ReSEARCH

ReFINE
RESEARCHING FRACKING IN EUROPE

ReFINE Briefing Note

How radioactive is fracking flowback water?

Durham University

This research brief is based on 'The flux of radionuclides in flowback fluid from shale gas exploitation' by Sam Almond, Sarah Clancy, Richard Davies and Fred Worrall (2014). The paper was published in *Environmental Science and Pollution Research* and is available for free download at www.refine.org.uk.

Shales are common, fine-grained sedimentary rocks, some of which contain large volumes of oil or gas trapped within them. To extract these **hydrocarbons**, the shales have to be hydraulically fractured. This involves the injection of fluids into the rock under high pressure. Some of the injected fluids may dissolve radioactive substances occurring naturally in the shale and transport them to the surface. To investigate whether the levels of radioactivity are high enough to pose a threat to human health, researchers at Durham University investigated the composition of fracking flowback water.

What are fracking fluids?

Hydraulic fracturing, or fracking, is a process used to create fracture networks in rocks. Shales have very low permeability, meaning that materials flow through them very slowly. If shales contain oil or gas, therefore, it can only be extracted economically by using hydraulic fracturing. The **fracking fluids** used to do this are a mixture of water, chemicals, and proppants (solid substances, such as sand), and are injected down a well into the shale at high pressure. This process creates a network of small fractures, held open by the proppants, enabling the oil or gas to flow into the well.

What are flowback fluids?

As they pass through the shale, fracking fluids dissolve many substances trapped naturally in the rock. The substances include particles of naturally occurring radioactive material (**NORM**), such as potassium (K) and radium (Ra). By dissolving chemicals trapped in the shale, the injected fluids can also become very salty. Some will return via the well to the surface and if they do so, are known as **flowback fluids.** Understanding their chemical composition is crucial to assessing whether they might have any impact on human health or the wider environment.

What radioactive exposure is permitted?

Everyone is exposed to radiation every day, with doses measured in millisieverts (mSv). In the UK, the average person is exposed to 2.7 mSv per year from a combination of natural sources, such as food and rocks, and medical sources, such as x-rays. In the USA the average annual radiation dose per person is 6.2 mSv. International regulations stipulate that, for members of the general public, the maximum permitted radiation dose above the natural background level is 1 mSv per year.

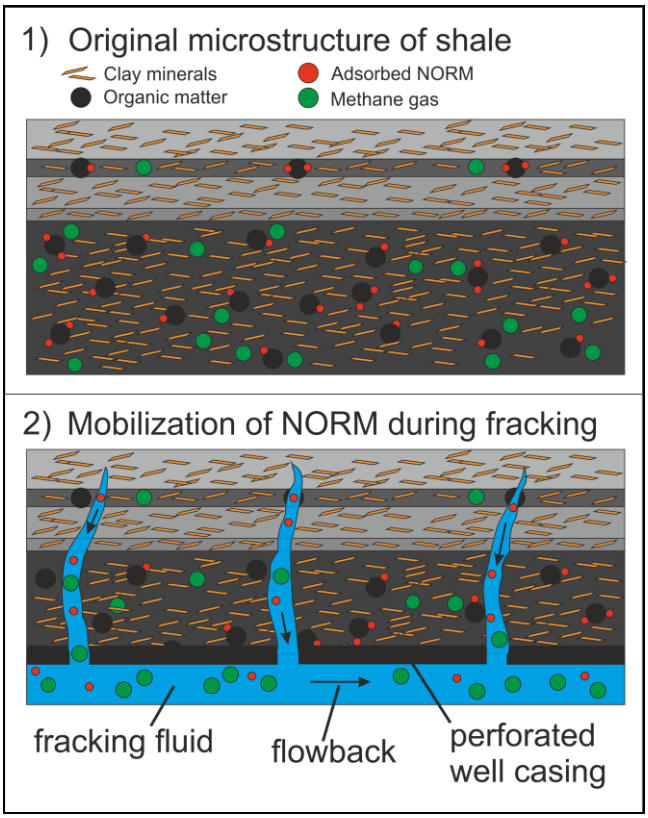

Figure 1: Schematic diagram of NORM in shales. **1)** Shales are typically composed of clay minerals, quartz and calcium carbonate. Some shales contain organic matter, which, when heated sufficiently, will release gas, such as methane. NORM is commonly stuck (adsorbed) to the surface of the organic matter. **2)** In shale gas production, a well is drilled down into gas-rich shales, usually buried at depths of 1.5 km or more. A horizontal well is drilled into the shale, and fracking fluids forced into the rock at high pressure through holes in the well casing. The flowback fluid carries gas back up the well to the surface, but also picks up and transports some particles of NORM.

How radioactive are flowback fluids?

To investigate how much NORM ends up in shale gas flowback fluids, researchers carried out a study of shale gas operations in the Barnett Shale, USA; the Bowland Shale, UK; and Silurian shales in Poland. The radioactivity of the flowback fluids was examined, and 99% exceedance values were calculated. These are the levels of radioactive exposure for which there is a 99% probability that they will not be exceeded. For the US and UK fracking fluids, the values were just over 0.09 mSv, whilst for Poland the value was 0.43 mSv.

How do these compare with other fluids?

To compare with their concentrations in flowback fluids, the levels of NORM present in groundwater in the US, UK and Polish shale basins were also analysed. These data showed that, in the US and Polish groundwater, the radioactive flux was 7-8 times lower than in flowback fluids, and around 500 times lower in the UK groundwater.

The radioactivity of fluids produced during conventional oil and gas production, and nuclear power generation were also examined. Data from the UK showed that fluids produced during conventional oil and gas production have a 50% likelihood of their radioactivity exceeding 13 mSv. Nuclear power discharge waters were found to have a radioactivity two orders of magnitude larger than the flowback fluids.

What can we conclude?

The levels of NORM measured in flowback water are many times higher than found in groundwater, but a long way below the permitted UK exposure limits. Their radioactivity is also lower than that of fluids produced by conventional oil or gas production, or nuclear power. In terms of flux per unit of energy produced, shale gas flowback fluids are also much less radioactive than the burn products of coal-fired power stations.

Shale gas exploitation will result in an elevated flux of NORM to the surface, and these flowback fluids must be treated. However, their radioactivity remains low enough that they are unlikely to pose a threat to human health.

ReFINE
RESEARCHING FRACKING IN EUROPE

School of Civil Engineering and Geosciences
Drummond Building
Newcastle University
NE1 7RU

Tel: +44 (0)191 208 6611

Contact:

Mr. Sam Almond:
sam.almond@newcastle.ac.uk

ReFINE website:
http://www.refine.org.uk

Follow ReFINE on Twitter:
@ReFINEresearch