

An introduction to shales and fracking

This science brief aims to provide a general overview of shale gas, explaining the terms commonly used. It is produced as part of the Researching Fracking In Europe (ReFINE) project, led by Durham Energy Institute. Further information on ReFINE can be found on the project website: www.refine.org.uk.

From Britain to Bulgaria, Ukraine to the USA, **shale gas** and **fracking** seem to be constantly in the news. But what are shales, why do they contain gas, and what is the fracking process? Led by the Durham Energy Institute, the ReFINE project is using scientific research to investigate fracking in Europe. This guide provides an introduction to the topic and explains some of the key terms.

What is shale?

Shale is a **mudstone**, a sedimentary rock formed by layers of mud accumulating over millions of years and slowly being squeezed and compressed into stone. Mudstones are very common in the rock record, which is not surprising, since mud is the most common sediment on Earth. It covers most of the present-day sea floor and much of the land.

Muds and mudstones are composed of four main components: **clay** (tiny, flat mineral particles), **quartz silt** (small pieces of this common, tough mineral), carbon-rich **organic matter** (the broken-down bodies of plants and animals), and **calcium carbonate** (lime, often from shells). These occur in different ratios in different mudstones, but geologists often give the name **shale** to clay- and organic matter-rich mudstones that split into thin layers. Figure 1 shows an example of a shale from the Jurassic Coast of Dorset, UK.



Figure 1: A Jurassic shale from Dorset, UK. The black layers are very rich in carbon-rich organic matter, whilst the white layers are full of the calcium carbonate shells of fossilized plankton. The field of view (left-to-right) is around 20 cm.

What is shale gas?

Particles of natural gas, typically methane, are often trapped in the pores of mudstones. If the quantity of trapped gas is high enough, and the succession of gas-bearing shale beds is thick enough, it can be economically viable to extract the gas for use as a fossil fuel. This is **shale gas**.

Why do shales contain gas?

Not all shales contain gas. They need to have formed from muds that had a high quantity of organic matter in them. When such muds get buried, compressed and heated, the organic matter is 'cooked' and broken down, and gas is



released. This typically requires temperatures of at least 100 degrees Celsius, which normally occur 3 km or more below the Earth's surface. Once the gas is generated, some of it will migrate up towards the surface, but much will remain trapped in pores in the shale. This trapped gas forms a **shale gas reservoir**, which is the target of exploration.

What is fracking?

Fracking is a short term for **hydraulic fracturing**. Hydraulic fractures can form naturally when pressurized fluids escape from deeply buried rocks and fracture them as they travel upwards. However, **fracking** is the process by which high-pressure fluids are injected into rocks to create fractures in them. These man-made cracks are kept open by **proppants** such as sand.

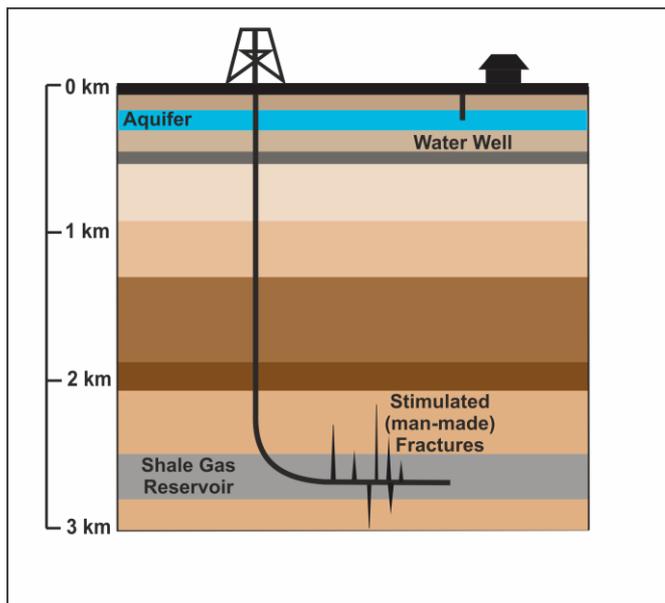


Figure 2: Simplified diagram of hydraulic fracturing (fracking) for shale gas. A well is drilled down into the shale gas reservoir and fluids are then injected into the well at high pressure. At the target horizon, the fluids are injected into the shale. This produces man-made fractures that enable gas to flow from the shale into the well.

Why is fracking used to extract shale gas?

Shales are **porous**, containing many tiny pores within which natural gas can be trapped. However, these pores are not interconnected, meaning that shales have very low **permeability**. As such, the gas will not flow through the rock. To release it, permeability must be created by hydraulically fracturing the shales. The thin, fluid-filled cracks produced by fracking enable the pores in the shale to become connected, and for the gas to flow out of the rock and into the well.

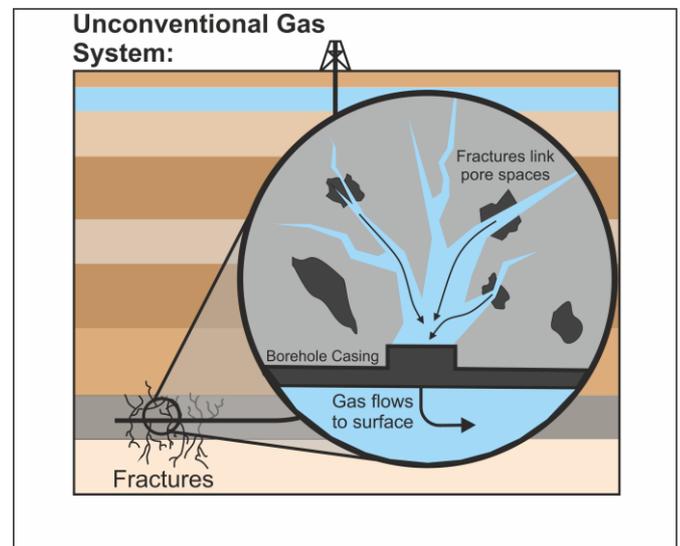


Figure 3: Simplified close-up diagram of hydraulic fracturing (fracking) for shale gas. The injection of high-pressure fluids into the shale creates thin fractures that connect the separate, gas-bearing pores. This allows the gas to flow into the well and up to the surface.

