end of this decade. This is replicated throughout the world. For example, the United States is preparing to build its first reactor since the 1970s; the United Arab Emirates have ordered reactors from Korea; Vietnam has two reactors on order from Russia and many other countries around the world are either considering renewing their nuclear reactor fleet or building reactors for the first time in their history. New detector technology is also helping us decommission our existing fleet of nuclear reactors in a safe, efficient and cost effective manner.

After 100 years of nuclear physics research we have a much more detailed model of the nucleus but the essence of the Rutherford model with a nucleus and orbiting electrons is still at its core. If he could visit The University of Manchester today he would still see a thriving School of Physics and Astronomy, and a dedicated team of nuclear physicists continuing to probe the nucleus and attempting to reveal more of its secrets. Although the UK no longer has a nuclear structure research accelerator, its nuclear physicists are still advancing this fundamental science at international facilities in France, Switzerland, Finland, Germany and the United States.

SHALE GAS – A HOME-GROWN SOURCE OF ENERGY AND FUEL

Professor Mike Stephenson
Head of Energy
British Geological Survey

Mike Stephenson publishes with the permission of the Director of the BGS (NERC)

Shale – usually thought of by geologists as a rather boring, uninteresting rock – might be an important source of methane gas for power and fuel in Britain into the future.

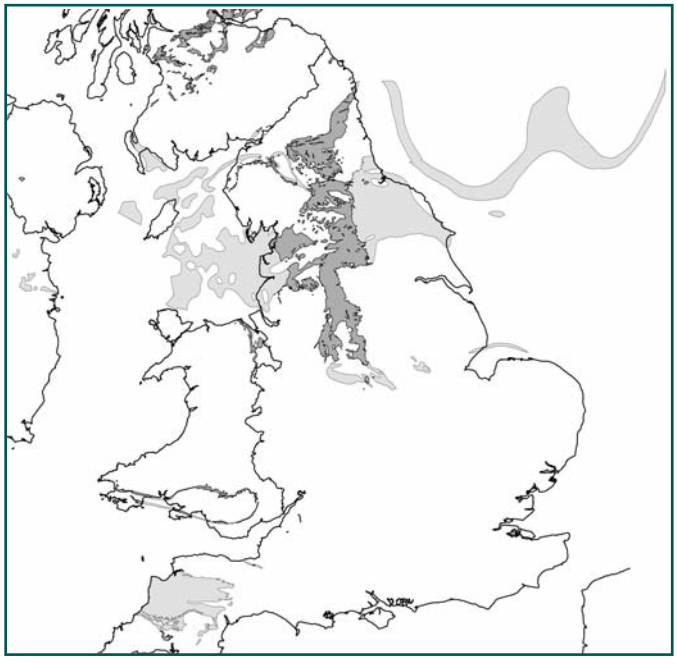
Shale is the most common sedimentary rock, and Britain has a lot of it – in northern England, the Midlands, Wales and southern England. It's a soft rock so often isn't seen at the surface, though it underlies much of the country. The British Geological Survey (BGS) has just finished an assessment of the amount of shale gas that might be present in these areas and has come up with some impressive figures[1]. The shale of the millstone grit rock sequence alone, for example, may contain 4.7 trillion cubic feet (TCF) of shale gas, which is about half of Britain's estimated reserves of more 'conventional' natural gas.

There is so much interest in shale gas that the last few years have been known as the 'dash for gas'. In the United States where much of the technology for shale gas extraction was developed, shale gas production has been a great success story. In 1996, shale gas wells in the US produced 0.3 TCF – only 1.6% of US gas production; but by 2006 production had more than tripled to 1.1 TCF per year, 5.9% of US gas production. One recent study has suggested that natural gas will provide 40% of America's energy needs in the future, from 20% today, thanks in part to abundant shale gas. Many people welcome shale gas particularly because of the increasing security of supply it brings, helping to make the US independent of energy producers in Russia and the Middle East.

The key to getting the gas out is hydraulic fracturing (also called 'fracking' or 'fraccing'). This technique, developed in the US, involves pumping high pressure water (or nitrogen) into the shale to crack it and release the gas. A simple well without fracking will not release much gas. The shale itself is very rich in organic matter from deposition in ancient seas and rivers, but the gas which is generated from the organic matter, can't move easily in the rock because it is so fine grained and impermeable. So fracking is generally essential.

The shale gas business is not so well-developed in Britain. There is only one shale gas well – near Blackpool – drilled by the American company Cuadrilla and there is no gas production yet. However, as the BGS study suggests, there might be shale gas over wide areas of Britain just waiting to be drilled.

The millstone grit is perhaps the best prospect. The millstone grit itself – famous for the millstones of the Peak District – is a sandstone, but between the layers of sandstone are layers of shale. One of these shale layers has been targeted by Cuadrilla. Another area is the Jurassic shale of the Weald and Wessex in the south of England. The BGS estimates that the onshore



Distribution of millstone grit in Britain

part of the Wessex Basin alone could yield up to 30 billion cubic feet (BCF) of shale gas. The very ancient Cambrian-age shale under the Midlands might yield another 300 BCF. Even the hard slates of parts of Wales and south west England might have gas in them.

But commercialisation of shale gas may not be so easy in Britain and Europe. Fracking has recently had a bad press in the United States and there is no denying that drilling for shale gas is an energy-hungry business. Water for fracking is needed in large quantities and there is also the problem of disposing of water that flows back to the well and the drilling rig after the fracking is finished. This water will be very dirty and need special treatment in tanks before it can be released into rivers or the sea.

At present the price of gas means that shale gas is only economic in the US. But for political reasons countries like Poland have their eye on shale gas as a possible secure source allowing them some independence from Russian gas, and a way of generating electricity in a slightly cleaner way than burning coal. Britain has cheap gas from Qatar and Norway, but if Britain's shale gas resource is as big as the BGS thinks, it will be hard to ignore.

1 https://www.og.decc.gov.uk/upstream/licensing/shalegas.pdf

THE MUSICAL BRAIN: IMPLICATIONS FOR EDUCATION AND BEYOND

Dr Ellie Dommett
Department of Life Sciences,
The Open University

The APPG on Scientific Research in Learning and Education explores issues at the interface between scientific research and education and few issues fit this remit more so than music, which has been the focus of a recent government review. As such the effects of music were considered by the APPG at a meeting chaired by Baroness Morris and Prof Coen of King's College London, a musician and neuroscientist. The meeting first heard from Prof Philip Sheppard of the Royal Academy of Music. Prof Sheppard outlined the extent of the impact music has on our lives, acknowledging its role in culture and bonding. He cites the example of nursery rhymes, which exist in all cultures, and carry a message about attempting something, failing and trying again – a primal message that is important to communicate to children. He also suggests that certain features of music such as inflection and gesture are critical to higher order communication. He explained how music can be beneficial to learning, citing the example of singing being used to assist learning lengthy material such as the Quran or periodic table. He suggested that there is a level of deep learning that occurs when individuals create music that is not present when you merely repeat what others have created. This creation also helps develop a sense of self and ownership and has strong implications for how we teach music.

Following Prof Sheppard, Dr Lauren Scott, a neuroscientist at Goldsmiths, University of London, outlined the impact music has on the brain. She explained that the brain changes throughout life in response to experiences and learning and that music can be considered a super skill. Unpicking this super skill she stated that music involves a number of different elements including the ability to plan and execute complex movement sequences as well as integrating information across the senses as one reads visual symbols and uses them to create a movement. She provided evidence detailing how the brains of musicians differ, showing enlargements of areas responsible for movement and touch processing as well as alterations to the regions involved in hearing. She states that one area often underestimated is expertise as listeners and how individuals can be educated to hear certain types of music as the brain learns what to listen to and effectively ensures that information is then heard. She outlined current research looking into musicality and what facets are associated with it. Although the research is ongoing, she suspects that not all facets will require formal musical training. From Dr Scott's presentation then, one could conclude that musicality in some form can be found in a large proportion of individuals, including those who have not received music training and that as well as education providing an opportunity to create music; it should consider teaching how to listen to music.

Finally Prof Susan Hallam from the Institute of Education spoke about the wider impact of music. She began with a note of caution that music is so much a part of our lives and so accessible that it is at risk of being taken for granted. She provided evidence of music improving social and personal development as well as language and therefore literacy, physical and intellectual development and attainment. For example, she cited music improving fine movements and therefore improving writing. She reported findings from the "In Harmony" project which demonstrated that music training can result in increased