

Fracking and earthquakes—weighing up the dangers in South Africa

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There are concerns about the negative environmental and social impact of fracking in the Karoo. Credit: Martin Heigan/Flickr

The South African government is looking into fracking to reduce the



country's huge reliance on coal for energy. Fracking involves pumping high pressured fluids <u>into rock formations</u> to release reserves of oil and gas.

Estimates for gas deposits in the main Karoo region of South Africa range widely. A few studies have been done for government on the potential for shale gas in the country. These include a report on the technical readiness for a shale gas industry, a strategic environmental assessment on shale gas and a multi-authored academic book on hydraulic fracturing in the Karoo. Government must now integrate this information into policy and develop regulations for the <u>fracking</u> industry.

Environmental groups and landowners <u>are concerned</u> about the negative environmental and the social impact of fracking. They say that it could have an impact on water quality and quantity, and could also cause habitat fragmentation and loss. They are also worried about possible increased seismicity associated with deep well waste water injection and <u>fracking operations</u>.

Our research set out to look at the link between earthquakes and fracking. It formed part of the vulnerability mapping for fracking in South Africa. We found that <u>the areas</u> with the highest vulnerability for seismicity linked to fracking were in the parts of Western Cape, Gauteng, North West Province, Mpumalanga, KwaZulu-Natal and one of South Africa's neighbours, Swaziland. Even though no gas is expected to be found in many of these areas, they would still be prone to the seismic effects of fracking in the Karoo basin, the site of what is assumed to be the country's biggest gas deposits.

Seismic hazards in South Africa are not high by international norms. But there could be significant damage to infrastructure if seismicity increases.



Fracking and earthquakes

During fracking a mixture of water, sand and chemicals – known as fracking fluid – is pumped under high pressure into a well to fracture rock and release hydrocarbons. These hydrocarbons are extracted at the wellhead together with wastewater that contains a mixture of fracking fluid and formation water. The wastewater can be disposed of by injecting it underground through deep wells.

Both extraction and underground injection of fluids have been <u>shown to</u> <u>cause earthquakes</u>. But the size of these events are unclear; ranging from relatively small earthquakes such as the magnitude 2.3 in <u>Blackpool</u>, <u>England</u> to the 5.7 magnitude <u>earthquake</u> in <u>Prague</u>, <u>Oklahoma in</u> <u>November 2011</u>.

There have been at least two <u>seismic events</u> of concern with magnitudes equal or larger than 7.0, both in <u>Gazli in Uzbekistan</u> where gas is withdrawn. Although they could not be linked directly to fracking, they showed some features associated with fracking-induced earthquakes.

The connection between waste water pumping and seismicity is unquestionable. <u>Scientists believe</u>, that three factors are responsible for fracking induced or triggered seismic events:

- the presence and orientation of tectonic faults,
- state of stresses in the fault subsurface, and
- the depth and relation between the faults and the fracking process as a whole.





Map of seismic hazard for South Africa showing the expected PGA with a 10 % probability of being exceeded at least once in a 50 year period. Credit: Esterhuyse et al., 2014

Seismic activity in South Africa

Seismic data of past events in South Africa are incomplete because the <u>South African National Seismograph Network</u> primarily monitors areas of mine-related seismicity in the country's central and northern parts.

The first seismic records were started in 1620, but these contain significant <u>data gaps</u>. Information about active faults that can cause earthquakes is limited; that's why information from similar tectonic



areas like central and eastern US is normally used.

What we do know is that large seismic events – or earthquakes – are rare in South Africa. This is because the country is positioned on the interior of a tectonic plate, a relatively rigid area that's more stable compared with other <u>plate boundaries</u>.

The country has experienced several large mining-related earthquakes in the past. One occurred in Stilfontein on <u>9 March 2005</u>; another near Orkney on <u>5 August 2014</u>. Both earthquakes, with magnitudes 5.3 and 5.5 respectively, were powerful enough to damage the surrounding infrastructure.

South Africa's most devastating tectonic-origin earthquake, measuring magnitude 6.3, occurred of the Cape at St Lucia on <u>31 December 1932</u>. On September 29 1969 an earthquake measuring 6.3 hit towns in the <u>Western Cape</u>, killing 12 people and causing extensive damage.

Seismic hazard in South Africa

The effect of fracking on the local seismic region can be measured by analysing the seismicity before, during, and after the fracking process.

But there is little knowledge on geological information for the Karoo region where fracking has been proposed. Figure one shows the distribution of <u>seismic hazard</u> in South Africa. This means that potentially dangerous faults in the region may go undetected. It's important to get more geological and tectonic information as well as data about the degree and depths of the proposed fracking process in the region. This could tell us what seismic effect to expect as a result of fracking.

It is extremely important to monitor local seismic activity before



fracking starts to create a baseline for the specific site and surrounding areas. Seismic monitoring before exploration will aid in identifying the location of faults and the stress field nature in areas where it is currently unknown. This, linked with <u>seismic monitoring</u> during and after fracking, can help scientists perform reliable risk assessments to assist with proper regulation.

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