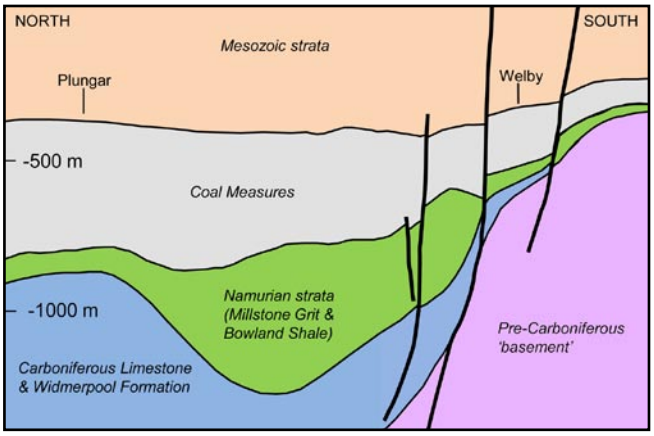
GEOBROWSER

Energy from the Vale of Belvoir

The pleasantly rolling pastoral scenery of the Vale and its surrounding wolds are developed on Mesozoic strata that conceal one of the most important resources of fossil fuels in north-western Europe. Its value is emphasized by the prodigious amounts of money spent during the last century on exploration. Coal was first proved in the 1920's, during a programme of deep drilling by the D'Arcy Exploration Company (later to become BP). Following intensive exploration during 1973-76 the NCB (National Coal Board) announced reserves of 510 M tonnes, making this the largest unworked coalfield in Western Europe (Mann, 1980; Vale of Belvoir Inquiry Report: HMSO). Meanwhile a combination of geophysics, underground colliery data and seismic surveys had earlier located anticlinal structures suitable for oil or gas accumulation. Oil was first struck in June 1939 to the north of the Vale of Belvoir, at Eakring (QJGS, 1945, 255-317); during the Second World War, with the help of imported American expertise from Oklahoma, many more wells were brought into production and the search extended farther south, into the Vale. This resulted in 33 wells sited around Plungar, which produced 304,067 barrels of oil between 1953 and 1959, but today there are only two producing fields, at Rempstone and Long Clawson.

One major outcome is that the Vale of Belvoir now contains a wealth of subsurface information - well over one hundred exploration boreholes have been drilled for coal and oil, some almost a kilometre deep, and these are augmented by a network of seismic profiles which, with an aggregate length of over 1000 km, probably exceeds the combined length of roads and footpaths. A brief period of underground coal extraction from the Asfordby pilot colliery was fraught with geological problems and ceased in 1997 (Report, Mercian Geologist, 1998), but the search for new oil reserves continues and the stage is now set for a third exploration phase - for shale-gas, which was highlighted on the BBC's Sunday Politics for the East Midlands on the 24th March this year.



Simplified section across the Vale of Belvoir (after BGS).

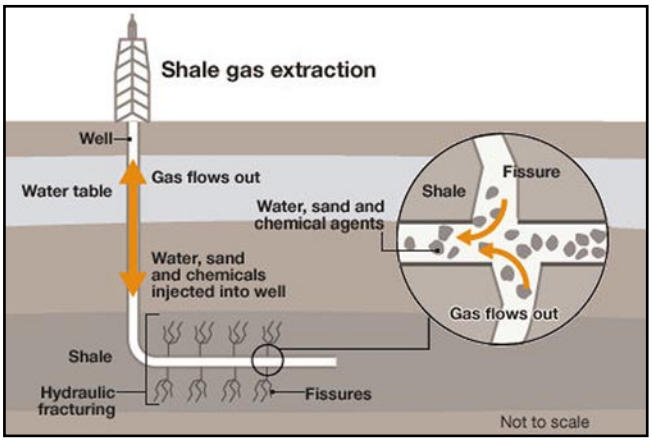
New prospects?

As we reported in Geobrowser for 2010, shale-gas could be a new hope for energy production and is a relatively 'green' resource of fossil fuel. Unfortunately however, sensational headliners have jumped on the bandwagon with titles such as: 'Rich Shale Gas Deposits found in Leicestershire' (http://thegwpf.org/uk-news/5321, from Leicester Mercury, 28 March 2012). On closer examination of this article we see that according to the BGS these are only potential 'deposits' that will require extensive sampling and drilling in order to prove. At the moment it seems that most prospection in the Vale of Belvoir will be directed at strata pre-dating the Coal Measures and in places lying at depths of over 1000 m. Due to syn-Carboniferous subsidence within a structure known as the Widmerpool Half-graben (or 'Gulf'), up to 500 m of potentially gas-rich source rocks are present in some parts. Of Namurian age, they are now referred to as the Bowland Shale Formation and are broadly equivalent to the unit formerly called the Edale Shale Group, which famously crops out at Mam Tor in Derbyshire. Rocks of similar age and lithology in the USA have proved suitable for gas production, causing a 'shale-gas revolution' there over the past 30 years; although the prospectivity of mudrocks is complex, and subject to a host of poorly-understood variables and the direct transfer of technologies to similar rocks in Britain is presently untested.

Fracking, earthquakes and toxic leakages

In order to extract shale-gas the enclosing strata must first be fractured, a process (hydrofracturing, or 'fracking') which involves pumping water and chemicals into shale rock at high pressure. Shale-gas exploration has attracted a vast amount of negative publicity associated with concerns including induced seismicity, demand for an already stressed water resource, and pollution of the local environment.

In Britain, the most alarming developments were the earthquakes of magnitudes 2.3 and 1.5 in April and May 2011 centred around the experimental fracking for shale-gas carried out by Cuadrilla Resources Ltd. at Preese Hall on the Fylde coast, Lancashire. An investigation confirmed that the timing of those earthquakes was closely related to that of fracking, and concluded that they most probably resulted from fluid injection that caused slippage along a pre-existing, critically-stressed



Method used for extracting gas from shale.

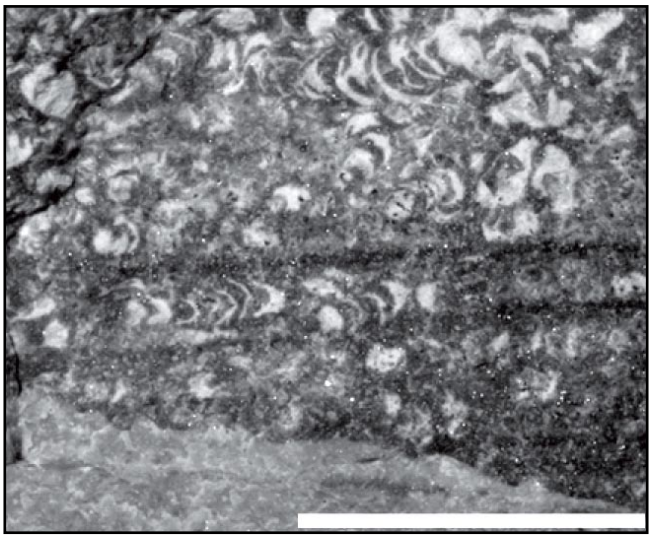
fault plane. The consensus of this and other reports, however, is that fracking-induced seismicity could be mitigated through a combination of close micro-seismic monitoring, more precise control over fluid injection, and the siting of injection intervals away from any fault systems identified in the borehole or known from geological surveys. Such occurrences should also be put into the local context, in that during the long history of underground coal extraction in Britain, mining-induced subsidence caused numerous events up to magnitude 3.

There have been several well-publicised reports in the USA of contamination of groundwater by methane, which in some cases has entered the domestic water supply via private water abstraction wells. The pathway in most cases is by poorly-completed gas abstraction wells, although it is worth stating that the regulatory regime in Britain is not the same as in the USA, and well integrity in Britain is covered by numerous stringent guidelines. Recommendations from the USA include assessing and continuously monitoring baseline data on groundwater quality and source of dissolved-gas concentrations before, during and after fracking (Proc. Nat. Academy of Science USA, 2011; 8172-8176). In Britain the BGS is currently undertaking the first part of this exercise, in order to establish baseline concentrations and likely sources of dissolved aquifer gases before any large-scale shale-gas exploitation begins.

If shale-gas extraction is proved to be commercially viable in the Vale of Belvoir, and the associated concerns can be satisfactorily controlled and mitigated without a prohibitive escalation of costs, then what are the chances of it going ahead? At the surface, the actual extraction sites for shale-gas are in themselves reasonably compact, but it is likely that a certain amount of infrastructure will be needed, such as booster stations and possibly a gas processing plant. The Environment Agency is currently supportive of shale-gas extraction but, as with all new power generation schemes in the UK, the final decision will most probably involve factors such as: national strategic necessity, local environmental 'pressure' and perhaps most importantly, a continued demand for safe, clean, indigenous sources of energy.

Precambrian bioturbation at Charnwood?

In 1995, a major upheaval in Charnian geology took place with the publication of a paper (Neues Jb. Palaeont. Abh. 195; 5-23) describing Teichichnus burrows in the Swithland Formation ('Swithland Slates'). Since Teichichnus is a deeply-penetrating burrow, and such features were unknown in strata of Precambrian age (i.e. pre-dating 542 Ma), the perceived wisdom was that the Swithland Formation was most probably Cambrian. This premise might now need to be revisited in the light of burrows described from of the Khatyspyt Formation (arctic Siberia), in a paper entitled: 'The oldest evidence of bioturbation on Earth' (Geology, 2012; 395-398). These burrows, named as Nenoxites, penetrate up to 5 cm in depth and represent both an intensely bioturbated ichnofabric as well as discrete, identifiable trace fossils. They occur in basinal mudstones and tuffs at a stratigraphical level constrained by U-Pb zircon determinations to be about 555 Ma old, which is 13 Ma before the end of the Precambrian. The appearance of Nenoxites is significant in two respects. First, it provides evidence that in the latest Precambrian there were animals capable of deep burrowing; and secondly it shows that for undated strata, such as the Swithland Formation, we may need to revisit certain of the palaeontological criteria previously used to assess their age.



Vertical cross section showing Nenoxites ichnofabric from the Khatyspyt Formation; the white scale bar is 1 cm long.