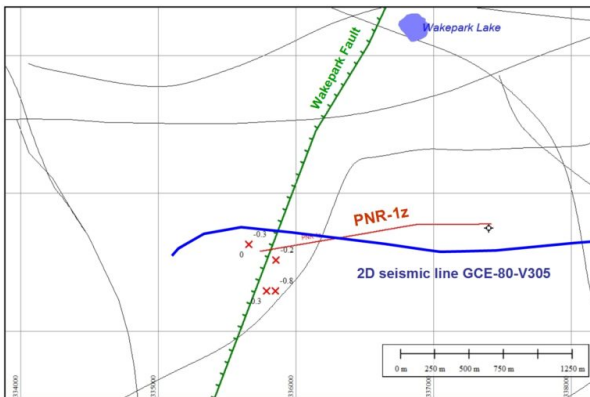


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There may be trouble ahead

Posted on 22nd October 2018 by [Professor David Smythe](https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/frackland/?author=1) (<https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/frackland/?author=1>)

Cuadrilla finally started fracking of the UK's first horizontal shale well, Preston New Road-1z, Lancashire, on 16 15 October 2018 [correction 24 Oct]. Very small tremors were immediately **registered** (https://web.archive.org/web/20230321205423/https://earthquakes.bgs.ac.uk/earthquakes/recent_uk_events.html) on the monitoring network set up by the BGS. I have positioned the five tremors of 18-20 October on the map below, shown by the red crosses. They lie towards the western end of the horizontal segment of PNR-1z at 2240 m depth (the surface track of which is shown by the red line). Fracking started with the stages furthest from the wellhead, that is, at the west end. The BGS hypocentral depths are very approximate (2 to 3 km depth), and the epicentral positions all lie within 300 m of the well track.



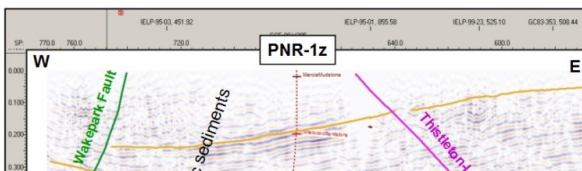
(<https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/frackland/wp-content/uploads/2018/10/PNR-1z-locn-map-labelled.jpg>)

Location of Preston New Road-1z, currently being fracked (red line). Thin black lines are 2D seismic profiles; the blue one highlighted is shown below. Red Xs mark the epicentres of the five tremors triggered to date. Grid at 1 km spacing (click to enlarge).

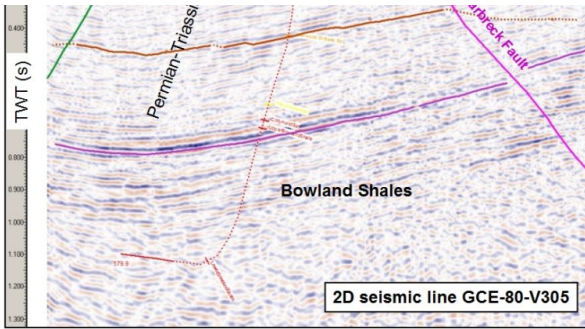
The three tremors of 18 October are tiny, and well below the $M = 0.5$ limit for the traffic-light monitoring system, which is itself very small. However, **recent research** (<https://web.archive.org/web/20230321205423/https://news.stanford.edu/2017/12/12/small-earthquakes-fracking-sites-may-indicate-bigger-tremors-come/>) by Stanford University shows that these tiny tremors can be indicators of bigger quakes to follow, like canaries in a coal-mine. The 19 October event with $M = 0.3$ is close to the red threshold ($M = 0.5$) of the traffic light system, at which fracking must stop. The fifth and latest tremor, at the time of writing (22 October) is $M = 0.0$.

However, triggering of earthquakes during fracking is, in my view, a subsidiary issue. My overall concern is that Cuadrilla is failing, even after nine years in the Fylde, to understand the geology. Part of a 2D seismic reflection line is shown below, with my geological interpretation and with the deviated well track superimposed, to illustrate this point.

To cite one example of Cuadrilla's incompetence: a supposedly 400 m thick layer of Millstone Grit, mapped by Cuadrilla as late as last year to overlie the Bowland Shale, was proved by PNR-1 (the vertical donor well for the horizontal PNR-1z) earlier this year to be *completely absent*. This Upper Carboniferous layer should have been found, according to Cuadrilla, between the Bowland Shales and the Permian sediments above. Cuadrilla's mis-mapping and misunderstanding after all this time constitutes a severe geological failure. The usual mismatch between the geological prognosis and the actual outcome when drilling in a supposedly well-understood basin is routinely just a few metres in layer thickness differences.



(<https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/frackland/wp-content/uploads/2018/10/PNR-1z-on-GCE-80-V305-2-labelled.jpg>)



Interpreted 2D seismic profile located in blue on the map above. Vertical scale is in seconds of two-way reflection time. PNR-1z is the red dashed/solid line (click to enlarge). (<https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/frackland/wp-content/uploads/2018/10/PNR-1z-on-GCE-80-V305-2-labelled.jpg>)

Furthermore, Cuadrilla appears to be hiding the fact that there are major faults in the near-vicinity of the PNR wells, which extend up to the near-surface, as shown in the seismic example above. These could be future conduits for contamination from fracked shale. One of these, the Wakepark Fault (green on the seismic section), runs in a NE-SW direction nearly through the Wakepark artificial lake, 1300 m north of the horizontal well. According to all the information Cuadrilla has seen fit to publish, this fault does not exist, even though it was originally mapped at depth independently by Eukan Energy and by British Gas some thirty years ago. I have merely remapped it, taking it higher up. The map above shows the surface outcrop of the fault; at the depths of the Bowland Shale this fault lies about 1 km west of the toe of PNR-1z. The four freshwater springs replenishing this lake may be being fed by water from the underlying Sherwood Sandstone aquifer, *via* the fault. Cuadrilla's published cross-sections through PNR, including cross-sections submitted in its planning applications, are all truncated in such a way as to avoid showing any of these faults.

Although I currently have access only to the released 2D seismic database, as in the example above, it is evident from the several small samples of the 3D survey published by Cuadrilla, and on which Cuadrilla's geological picture depends, that the 3D survey is not up to the task. This is particularly true at the SW corner of the 3D survey rectangle where PNR is situated. The data processing strategy seems to have been biased towards obtaining strong horizontal smeared-out reflectors in the Bowland Shale, at the expense of imaging the faults.

Cuadrilla belatedly asked the Oil and Gas Authority to withhold release of the 3D survey, which should have become publicly available on 1 January this year, and which I had pre-ordered over a year ago. It took several FOIs and a letter threatening legal action from my brilliant lawyer [Kate Harrison](https://web.archive.org/web/20230321205423/https://www.hglaw.co.uk/site/people/profile/kate.harrison) (<https://web.archive.org/web/20230321205423/https://www.hglaw.co.uk/site/people/profile/kate.harrison>), of Harrison Grant Solicitors, London, to get the OGA finally to authorise release of this survey some 10 months late – but even now I have not actually received it. In my view the government is doing everything in its power to delay the due release of data that might be used to argue against Cuadrilla. That is not sound regulation; it is **giving the cowboys free rein** (<https://web.archive.org/web/20230321205423/https://www.youtube.com/watch?v=RYCMrcjtBWg>).

The Bowland Shale is riddled with faults that Cuadrilla either does not recognise, as cited above, or else wilfully seeks to misplace. An example of the latter is the fault that was intersected by the Preese Hall-1 wellbore in 2011, triggering the earthquakes there during fracking. **I have shown** (<https://web.archive.org/web/20230321205423/https://www.solid-earth-discuss.net/se-2015-134/>) that the wellbore cut the fault, and the later fault displacement due to the earthquakes ovalised the drillpipe to such an extent that the well had to be abandoned. But Cuadrilla persists in positioning the fault to the east, away from the wellbore.

Some of these shale layer faults extend up into the Sherwood Sandstone aquifer and higher up, as shown in the section above. If and when Cuadrilla starts drilling and fracking at its other current site, Roseacre Wood, the problems of faulting and of general geological interpretation will be even more severe than here at Preston New Road.

My strong impression is that Cuadrilla is once again trying to hide its own technical incompetence. I recall the **letter from DECC energy minister** ([https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/fracking/Charles Henry \(DECC\) - Cuadrilla correspondence 2012.pdf](https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/fracking/Charles%20Henry%20(DECC)%20-%20Cuadrilla%20correspondence%2012.pdf)) Charles Hendry of 11 May 2012 calling into question Cuadrilla's "*performance as a licensee*" – a rare rebuke by government to industry. I recall also that Cuadrilla boreholes Grange Hill-1, Singleton-1 and Anna's Road-1

had severe technical problems in addition to those at Preese Hall-1, resulting in abandonment of all four wells – a 100% drilling failure rate!

The problem for Cuadrilla is that if it now carries on regardless after just five days' fracking, bigger earthquakes are likely to be triggered. Cuadrilla's **reported response** (<https://web.archive.org/web/20230321205423/https://www.theguardian.com/environment/2018/oct/20/minor-earthquakes-detected-near-cuadrilla-fracking-site-in-lancashire>) (20 October) to the tremors is:

"This is not an 'amber' incident under the traffic light system operated by the OGA as we were not pumping fracturing fluid as part of our hydraulic fracturing operations at the time and the seismic events remain under 0.5 local magnitude."

Note the disingenuous "at the time" disclaimer above (discussed in more detail by **Refracktion** (<https://web.archive.org/web/20230321205423/https://www.refracktion.com/index.php/the-fraxit-dilemma/>)), belying the fact that tremors frequently occur some hours after cessation of fluid injection. Furthermore, there is no published information on the times when Cuadrilla claims to be injecting, so the assertion cannot be verified independently.

To quote Cole Porter; "There may be trouble ahead". Cuadrilla's only safe option is to cease fracking the critically stressed Bowland Shale. Otherwise Francis Egan, Cuadrilla's CEO, will have to "face the music and dance" – but I don't think Egan will be as nimble on his feet as Fred Astaire.

Categories: **Cuadrilla** (<https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/frackland/?cat=13>)



Professor David Smythe (<https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/>)

I am Emeritus Professor of Geophysics in the University of Glasgow (a courtesy title). I retired from the University in 1998 and live in France, where I continue my research in geology and geophysics.

View all posts by Professor David Smythe → (<https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/frackland/?author=1>)

Response to There may be trouble ahead

Linda Hurrell

22nd October 2018 at 1:15 pm (<https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/frackland/?p=551#comment-190>)

Thank you for this detailed analysis. How much of this essential information do you think Claire Perry and others in Government are aware of?



Professor David Smythe (<https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/>) Post author

22nd October 2018 at 1:47 pm (<https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/frackland/?p=551#comment-191>)

Precious little, because the government relies solely on what industry chooses to tell it. Independent

experts such as myself are ignored. Even former pro-fracking academics such as Professor Peter Styles and Professor Richard Selley, who are now opposing certain aspects of unconventional fossil fuel exploration, and who in the past have had the ear of government, are now ignored.



Netty

22nd October 2018 at 2:41 pm (<https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/frackland/?p=551#comment-195>)

Hi David, good artical. Evidence seems to confirm engine fired up 30 mins before the 0.3 earthquake.



Robert

22nd October 2018 at 4:53 pm (<https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/frackland/?p=551#comment-196>)

THANK YOU FOR YOUR TIME. 😊



warren matthews

22nd October 2018 at 2:19 pm (<https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/frackland/?p=551#comment-193>)

Brilliant, but worrying work. Thank you.



Elaine Speakman

22nd October 2018 at 2:40 pm (<https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/frackland/?p=551#comment-194>)

Keep on churning your thoughts out. They are very much appreciated by those of us opposing fracking and I am sure the legal teams fighting on our behalf appreciate the technical input too.

You are giving us FACTS that we can share widely, outside of our own and of warriors.

Thank you.



Marie

22nd October 2018 at 6:03 pm (<https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/frackland/?p=551#comment-197>)

Thank god that you are on the ball



marianne

22nd October 2018 at 6:14 pm (<https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/frackland/?p=551#comment-198>)

I wonder if the 3 million gallons of freshwater a day (every day over the last 70 years) used by Springfields Nuclear Fuels have already had an impact on the stressed Bowland Shale? Incredible that the water intensive and high hazard nuclear fuel fabrication plant has been hidden from public discourse on the wisdom of fracking the Fykde. This lack of scrutiny is despite the nearest fracking area being a mere 2 miles away from the Springfields Nuclear Fuel site.



Peter K Roberts

22nd October 2018 at 6:56 pm (<https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/frackland/?p=551#comment-199>)

Excellent technical report explaining why fracking should not have been allowed to commence on our small, faulted, (natural or by mining), island.

Quick question, would you expect horses at Penny Farm horse rescue centre on Preston New Road, 1 mile to the west of the fracking site and cattle in the surrounding fields to be spooked by the seismic activity?



Professor David Smythe (<https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/>) Post author

22nd October 2018 at 7:49 pm (<https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/frackland/?p=551#comment-200>)

Thank-you Peter. The animals would react to any unusual shock at the ground surface – but please remember that the PNR tremors (so far) are very tiny.

Incidentally, the notion that animals can detect earthquakes by some sort of precursor has been around for a long time, but has no sound basis; however they may feel small foreshocks undetected by humans as 'felt' ground motion. So it would be interesting to monitor (preferably by camera recording) the horse behaviour at the rescue centre, to see whether the animals do react in any way to these small tremors unfelt by us humans.

I forgot to put in my report that Professor Styles has recommended a stand-off, or respect, distance of faults from fracking to be 850 m. Needless to say his recommendation of that figure (or any larger distance he has proposed, up to 5 km) has been ignored by government. This is doubtless for the simple reason that there would be no shale fracking in the UK at all, were such a safety distance to be in force.



Will

23rd October 2018 at 2:37 am (<https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/frackland/?p=551#comment-201>)

Thanks David, so glad you are looking into this.



Rex tyler (<https://web.archive.org/web/20230321205423/http://cooksdelight.co.uk/blog>)

23rd October 2018 at 8:12 am (<https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/frackland/?p=551#comment-202>)

With the passing of time we have grown less sensitive to the murmuring of the planet picked up by the fish and all those who the force of gravity through their feet. Living in one's own spirit accounts for all the realms above and below.

Staying put and eating what we ourselves forage for can illustrate a greater dependency on the planet than human intelligence can ever imagine the principal of magick creates a freedom to express the obvious



Andrea Willers

23rd October 2018 at 1:14 pm (<https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/frackland/?p=551#comment-203>)

So summing this up, fracking is a no, no. Because the bigger the frack the bigger the earthquake.



Peter K Roberts

20th March 2020 at 1:08 pm (<https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/frackland/?p=551#comment-225>)

Update on August 2019 Bank Holiday Weekend Hydrofrac Earthquakes.
Our family home in Warton, 4.4 road miles from the PNR fracking site, was damaged by felt movement on Bank Holiday Monday. I am preparing direct legal actions for compensation. I have before and after photographs, personal statements and sent Personal Notices of Liability to those responsible.
Any advice or backing would be much appreciated.



Dee Mee

23rd October 2018 at 1:17 pm (<https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/frackland/?p=551#comment-204>)

Thank you for such a detailed review David. It's such a shame that science is ignored for Kudos by this government. Thank you for being vigilant .



Geo89

23rd October 2018 at 3:12 pm (<https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/frackland/?p=551#comment-205>)

David,

Don't necessarily disagree with your analysis, however i do think your first map is a little misleading as on first glance it seems to suggest the seismic events are occurring along the green fault, when in fact this is the surface expression of the fault and at target depth it is some way to the west.



Professor David Smythe (<https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/>) Post author

23rd October 2018 at 4:09 pm (<https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/frackland/?p=551#comment-206>)

Thank-you Geo89. I couldn't see a way round that, other than explaining in the text that the Wakepark Fault at Bowland Shale depths is 1 km further west. A limitation of a 2D map.



richard

23rd October 2018 at 7:28 pm (<https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/frackland/?p=551#comment-207>)

Thankyou David.

Have you been able to ascertain if the seismic discontinuities of SD4, SD5 and SD6 in the hydraulic fracture plan are likely host sites for the tremors?

Is there any possible concept of a fault zone that encompasses the Wakepark fault and these discontinuities with the ensuing disturbing thought of fluid and gas migration upwards?

Do we have any knowledge of the stress nature of the Wakepark fault?



Professor David Smythe (<https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/>). Post author

23rd October 2018 at 7:58 pm (<https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/frackland/?p=551#comment-208>)

Richard

The answer to all your questions is No. We know very little about the faults in the Bowland – which of course is another good reason not to be fracking it. Since Cuadrilla can't even properly identify the higher-level faults that cut the Permian-Triassic sediments, I don't expect them to have any proper grasp of the deeper faulting.

Fred

23rd October 2018 at 10:34 pm (<https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/frackland/?p=551#comment-209>)

Off topic but do you know of any faults in the vicinity of the soon to be tested Brockham well?



Professor David Smythe (<https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/>). Post author

23rd October 2018 at 11:16 pm (<https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/frackland/?p=551#comment-210>)

Somewhat off-topic, but never mind!

The Brockham field is bounded by an ENE-WSW fault (the Brockham Fault) downthrowing to the south on its south side. To the north there is a similar parallel but mirror image fault, so that the field is contained in a high-standing block (a horst, in the jargon). But because this slab of rock is tilted (dips) slightly north the oil is all found towards the southerly side, up against the Brockham Fault.

The drilling has all been done some 400 m from the nearest 2D seismic lines. This was OK back in the days of BP, which drilled a slightly deviated vertical discovery well (Brockham-1) in 1986, the end of which is some 300 m SE of the surface location, but is inadequate for detailed understanding and horizontal drilling.

Brockham-X2z and Brockham-X4 both run SW, parallel to the Brockham Fault, running along the Portland Sandstone reservoir. However, I remember a report stating that one of the older wells went in and out of the reservoir four times, presumably encountering faults on the way (or else the driller was

drunk, making a snaky wellbore!). Without a 3D seismic or several more 2D lines to fill the gap this is drilling blind, and in my view is irresponsible.

Fred

24th October 2018 at 10:53 am (<https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/frackland/?p=551#comment-211>)

It does appear to be the case that so far the only examples of oil flows from the Kimmeridge have been in fault zones. Although Broadford Bridge failed to flow they possibly missed the damage zone.

I also noted that the recent Balcombe flow test reported produced formation water so evidently there is either water in the micrites or interconnection with water bearing formations.

Chris Hesketh

24th October 2018 at 7:41 pm (<https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/frackland/?p=551#comment-212>)

Excellent work indeed David

The fact that faults are pollution pathways to the surface is the most worrying aspect here. Cuadrilla know that if the second well fails in the same way as the first then the industry may not recover from the reputation damage, despite the Government telling regulators to look the other way. Despite this, the approach appears to be one of “cross the fingers and hope”.

Fred

26th October 2018 at 2:19 pm (<https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/frackland/?p=551#comment-213>)

Work has started today at Brockham.

Fred

26th October 2018 at 6:21 pm (<https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/frackland/?p=551#comment-214>)

David

As you predicted there have been further seismic events.

<https://www.ogauthority.co.uk/news-publications/news/2018/minor-seismic-events-recorded-in-the-preston-new-road-area/> (<https://web.archive.org/web/20230321205423/https://www.ogauthority.co.uk/news-publications/news/2018/minor-seismic-events-recorded-in-the-preston-new-road-area/>)

Fred

1st March 2019 at 5:04 pm (<https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/frackland/?p=551#comment-215>)

David

According to Angus RNS releases the well at Brockham was suspended awaiting isolation of the water zone that was at 200psi above the oil zones. Does it not follow that there will be ongoing cross flow in the well and that high pressure water will be flowing in to other formations. This could be causing seismic events.

Dominic Ramos

14th September 2022 at 5:36 pm (<https://web.archive.org/web/20230321205423/http://www.davidsmythe.org/frackland/?p=551#comment-227>)

The new government of Liz Truss is again issuing fracking licenses. They say they will do this subject to expert analysis of its safety and feasibility. What are the chances they will get a balanced verdict on this?
