PREESE HALL SHALE GAS FRACTURING:
REVIEW & RECOMMENDATIONS FOR INDUCED SEISMIC MITIGATION

Comments from:
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GeoScience Limited

GeoScience Limited is an earth science consulting company formed in 1985 by staff who were then working on the UK Hot Dry Rock geothermal research programme. We have a long standing interest in the exploitation of geothermal resources in Devon and Cornwall and we are now partners in a deep geothermal project proposed for United Downs, near Redruth. We also work for oil & gas companies on new and existing developments, and gas storage projects.

The development of deep geothermal resources in the UK relies on a range of techniques encompassed by the term EGS, or Engineered Geothermal Systems. One of those techniques is the shear stimulation of natural fractures by the injection of water. Such injections will cause microseismic activity which will be detected and located by highly sensitive equipment as a diagnostic tool for reservoir creation. Several thousand similar events were induced during the Hot Dry Rock programme, (1979-1990) at the site of the experiments in Cornwall.

We therefore have significant relevant experience in the field of induced seismicity and also a vested interest in the principles and methodologies that will be used to monitor and control it in the UK.
Summary of our comments

We have concerns and questions about several aspects of the report and its recommendations:

1. We believe that the basis for any 'traffic light system' of control should not be event magnitude, but surface ground motions.

2. We believe that the appropriate control mechanism should be through Local Authority planning procedures, using methodologies adapted from those already in use to control ground vibrations from construction, mining and quarrying.

3. IF event magnitude is to be used as the basis for control then we believe that the 0.5ML trigger proposed is much too low and is not justifiable.

4. We believe that the objective of mitigating against events that are 'perceptible to local residents' is unrealistic and unreasonable. The objective should be to mitigate against events that are potentially harmful or a nuisance.

5. We believe that the current trigger level will effectively prevent any significant fluid injections from taking place, whether for shale gas, carbon dioxide storage, or geothermal development, since no seismic hazard assessment would rule out the possibility of events greater than 0.5 ML. The proposals would therefore effectively prevent shale gas, carbon dioxide storage, or geothermal developments from proceeding.

6. We believe that, if similar constraints are placed on any activity that is liable to induce surface disturbances consistent with deep 0.5 ML events, then there will be a serious impact on other industries, for example oil & gas, mining, quarrying, gas storage and construction.
Further discussion

1. We believe that the basis for any ‘traffic light system’ of control should not be event magnitude, but surface ground motions

A traffic light system based on magnitude is not appropriate. The depth, location, population density, cover geology and even the weather would all significantly affect how many people felt any given event, and what they would experience. The report itself mentions that Intensity is a better measure of the effects people feel at surface and that small shallow events may be more strongly felt than large deep ones.

The magnitude number is only a measure of the strength of the event at its source and several factors could determine the felt effect. Indeed the report mentions that the observed effects of the 1.5 M_L event last year were an order of magnitude different at two nearby locations.

What matters to people is the amount of shaking they feel, either because it disturbs them or because they fear the damage or harm it may cause. However, the report doesn’t explore the possibility of using surface measurements of ground motion for the traffic light system.

2. We believe that the appropriate control mechanism should be through Local Authority planning procedures, using methodologies adapted from those already in use to control ground vibrations from construction, mining and quarrying.

The monitoring should be brought in line with existing Local Authority planning controls for damaging vibrations caused by construction, mining or quarrying. These are well understood, the impacts on residents are well known, the vibrations are relatively easy to measure and the concepts are easier for the public to relate to.
3. If event magnitude is to be used as the basis for control then we believe that the $0.5M_L$ trigger proposed is much too low and is not justifiable.

The report recommends that if any events of $0.5M_L$ or larger are detected, then activity must stop and remedial action must be taken. However, we believe that there is insufficient justification for this trigger level and that it is unrealistically low.

The report uses seismic activity from flooding mines as an analogy and concludes that $M_L 3.0$ is the likely maximum induced event in the UK. It goes on to say that this size of event is essentially harmless; there is no record of such an event having caused any structural damage.

However, it then makes the case for setting the red light trigger at $0.5M_L$ on the grounds that if it had been higher (e.g. the 1.7 proposed by Cuadrilla) then the 2.3 $M_L$ event last April wouldn’t have been prevented when the 1.5 $M_L$ event occurred. The logical implication is that 2.3 $M_L$ events should be prevented, even though the actual event did no damage and it is several times smaller than the hypothetical maximum, and ‘harmless’, 3.0 $M_L$ event.

During stimulation and circulation experiments on the Hot Dry Rock programme in the 1980s, many thousands of very small events were induced. Several hundred events were large enough to be located by the BGS regional network and, of these, about 250 were $0.5M_L$ or larger. Only two were felt by the local population and neither did any damage.

4. We believe that the objective of mitigating against events that are ‘perceptible to local residents’ is unrealistic and unreasonable. The objective should be to mitigate against events that are potentially harmful or a nuisance.

The logic of the red light trigger level seems puzzling until it is recognised that the recommendations are not intended to prevent harmful events, but to prevent perceptible events. In other words, the report recommends a methodology by which any event that might be noticed by anybody at surface should be prevented. We believe that this is unrealistic, unreasonable and unnecessary.
There is a great deal of room between perceptible events and harmful ones, or even nuisance ones. The fact that an event may be noticed should not automatically make it unacceptable. We would like to see a wider acceptance of ‘acceptable seismicity’ and ‘harmless, even if felt’ events.

There is a good analogy here with noise. Local Authority planners do not place conditions on construction sites, airports, or industrial installations to make noise imperceptible to residents; they require it to be kept below certain levels to prevent harm or nuisance. The same principle should apply to induced seismicity.

We also believe that it would be helpful to adopt a less emotive terminology when discussing these events. ‘Earthquakes’ is used throughout the report to describe seismic events of any size, however small. The UK population is generally unfamiliar with the precise meaning of the various measurement scales and therefore even referring to small earthquakes is likely to over emphasise the size of the event.

5. We believe that the current trigger level will effectively prevent any significant fluid injections from taking place, whether for shale gas, carbon dioxide storage, or geothermal development, since no seismic hazard assessment would rule out the possibility of events greater than 0.5M\textsubscript{L}. The proposals would therefore effectively prevent shale gas, carbon dioxide storage, or geothermal developments from proceeding.

If the red light trigger level is set at 0.5 M\textsubscript{L} it will be impossible to apply the recommendations in any practical sense because all shale gas operations will stop. The report rightly recommends that seismic hazard assessments should be carried out before any operation. However, it is inconceivable that any worthwhile assessment would rule out the possibility of M\textsubscript{L} 0.5 events, in which case, presumably, the operation would not be permitted.

In this sense, the report contradicts itself. It gives permission for ‘fracking’ to take place but then sets conditions that will most likely make it impossible.
The impact reaches beyond shale gas. In our own proposed geothermal project we require numerous events at sub 1.0 M$_{L}$ in order to map the developing reservoir. Furthermore, our seismic hazard assessment predicts that events of 2.0 M$_{L}$ are likely, but would be imperceptible. If DECC were the regulator for our project and we submitted this assessment for approval, presumably we would be prevented from proceeding.

The report suggests that in the light of the trigger being exceeded (or presumably if it is predicted to be exceeded) operators should determine suitable protocols to mitigate any future risks. We do not believe any protocols could be developed to operate below the proposed trigger level.

The report goes on to say that the threshold can be adjusted over time in the light of developing experience but that does not allow operations to begin now and, therefore, there will be little or no experience to learn from.

6. We believe that, if similar constraints are placed on any activity that is liable to induce surface disturbances consistent with deep 0.5M$_{L}$ events, then there will be a serious impact on other industries, for example oil & gas, mining, quarrying, gas storage and construction.

Industries that potentially cause ground vibrations by induced seismicity should not be singled out from those that cause it by other means. Under nearly all circumstances, the ground motion that would be caused by a 0.5 M$_{L}$ event would be extremely small, or non-existent. If the same constraints were placed on other industries that cause motion by blasting, subsidence, air blast, fluid injection or withdrawal then all these industries would be severely affected, or even prevented from operating.

For and on behalf of
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