too much latitude, first, to allow his manuscript to be posted online in the first place, containing as it does so much innuendo directed against members of the UK Earth Science community; he should confine such allegations to his notorious website. As the reviewer has made clear (Aplin, 2016), this manuscript contains no content that might justify publication, yet it has been allowed to appear online as a permanent record within the public domain, associated with and thus given credibility by a leading scholarly society. This author has also been allowed by the journal to include in his postings on this discussion phase

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much material that can only be described as personal attacks on his critics, which will likewise persist indefinitely within the public domain. It would be appreciated if the journal can ensure no repetition of this episode.

I shall deal briefly with each of the substantive points mentioned by Smythe (2016b) and not covered in previous postings in the order they are set out.

(1) Smythe's (2016b) first comment concerns the fact that, in response to a complaint from him, the journal editor asked me to remove a citation of a newspaper article by an investigative reporter, which had been highly critical of his past conduct opposing shale gas development in the UK. The editor indeed stated 'I am thus writing this email after having received a complaint from Dr. Smythe who felt offended by the first part (the first three lines and the corresponding references) of your comment, where his scientific reputation is doubted by citing "non scientific" press articles.' Although I complied with this request, I had been surprised to receive it, given that the Smythe (2016a) manuscript cites a great deal of similar material, not just newspaper content but also website postings by environmental activist groups. In response to this, I removed the citation of the one newspaper article that I had cited. I am most surprised that Smythe (2016b) has now aired this issue over again, and has thereby been allowed to place in the public domain his own spin on the matter. It therefore now seems reasonable to provide the reference details for the newspaper article he is alluding to, by Seamount (2014), so readers can judge the matter for themselves.

(2) His second comment concerns the Westaway and Younger (2014) article regarding the strength of ground vibrations from induced seismicity caused by fracking. He now states that Smythe (2016a) 'did not discuss this paper, because it is peripheral to the main problem'. Nonetheless, much of the content of Smythe (2016a) concerned the adequacy or otherwise of existing UK regulations for any future shale gas industry. As part of this, Smythe (2016a) gave the impression that induced seismicity is in his view one of few aspects that are currently adequately regulated. On the contrary, the gist of Westaway and Younger (2014) is that the current 'red traffic light' limits for such

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regulation, of magnitude 0.5, is so low as to be ridiculous: in particular, it makes no sense to regulate ground vibrations from fracking much more stringently than ground vibrations from other forms of human activity, such as from quarry blasting, construction activity, or indeed from use of vehicles on local roads.

(3) Smythe (2016b) claims to have independently spotted the inconsistency in the documentation by Clarke et al. (2014) of the focal mechanism orientation for the Preese Hall-1 microseismicity, even though he did not mention this until after it had been pointed out in my publications and postings in this thread (e.g., Westaway, 2015, 2016a, 2016b). His solution to resolving this inconsistency is to presume that the unshaded (white) quadrants of this focal mechanism are compressional and the shaded (red) quadrants are dilatational, the opposite of how such diagrams are usually drawn. Nonetheless, this cannot possibly be the correct explanation for a number of reasons, for example: (a) if it were so, the downward vertical would lie in a compressional quadrant, so the focal mechanism would involve strike-slip and reverse faulting, rather than strike-slip and normal faulting. However, the key issue requiring resolution has been the meaning of the negative rake angle reported by Clarke et al. (2014); if there were a component of reverse faulting to the focal mechanism, then the rake angle would be positive, by definition. In addition (b) if the red quadrants of the published focal mechanism were dilatational, the minimum principal stress (which is roughly east-west in this vicinity; e.g., Westaway, 2016a) would lie within a dilatational quadrant, a physical impossibility (cf. McKenzie, 1969). Smythe's (2016b) claim that the white quadrants of this published focal mechanism are compressional and the red quadrants dilatational therefore makes no sense, and joins the list of pieces of demonstrably wrong 'information' that he has been allowed to place in the scientific literature.

(4) Smythe (2016b) challenges the statement by Westaway (2016b) regarding his "un-critical acceptance of the accuracy of this Clarke et al. (2014) hypocentre" for the Preese Hall induced seismicity. He says that the underlying data are poor and the precise location of the activity is immaterial, but he has nonetheless used the Clarke et al.

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(2014) hypocentre in his construction of the geometry of the seismogenic fault and has illustrated this hypocentre, and no other candidate locations, in several of his diagrams. As already noted, the problems with the Clarke et al. (2014) location procedure, including their use of a seismic velocity model that is too fast, exaggerating the depth of the hypocentre, and not factoring in the clear lateral variations in seismic velocity structure that result from the dipping stratigraphy (e.g., Westaway, 2016a), cast strong doubt on this particular hypocentre.

(5) Smythe (2016b) now also claims to have independently realised that the likely explanation for various contradictory aspects of the published parts of the Preese Hall-1 dataset is that the well track is not marked in the correct place on the Clarke et al. (2014) seismic section, even though this is another 'fact' that he never mentioned until after I had pointed it out (cf. Westaway, 2016c, 2016d).

(6) Smythe (2016b) claims that I exaggerated the support provided for the Myers (2012) paper in the Smythe (2016a) manuscript. On the contrary, Smythe (2016a) provides multiple favourable citations of this flawed paper, including stating on the basis of its results that 'when fracking occurs the transport times of contaminated fluid from the fracked shale to the near surface can be reduced to a few tens of years "or less"'. Engelder (2016) has covered these aspects thoroughly and no further deliberation is needed.

(7) Finally, Smythe (2016b) criticises me (Westaway, 2016b) for claiming that he had advocated that drilling through faults (in relation to shale gas development) should be prohibited. However, he has repeatedly argued this in his submissions to local authorities in the UK. For example, when objecting to one proposal for shale gas development, Smythe (2014) wrote 'Cuadrilla has defined so-called 'regional' faults, which will be avoided by the fracking operations, and 'local' faults, through which drilling and fracking may take place. Its definitions are inconsistent and illogical. All faults should be avoided, whatever the scale; if this results in the Bowland Basin being unexploitable for shale gas, then so be it.' Smythe (2016a) likewise states 'In the UK there is as

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yet neither legislation nor guidance on the what should be the minimum ('respect' or stand-off) distances from faults, vertically and horizontally, of both the wellbores and the fracked shale volumes', implying that when this author wrote that a few months ago he still favoured some form of legal prohibition on drilling through faults, even if he has changed his mind since.

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