

## Information In Question & Answer Format – Natural & Induced Seismicity

### What is an earthquake?

Earthquakes happen when rocks underground move suddenly because of the surrounding pressure. If the movement is large, and takes place along a natural break in the rock (for example a major structure like the San Andreas Fault in America), a large amount of energy is released and the ground shaking can cause a lot of damage. At the other end of the scale, tiny movements along small faults and fractures such as those in Cornwall release much less energy and generally go unnoticed.

Earthquakes happen constantly all over the world. Large and destructive ones are relatively rare but there are a million tiny earthquakes every year.

### How are earthquakes detected and located?

Earthquakes can be detected and located using networks of seismometers. In the UK these are installed and managed by the British Geological Survey (BGS). The energy from an earthquake reaches seismometers at different times, depending on how far away they are from the event and the speed that the signal (vibration) travels through the rocks.

If the same earthquake is detected at several seismometers it is possible to calculate where the epicentre was, how deep the earthquake was and how big it was. The epicentre is the location on the earth's surface directly above the earthquake.

There is little coverage by the national network in Cornwall but Geothermal Engineering Ltd (GEL) has installed a more sensitive network around the site to improve the detection limits and accuracy.

### Is a seismic event the same as an earthquake?

Yes, seismic event is just another name for an earthquake. They are sometimes also called tremors.

### What is a microseismic event?

As the name suggests, a 'micro' seismic event is a very small seismic event. This term is usually used to describe events with a magnitude of less than 1.

### What does seismic magnitude mean?

There are various scales used to measure the size of earthquakes. Many people are familiar with the Richter Scale, which describes the amount of energy released at the source deep underground. Earth scientists now refer to this as the local magnitude ( $M_L$ ). When people talk about a magnitude 2 event, this is what they mean.

The magnitude scale is logarithmic, which means that each increase of 1 in the scale means a 10-fold increase in the amount of energy released. So, a magnitude 2 event is ten times bigger than a magnitude 1, and a magnitude 3 is ten times bigger than a magnitude 2, and so on.

Destructive earthquakes generally have magnitudes of 6 or above. The 2011 earthquake in Japan had a magnitude of about 9; ten million times stronger than a magnitude 2 event.

### What is an induced seismic event?

Induced events are exactly the same as natural ones, except that the trigger for the movement is human activity, rather than a gradual build-up of geological pressure over time. The seismic shock waves are still generated by movements of rock, but in the case of geothermal projects, this can be caused by water pressure helping to unstick the rock along the faults or small fractures.

### Should I be worried about seismicity induced by geothermal development in Cornwall?

No, there is no need to worry. Although the operation of geothermal reservoirs in Cornwall is likely to cause some seismicity, most induced events will be much too small and too deep to be noticed at the surface. And even if any are strong enough to be felt, they are still very unlikely to cause any damage.

GEL has installed a sensitive network of instruments to detect and locate any seismicity and will continuously monitor activity and take mitigating action.

During the Hot Dry Rock project in Cornwall in the 1980s, about 10,000 microseismic events were recorded but only two were felt at the surface and neither did any damage or caused any harm.

### How big an earthquake might you create?

A detailed seismic hazard assessment was carried out by Ove Arup & Partners in 2017 for the project. The assessment concluded that the seismicity induced during the Hot Dry Rock research programme in the 1980s is probably the best indicator of the seismicity to expect at United Downs and that those events never reached a magnitude greater than 2 (see "what does seismic magnitude mean?" above).

### Is what you're doing the same as 'Fracking'?

No it isn't. The concept being tested at United Downs relies on circulating water through natural fractures in the rock. This is not the same process as Fracking, where the injection of large volumes of fluids at high flow rates and pressures is used to create multiple new fractures in intact rock, to drain the oil or gas from the reservoir.

### Is UDDGP an EGS project – do you have to stimulate to make it work?

EGS stands for Engineered Geothermal System (or some people refer to it as Enhanced Geothermal System). In general, developers of these systems use large scale hydraulic or thermal stimulation to improve the permeability of natural fractures in the rock. There is a lot of research going on around the world into investigating techniques that can achieve good results without an unacceptable seismic or environmental risk.

Although there are some similarities, GEL does not consider UDDGP to be an EGS project. Our concept relies on naturally high permeability existing in our target structure (the Porthtowan Fault), and very large spacing between the wells. We might carry out localised stimulation of our wells

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to improve their connection into the natural fracture system, but we don't plan to carry out a large scale hydraulic stimulation programme.

### How do you know whether you caused a seismic event or not?

GEL has installed a network of seismometers around the UDDGP site, which is continuously providing real-time data and can detect and accurately locate both large and small seismic events. If a seismic event is detected, GEL and seismic specialists will quickly be able to work out where it happened. Depending on how far it was from the site, and on what work was being done at the time, it will be possible to determine whether it was the result of GEL's activities or not.

In fact, the seismic monitoring equipment can detect events that are hundreds of times too small to be felt at surface and this monitoring will be done on a continuous basis. GEL has a contract with a local seismic specialist who will provide accurate measurements of any seismic activity and will also pass the data to BGS for them to interpret. A seismic management procedure is in place so that GEL can work with the relevant authorities. The team will post relevant information on their social media.

### How are you regulated?

The project is regulated by Cornwall Council. Our seismicity management protocol uses existing British Standards and planning guidelines for blasting, quarrying and mining activity. Importantly, it is based on how much ground vibration is measured at the surface, rather than on the magnitude of the induced event (see "what does seismic magnitude mean" above).

### Is your traffic light system the same as the shale gas industries and why are you allowed to create larger events than them?

The 'unconventional' oil & gas extraction industry (often referred to as the Fracking industry) is regulated by the Oil and Gas Authority (OGA), who have set low limits on induced seismicity and require the developers to operate a 'traffic light' system to manage their activities. They must halt activity if an event of magnitude 0.5 is detected, irrespective of its effect at the surface. Geothermal developers are not regulated by the OGA and are not required to adhere to their limits or their methodology. This does not mean that geothermal projects are unregulated; just that they are regulated in a different way.

The most important difference as far as UDDGP is concerned is that our seismicity management protocol is based on ground vibration at the surface, not on event magnitude at the source. We believe that this is a more appropriate methodology since it relates directly to the impact on people and property and it is consistent with planning regulations already in force in Cornwall for other industries that could cause ground vibrations, such as mining, quarrying and construction.

Our protocol requires GEL to take action only on the basis of surface vibration, so it is possible that an event larger than magnitude 0.5 would be 'allowed' – as long as the surface vibration was below the threshold for action.

The protocol uses Peak Ground Velocity (PGV) measurements to trigger changes in operational state. Typically, people cannot feel movements below 2mm/s but GEL will move from a 'Normal' to a 'Caution' operating state if any seismicity results in a PGV of more than 0.5mm/s as measured by the project's seismometer network.

### Is my house insured if you cause damage?

We have the normal public liability insurance but there is no specific cover for induced seismicity. It would be necessary to prove that the damage was caused by induced seismicity from the project.

### How can I get more information?

You can always contact the project team if you have any questions or concerns using one of the methods below:

24 Hour Phone:	01326 331920
Email:	<a href="mailto:contact@geothermalengineering.co.uk">contact@geothermalengineering.co.uk</a>
Postal Address:	Community Relations Manager Geothermal Engineering Ltd Unit 3, Gate B United Downs Industrial Estate Redruth Cornwall TR16 5HY
Website:	<a href="http://www.geothermalengineering.co.uk">www.geothermalengineering.co.uk</a>

Seismicity Animation can be viewed on the **Geothermal Engineering Ltd YouTube channel**

Project updates are posted on social media, follow us on Facebook or Twitter.