



Further Potential for Earthquakes from Oil Exploration in the Weald

Dr Andrew Cavanagh, Dr Stuart Gilfillan, Professor Stuart Haszeldine
School of GeoSciences, The University of Edinburgh, Edinburgh EH9 3FE 5th February 2019

The thirteen minor earthquakes that occurred in the Weald in 2018 form a shallow cluster of events that is without precedent for the region. Given their close proximity to neighbouring oil exploration at Horse Hill, it is reasonable to consider the possibility of cause and effect, and if further earthquakes could be triggered by future drilling in the area.

We considered six criteria when assessing the 2018 earthquake cluster to the east of Newdigate. We conclude that our assessment supports the concern that Horse Hill oil exploration triggered the earthquakes. We infer that future oil exploration and production close to critically stressed faults in the Weald is likely to result in similar earthquake events.

Precedence: Prior to 2018, there are no shallow earthquake clusters on record for the Weald since records began in 1969. It has been suggested by others (OGA, 2018) that three earthquakes in 2005 near Billingshurst, Kent (20 km to the southwest of Newdigate), are similar. However, two of these events are estimated at 5 km depth, i.e. in the crust below the sedimentary basin and much deeper than any industrial subsurface activity. It is reasonable to conclude that the 2018 Newdigate cluster sets a precedent for the Weald.

Timing: A detailed timeline of activity at Horse Hill indicates that the exploration well had recently commenced preparations for flow tests on oil-bearing targets prior to the earthquakes in April and July 2018 – see Figure A, Timeline. Furthermore, the earthquakes in August and September coincide exactly with the deployment of a perforation gun downhole to improve flow. The pattern appears to be months of inactivity prior to well intervention and preparation for flow testing. The well interventions then precede earthquake activity by hours to days.

Location: The areal distribution of the Newdigate earthquakes as a tight cluster close to Horse Hill is commonly established by all parties (OGA, 2018). The exploration well is 3 km away from the largest event, with eleven earthquakes occurring within 2 km of this event. Depth estimates indicate earthquakes clustering at around 1 km below the surface, close to the intersection of two faults – see Figure B, Map. The best constrained events have a range of 0.5 to 1.5 km depth, coincident with Horse Hill exploration targets from 623 to 971 m depth.

Faults: A number of faults close to Horse Hill can be identified in seismic surveys (Smythe, 2018; Xodus, 2018). The Newdigate fault passes through the cluster and is highly likely to be the focal location for earthquakes. The Horse Hill fault intersects the well at the same depth as the exploration targets and continues towards the Newdigate fault, suggesting a likely conduit for pressure changes between Horse Hill and the Newdigate cluster – see Figure C, Section.

Pressure: The perforation gun shots in August and September 2018 are the only stimulus applied to improve flow at Horse Hill. However, prior to flow testing in April and July, Horse Hill appears to have encountered a natural source of overpressure* in the gas-rich oils of the Kimmeridge, as observed in the 'gas lift' reported for the well. We infer that management of this pressure (probably by bleeding the well annulus prior to testing) likely altered the Horse Hill fault stress balance, which then impacted on the Newdigate fault, causing the earthquakes.

Other Evidence: Freedom of Information requests and social media posting from the fence line of Horse Hill clearly indicate that well preparations for flow testing immediately precede the Newdigate earthquakes. We infer that the Horse Hill well and site engineering logs (not released at this time for scrutiny) may provide additional information on well intervention pressure changes as the trigger for the 2018 Newdigate cluster.

–
*AAPG Wiki, *Overpressure Causes*, February 2015: bit.ly/AAPG-WIKI-OVERPRESSURE
Oil & Gas Authority, *Newdigate Workshop*, October 2018: bit.ly/OGA-WORKSHOP-NEWDIGATE
Xodus Advisory, *UKOG Competent Person's Report*, June 2018: bit.ly/UKOG-CPR
Smythe, D.K. *Geological Analysis Of Horse Hill Prospect*, August 2018: bit.ly/DKS-ANALYSIS

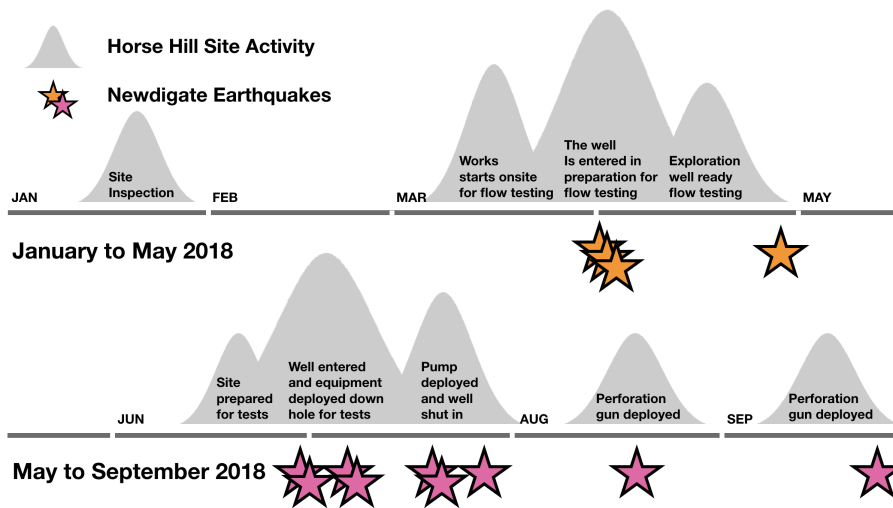


Figure A, Timeline: Site activity at Horse Hill compared to earthquake timing

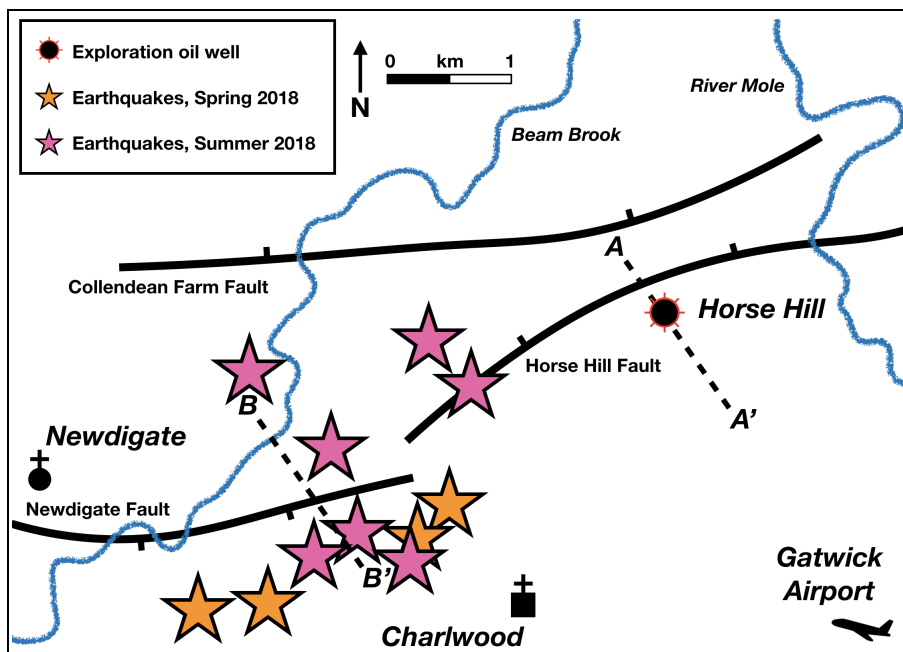


Figure B, Map: Newdigate earthquake cluster, faults and Horse Hill well location

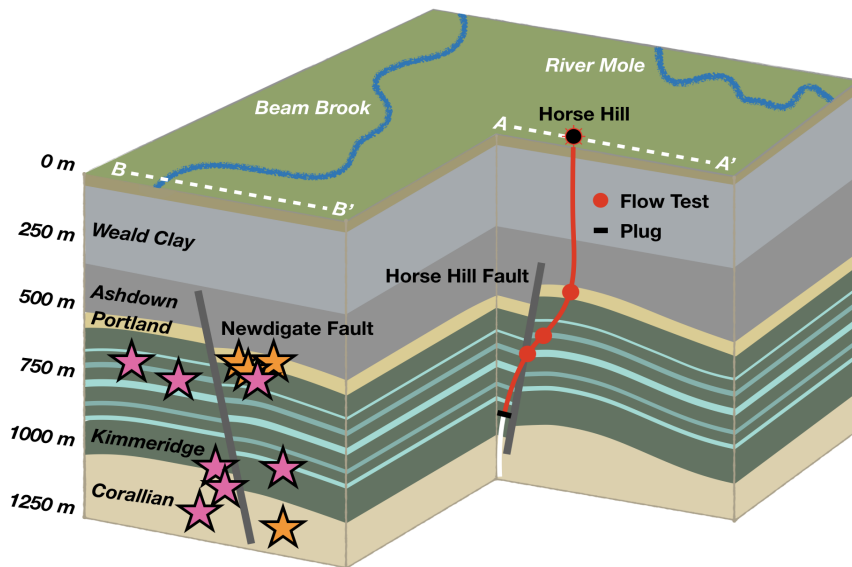


Figure C, Section: Horse Hill well relative to local faults and earthquakes projected onto section B-B'