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Solid Earth
Discussions

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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DISCUSSION OF FAULTS AND EARTHQUAKES IN THE VICINITY OF THE PREESE HALL WELL

The presence of faults within the Bowland Shale and overlying Carboniferous successions in the United Kingdom is not controversial. The Preese Hall well in the Flyde, Lancashire was subject to a number of small earthquakes in 2011 in the vicinity of the wells related to hydraulic fracturing ("fracking") operations, and deformation of the actual well bore. Having raised concerns about the accuracy and apparent ambiguity in locations between interpretations of the various faults in the vicinity of the Preese Hall well, the author proposes an alternative interpretation of the fault that moved caus-

ing these earthquakes. There are number of issues with the author's methodology for achieving this.

MANIPULATION OF FIGURE 4B

Smythe makes clear that his Figure 4B (originally from Clarke et al., 2014) has been digitally altered to facilitate his interpretation. However, by choosing to cover an arrow in the original figure with red a potentially misleading impression of the continuity of reflectors may occur. It is impossible to identify from this diagram as currently presented whether his preferred fault orientation is a valid interpretation or whether this is an artefact of the removal of the text box. In the form that this figure is currently presented, it is too ambiguous to support his hypothesis.

INTERPRETATION OF A FAULT CROSSING THE PREESE HALL WELL.

The author is highly critical of the interpretation of borehole deformation described in De Paiter and Baisch (2011) who noted that "the $5\frac{1}{2}$ in production casing was ovalized over a considerable distance of hundreds of ft. This ovalization is possibly related to the fault slip, but in view of the large interval of deformation it is most likely that the wellbore deformation is caused by shear slip on bedding planes, which is possibly associated with the fault slip." The author's alternative hypothesis is that this ovalisation was caused by intersection of the well bore with a fault at a previously unidentified orientation so that the fault was directly injected with the fracking fluids. Thereby he questions both the way that the original fracturing operation was conducted and also questions the subsequent investigation of the cause of the deformation. Smythe's interpretation of this presumed fault is based on two sources, conventional petrophysical data and the interpretation of ovalisation identified in the well by De Paiter and Baisch (2011), using their figure (shown in this paper as figure 6) as a study of borehole ovalisation. He then hypothesises that the maximum deformation zones are indicative of one or more fault strands intersecting with this wellbore in the interval 8500 to 8640'. Borehole imaging allows high resolution interpretation of the majority of the circumference of the borehole wall. This technique dates in primitive form (borehole camera and televiewers) from the 1960s and has been extensively applied to well interpretations and published on since. Resistivity borehole imaging data was collected by Weatherford using their CMI tool for an extensive interval of the Preese Hall well. The imaging data collected in the Preese Hall well are of high quality providing a clear view of the state of the borehole wall. The original De Paiter and Baisch report includes figures showing a number of sections of borehole imaging. Their Figure 31, which highlights the borehole ovalisation, includes interpreted dip data directly derived from the CMI imaging tool; this figure is included in Smythe's paper (his version included as figure 6), though with this dip data omitted. Therefore the author must have been aware of the availability of this borehole imaging data. (As the author describes in section 2) Data for all UK hydrocarbon wells are available from DECC appointed data release agents. Data typically includes composite plots, conventional geophysical logs and well data reports; Preese Hall data was released in April 2015. It would therefore have removed ambiguity from the author's interpretations if he had chosen to publish this original data, rather than reusing other author's figures. Examination of the borehole imaging for Preese Hall, collected prior to the fracking operation, showed unambiguous evidence of faults in this borehole in other sections of the well (for example at 2015 mbKB / 6613 fbkb showing a 40cm displacement fault). However, borehole imaging in the interval 8500 to 8640' shows consistent low angle bedding but no evidence of a fault intersection. The author could have accessed the borehole imaging data as it was available from release agents with all other data during April 2015. (IHS 2016, personal communication). It is unfortunate that the author chose not to examine the borehole imaging as this shows without ambiguity that his hypothesised fault does not intersect the wellbore in this interval.

INTERPRETATION OF THE FAULTING AT BALCOMBE

A further apparent manipulation of existing published data can be seen in section 4, dealing with faulting in the Weald Basin of Southeast England, which critiques the in-

terpretations of Andrews, (2014). After examination of geophysical logs he hypotheses a 10m fault that crosses the Balcombe 1 well (some of these logs were included in the Andrews interpretation) which is adjacent to the recently drilled and still confidential Balcombe 2 well. He therefore postulates a fault to account for a hypothesised missing section. Examination of the log data used to demonstrate this 10m fault in Balcombe 1 highlights that some degree of exaggeration is apparent as about 3m of the raw log data has just been omitted. Adding that back in, the fault should have a thrown of about 6m. Whilst this may seem pedantic, this constitutes a 60% exaggeration.

CONCLUSIONS

The borehole imaging from Preese Hall well shows that Smythe's interpreted fault is not present. Given that a key element of his hypothesis can be disproven using freely available data I would recommend that this version of this paper should be withdrawn from publication by the author.

REFERENCES

Andrews, I. J., 2013: The Carboniferous Bowland Shale gas study: geology and resource estimation, British Geological Survey for Department of Energy and Climate Change, London, UK, https://www.gov.uk/government/publications/bowland-shale-gas-study, 2013. Andrews, I.J., 2014 : The Jurassic shales of the Weald Basin: geology and shale oil and shale gas resource estimation, British Geological Survey for Department of Energy and Climate Change, London, UK, de Pater, C.J. and Baisch S., 2011: Geomechanical Study of Bowland Shale Seismicity, Synthesis Report for Cuadrilla Resources Limited. http://www.cuadrillaresources.com/wp-content/uploads/2012/02/Geomechanical-Study-of-Bowland-Shale-Seismicity_02-11-11.pdf

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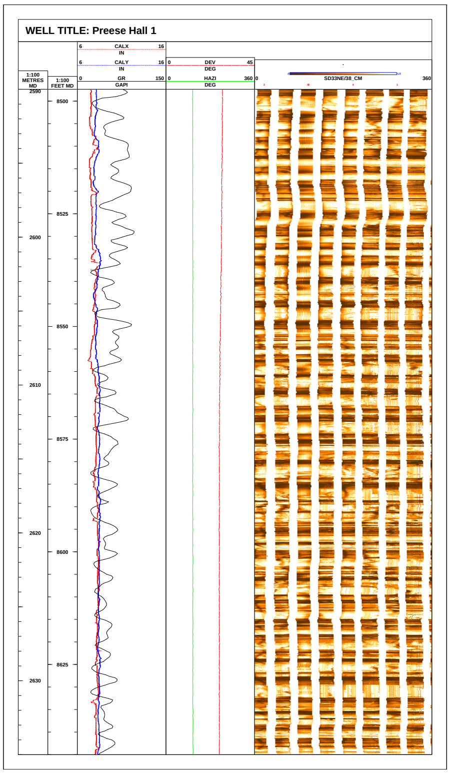
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DEG
0 HAZI 360
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METRES
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Fig. 1.