

Imperial College London

'Surrey swarm' earthquakes not caused by nearby oil extraction, says study

by [Caroline Brogan](#)
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The Gatwick quakes seem naturally caused

Imperial College London research has found no evidence that oil extraction caused recent earthquakes known as the 'Surrey swarm' in Surrey and Sussex.

The series of [34 small earthquakes](#) between April 2018 and May 2019 occurred within 10 km of two active oil extraction sites at Brockham and Horse Hill in Surrey.

If oil extraction caused the earthquakes, then it did so by a mechanism that hasn't yet been reported anywhere else in the world.

— **Dr Stephen Hicks**
Department of Earth Science and Engineering

Many residents of Newdigate, Dorking, Horley and Charlwood in Surrey, and Crawley and Horsham in West Sussex, [felt the largest quake](#), which reached a magnitude of 3.2.

As the British Isles don't lie along boundaries separating two tectonic plates, earthquakes that are felt by people are relatively rare - so there was concern that the swarm was triggered by nearby drilling and extraction.

Now, the [first in-depth study](#) of the quakes by Imperial, the [University of Bristol](#), and the [British Geological Survey](#) (BGS), has shown no direct link between oil extraction and earthquakes in the region.

The authors therefore believe natural causes were behind the earthquakes, which occurred close to [Gatwick Airport](#) in West Sussex.

The study looked only at conventional oil extraction. [Hydraulic fracturing](#) (fracking) does not happen in Surrey or Sussex and was not looked at in this study.

Lead author [Dr Stephen Hicks](#), of Imperial's [Department of Earth Science and Engineering](#), said: "The quakes seem to have occurred naturally, and our findings suggest their closeness to oil extraction sites is probably a coincidence."

The paper is published in *Seismological Research Letters*.

Clues in the ground

During the early stages of the swarm, the researchers installed seismometers – instruments that measure ground vibrations – around the affected areas. The highly sensitive devices tracked the timings, strengths, and distribution of earthquakes.

The researchers also used earthquake data from existing sensors in citizens' homes, known as '[RaspberryShakes](#)', that had been 'listening' since late 2017 for seismic activity in the area.



Fig 1: Dr Stephen Hicks (L) and a colleague install seismometers

Based on data from the seismometers, the study team examined a variety of properties of the Surrey quakes and compared them to previous ones that were caused by both human activities and by natural causes in the UK and elsewhere.

Most natural earthquakes in the UK cause rocks on either side of weaknesses in the ground, known as faults, to move horizontally. In contrast, earthquakes caused by oil extraction cause rocks either side of faults to move vertically.

The researchers found that the Surrey swarm quakes moved ancient faults horizontally, indicating that the quakes would probably have happened regardless of nearby oil extraction.

From the BGS seismometers, the researchers detected 168 small magnitude earthquakes between 2018 and 2019. The first cluster of earthquakes happened in April 2018, long after oil extraction tests in 2016, but well before further extended tests starting in July 2018, adding to the evidence that they were naturally caused.

This is not the first time earthquakes have come seemingly from nowhere and without human input.

– Dr Stephen Hicks
Department of Earth Science and Engineering

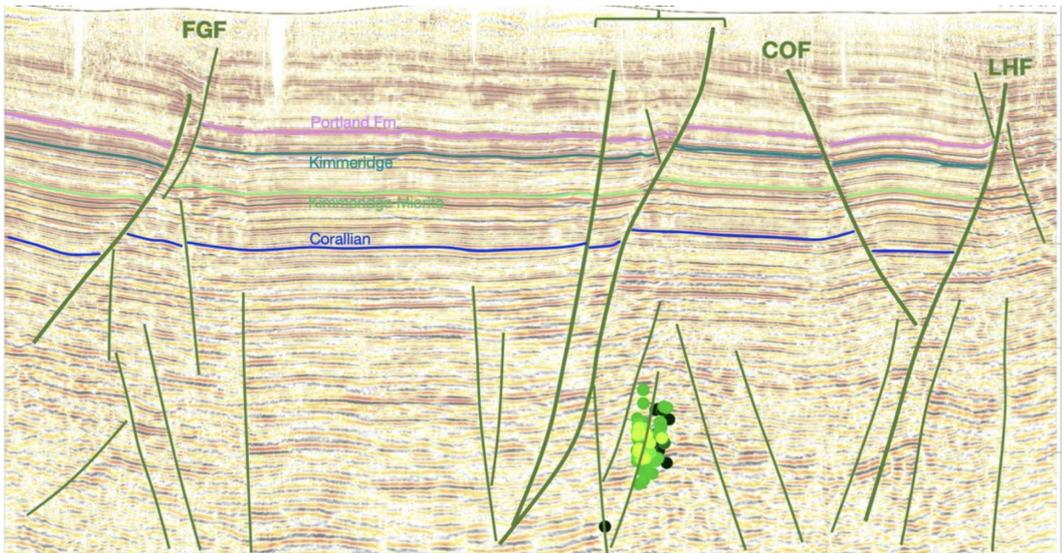


Fig 2: The ground beneath the quakes. Green vertical lines show fault lines; Multicoloured horizontal lines show the main rock formations; Green bubbles indicate quake locations.

Dr Hicks said: "The ground vibrations recorded from earthquakes provide clues that hint at their cause. There are increasing examples worldwide of human activity causing earthquakes, but it can be difficult to work out which newer cases are natural, and which are human-caused."

Correlations

The researchers also looked at the distance between the earthquakes and extraction sites. Rather than cluster round the extraction sites, the quakes were distributed in a tight cluster more than 3 km away from the extraction sites.

This area, said Dr Hicks, is too far away to link the quakes to oil extraction. He said: "It would be unprecedented for this type and scale of oil extraction to affect sites more than a kilometre away."

The team also examined the depth at which the quakes occurred. To do this, they compared the locations of the earthquakes with images of rock layers beneath the area. The images were created by measuring the reflection of sound waves off each layer (Fig 2).

They found that although the Surrey earthquakes were shallow (around 2.5 km deep), they occurred deeper than rock formations from which oil is extracted (less than 1 km deep).

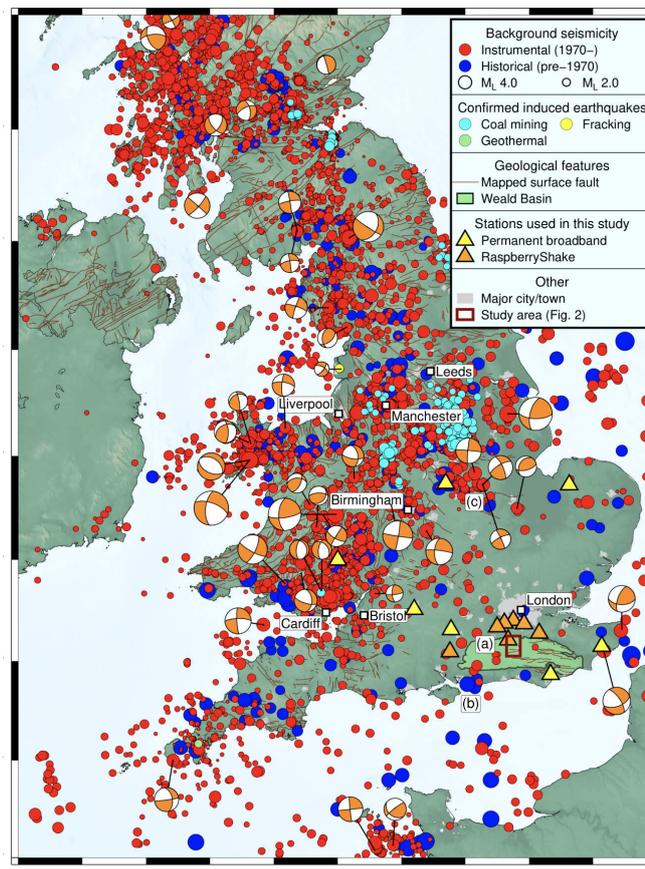


Fig 3: Map of earthquake data in England and Wales, showing the study area south of London and indicating background seismic activity (from BGS), industrial-induced earthquakes, and locations of study seismometers.

Tectonic stress

The more data we have, the more we'll know about the causes and effects of these earthquakes. Who knows which clues from the ground we'll pick up in the future.

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The paper is the first piece of research that uses high-precision data and modelling to look at the cause of the Surrey swarm. The researchers are unsure why the swarm came about suddenly in one of the UK's least seismically active areas - and it's not currently possible to predict natural earthquakes.

The authors say the swarm, like most natural earthquakes in the UK, could have been caused by ongoing collision of the African and Eurasian tectonic plates in the Mediterranean Sea – the UK's nearest plate boundary – which stresses the crust and causes earthquakes across Europe.

Dr Hicks said: "This is not the first time earthquakes have come seemingly from nowhere and without human input. Decades of instrumental recordings and hundreds of years of historical accounts of earthquakes show that similar seismic swarms have happened in the UK before due to long-term tectonic stresses and without any clear link to human activities."

Industrial activities have been known to cause earthquakes in the past, known as 'induced seismicity'.

In most of these cases, quakes are caused by injecting fluids for fracking or disposal of waste fluids. Since fracking does not currently take place in Surrey or Sussex, this study focused on conventional oil extraction, in which there is no such large-scale injection of fluid.

Dr Hicks added: "If oil extraction caused the earthquakes, then it did so by a mechanism that hasn't yet been reported anywhere else in the world."

The researchers are continuing to monitor quakes in the area for the foreseeable future. Dr Hicks said: "The more data we have, the more we'll know about the causes and effects of these earthquakes. Who knows which clues from the ground we'll pick up in the future."

This piece of research was not funded or commissioned by any organisation. The researchers involved are funded on other, separate geoscientific projects unrelated to the Surrey earthquake sequence.

The equipment used to monitor the earthquakes, and arising data, was fully provided by the British Geological Survey, as part of the UK's responsive national seismic monitoring capability.

The researchers do not receive any funding from the companies discussed in the study. There are no conflicts of interest to declare.

"A Shallow Earthquake Swarm Close to Hydrocarbon Activities: Discriminating between Natural and Induced Causes for the 2018–2019 Surrey, United Kingdom, Earthquake Sequence" by Stephen P. Hicks, James Verdon, Brian Baptie, Richard Luckett, Zoë K. Mildon, and Thomas Gernon, published 27 August 2019 in *Seismological Research Letters*.

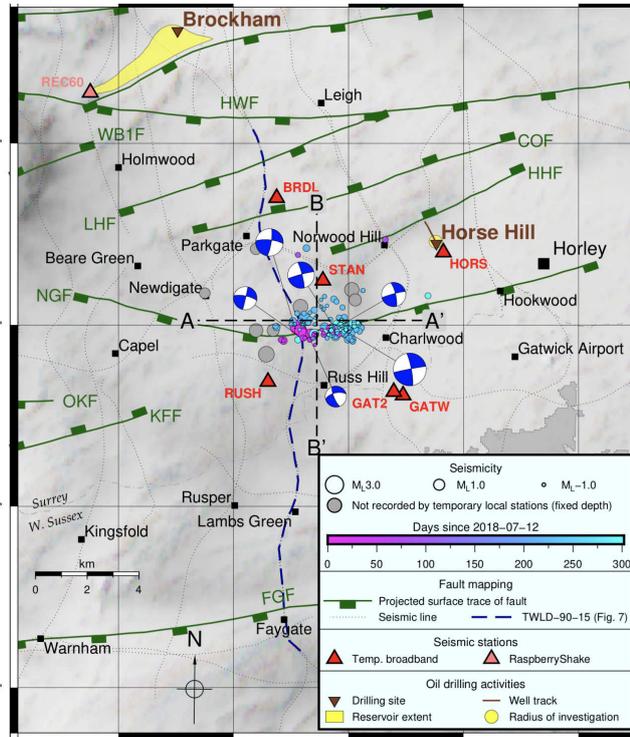
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A closer look at seismic and scientific activity in Surrey and Sussex.



The quakes affected areas around Gatwick Airport

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