

What is an earthquake?

Earthquakes happen constantly all over the world when rocks underground move suddenly because of a build-up in surrounding pressure. This generally happens along a natural break in the rock, such as a fault or fracture zone produced by tectonic movement in the past. If the movement is large, a large amount of energy is released, and the ground shaking can cause a lot of damage. However, these sorts of events only tend to happen along tectonic plate boundaries, where the Earth's crust is moving at incredibly fast rates. At the other end of the scale, tiny movements along small, natural faults and fractures such as those in Cornwall release much less energy and generally go unnoticed.

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 the location, magnitude and depth of the earthquake.

There is limited coverage by the national network in Cornwall but Geothermal Engineering Ltd (GEL) has installed a more sensitive network to improve our detection limits and accuracy. The location of the seismometers within this network will be moved to suit new development sites.

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?

A microseismic event is a very small seismic event. This usually means an event 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 the cause may be blasting in a local quarry, a low-flying helicopter or the testing of a geothermal well. In the case of geothermal projects, ground movement 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?

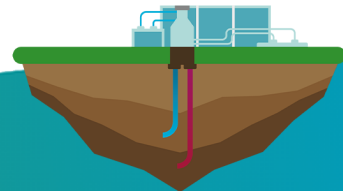
No, there is no need to worry. Although the testing and development of geothermal reservoirs in Cornwall is likely to cause some seismicity, most induced events will be incredibly small and release very little energy. Cornwall's geology means that even minor movements may be felt across a small area close to the development. However, induced seismicity is regulated and carefully managed so it is not dangerous and will not cause any damage.

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 caused any damage to infrastructure or any harm to the local community.

How big an earthquake might you create?

A detailed seismic hazard assessment was carried out by Ove Arup & Partners in 2017 for the United Downs 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; those events never reached a magnitude greater than 2 (see "what does seismic magnitude mean?" section).

This was proven at United Downs, where injection testing caused a maximum event magnitude of 1.7 M_L . However, production testing caused no seismicity, so no events are expected once the powerplant is operational.



Is what you're doing the same as Fracking?

No it isn't. The concept proven at United Downs relies on circulating water through natural fractures in the rock. This is not the same process as fracking, where a large volume of fluid with a complex chemical composition is injected at extremely high flow rates and pressures to create multiple new fractures in intact rock, to drain the oil or gas from the reservoir. Fracking brings concerns with waste disposal and contamination, whereas geothermal development simply circulates fresh water in pre-existing fractures and, once the heat is used at the surface, reinjects it into the same formation, as regulated by the Environment Agency.

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

GEL has installed a network of seismometers around the United Downs site, which will be relocated and expanded for future sites, as necessary. This network 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 also post relevant information on their social media.

How is seismicity 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, referred to as Peak Ground Velocity, or PGV. This is believed to be a more accurate depiction of what will be felt by people in the local area compared to the magnitude (M_L) of an event (see "What does seismic magnitude mean?" section).

Is your traffic light system the same as the shale gas industry 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 GEL projects are 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.

GEL operates at very conservative vibration limits. Cornwall Council set a maximum PGV of 8.5mm/s for a single event in their daytime blasting regulations, and previous research suggests that humans cannot generally feel movements with a PGV of less than 2mm/s. However, at United Downs a maximum PGV of 0.8 mm/s was felt by some individuals. Therefore, operations at all GEL sites will enter a 'caution' state if events with a PGV greater than 0.5mm/s are detected during the day. Above this, operations will be closely monitored and if further significant events are detected, operations will cease until the reservoir stabilises.

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 find information on the GEL website or contact the project team if you have any questions or concerns using one of the methods below:

Telephone:	01326 331920
Email:	contact@geothermalengineering.co.uk
Postal Address:	Community Relations Manager Geothermal Engineering Ltd Unit 3, Gate B United Downs Industrial Estate Redruth Cornwall TR16 5HY
Website:	www.geothermalengineering.co.uk

