British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Shale gas

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Shale Gas Project
BRITISH GEOLOGICAL SURVEY

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- How much?
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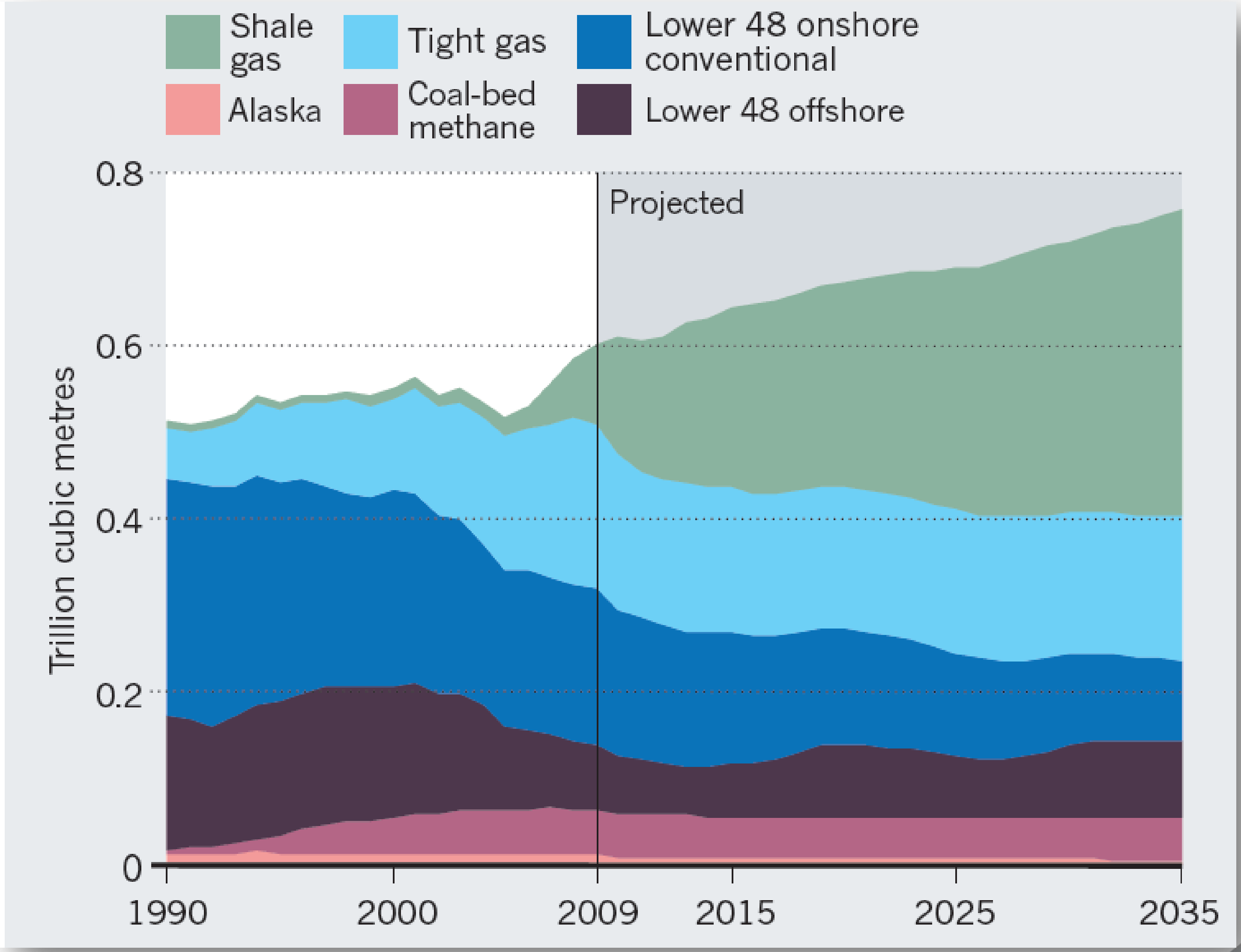
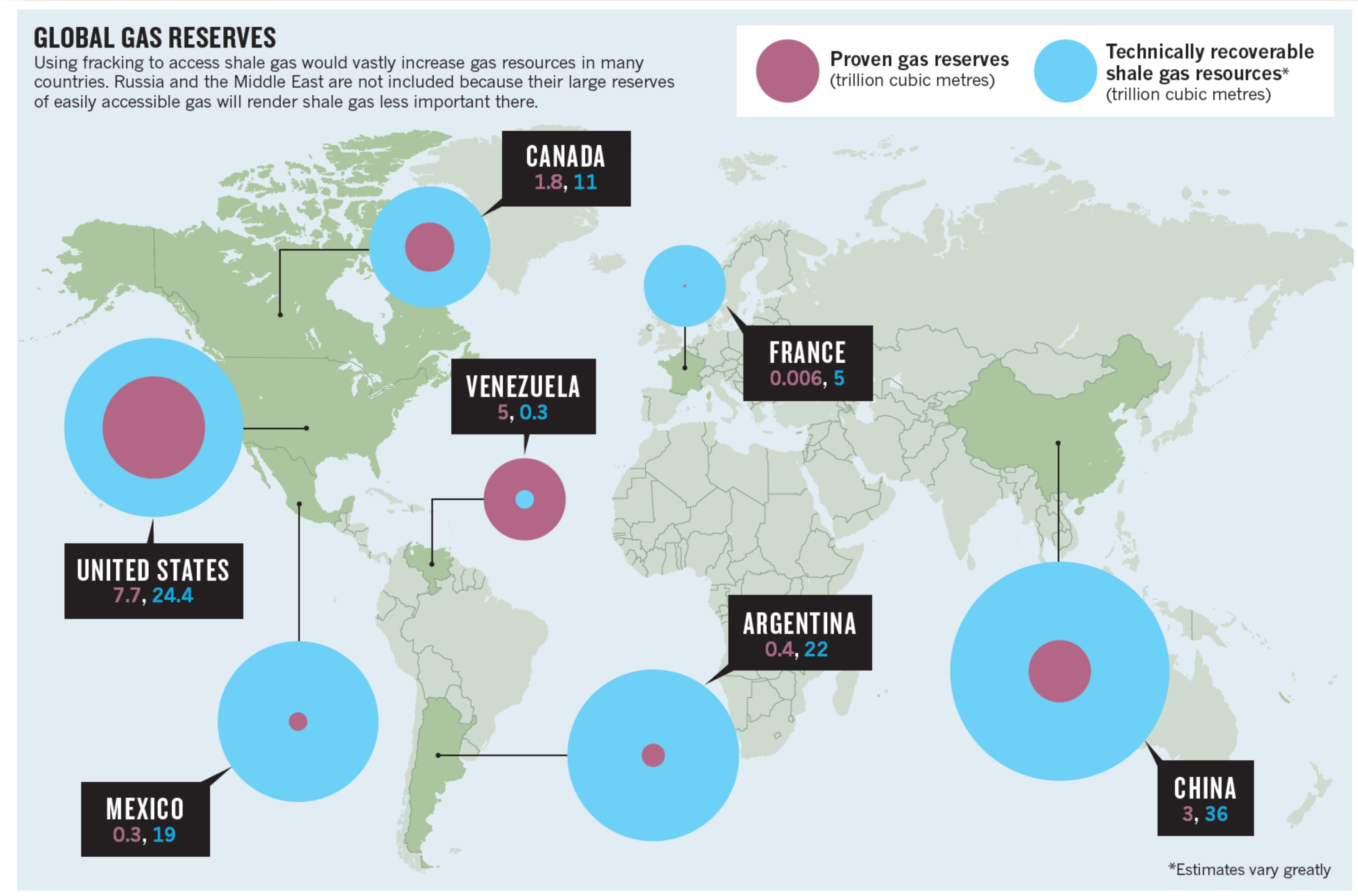
Background



Source: Nature Sept 2011

Background



Source: Nature Sept 2011

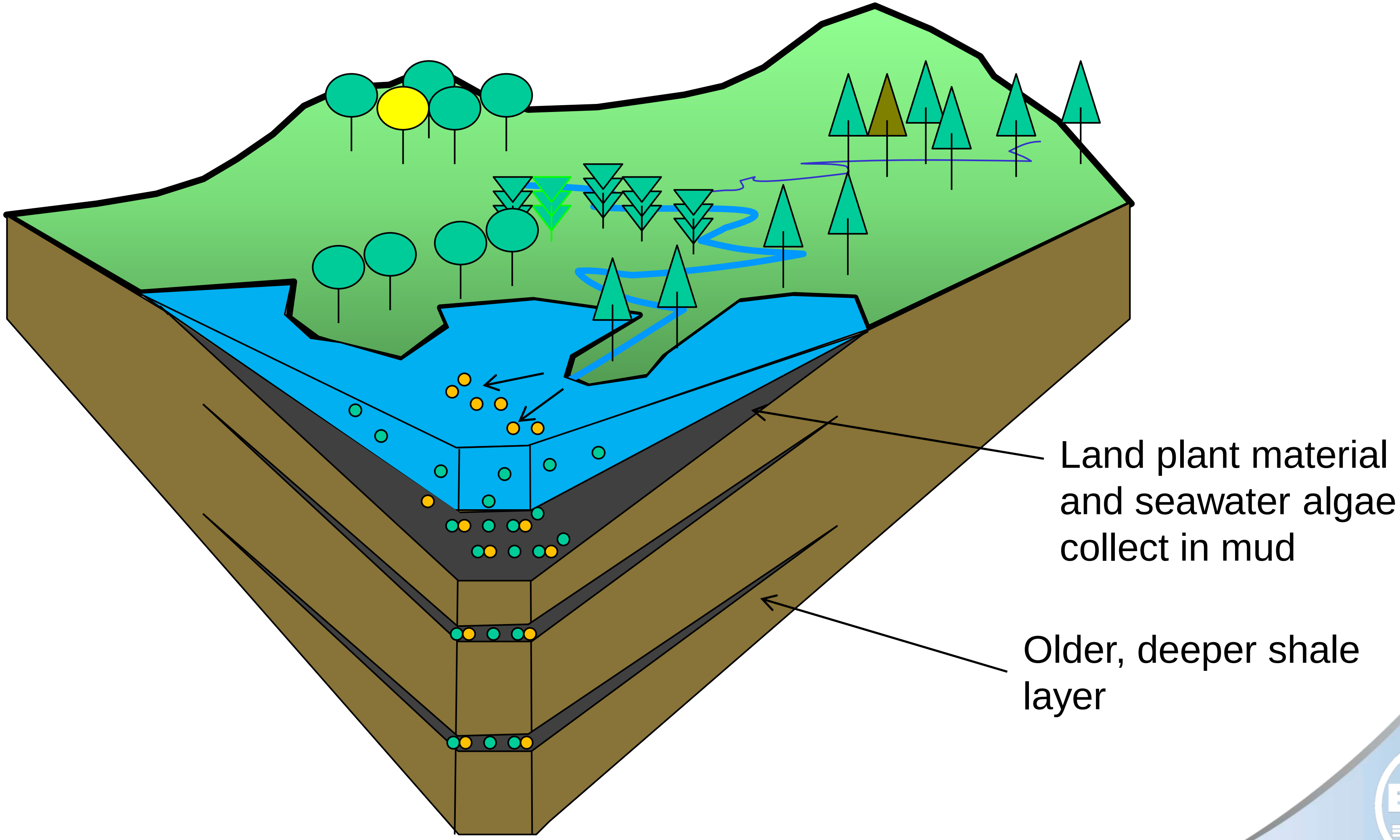
Background

Background

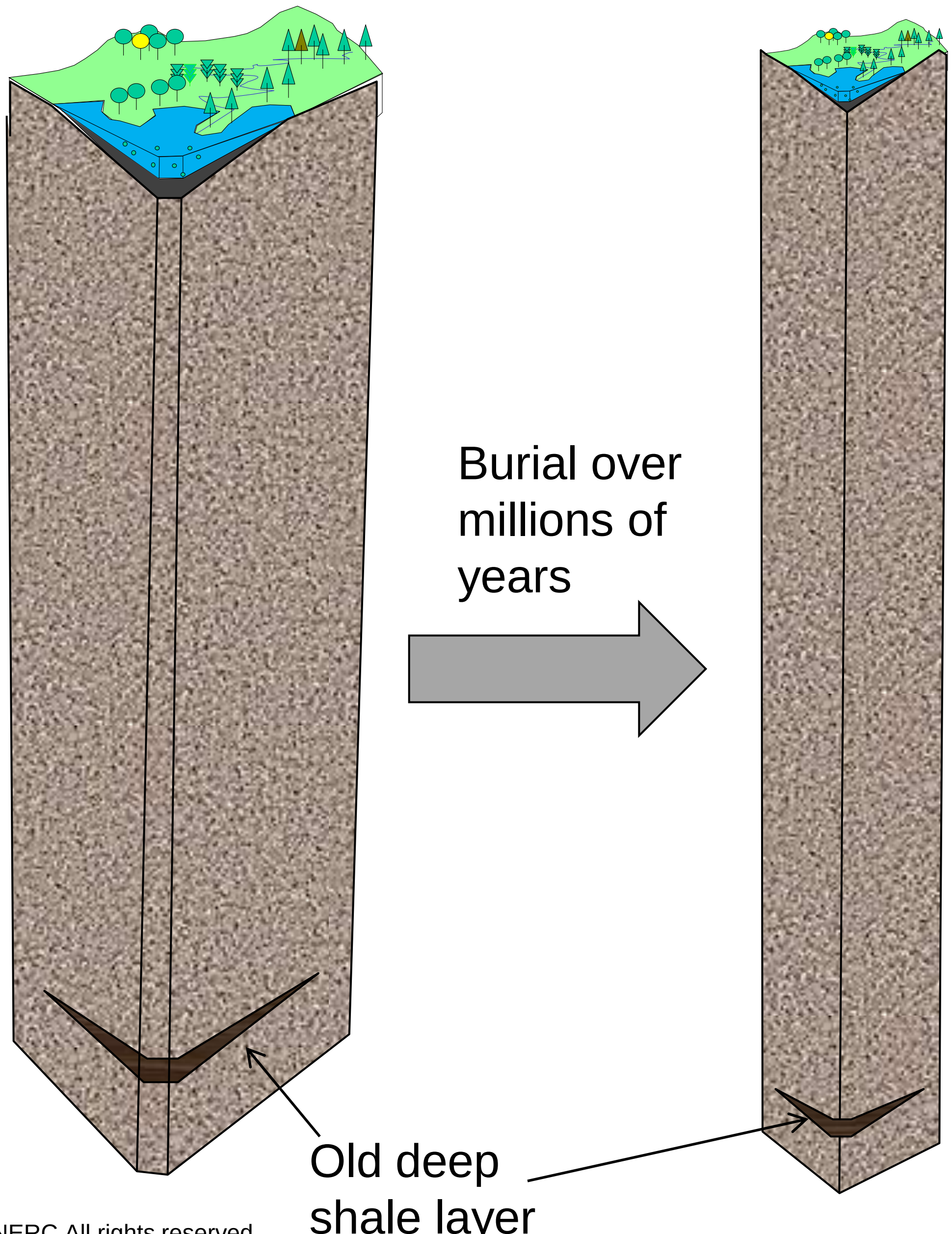
Shale basics

- Grey or black, soft
- Fine grained
- 70% of the world's surface rocks are sedimentary; 50% of those are shale.
- Contain ~95 % of the organic matter in sedimentary rocks

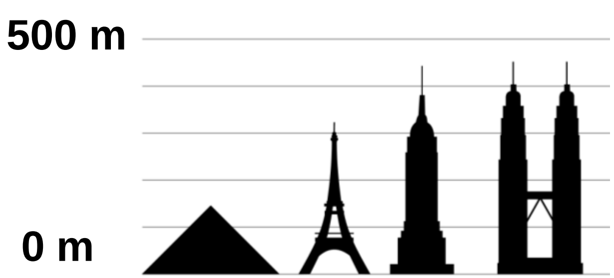
Where does the organic material come from?



What is shale gas?

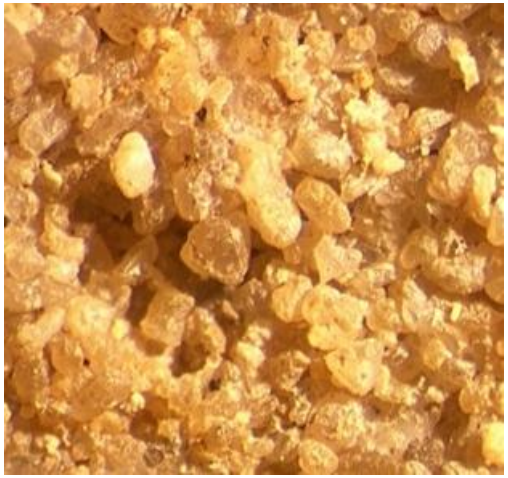


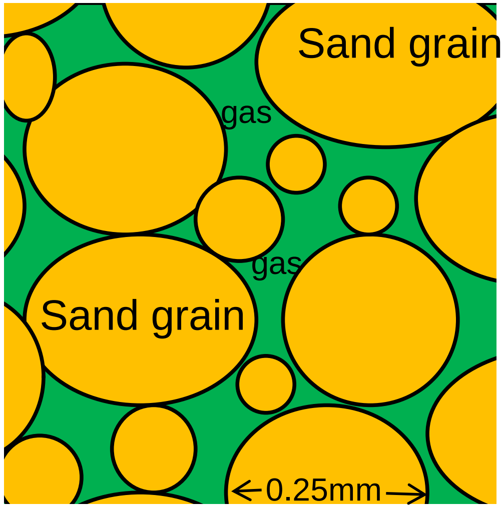
- Shale buried
- Biological decay – biogenic methane
- Organic matter ‘cooked’ – thermogenic methane



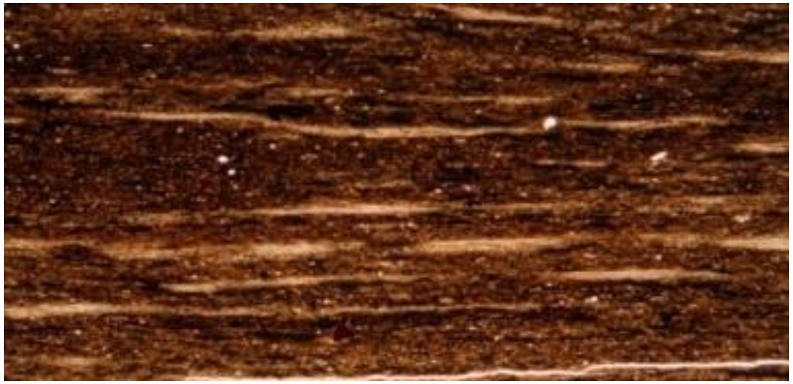
Conventional and unconventional

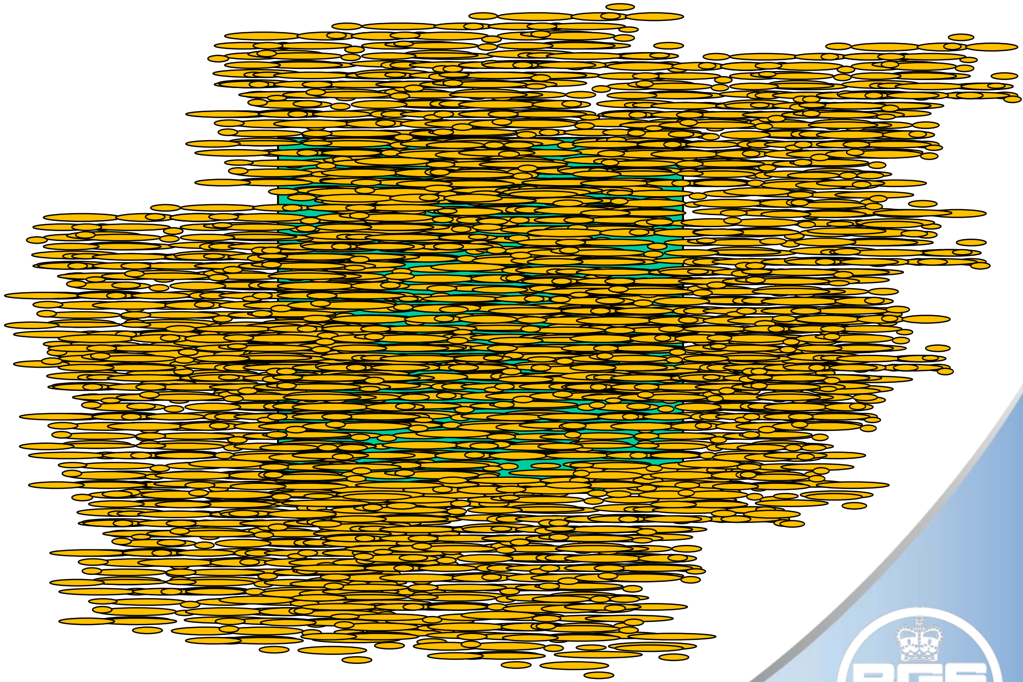
sandstone



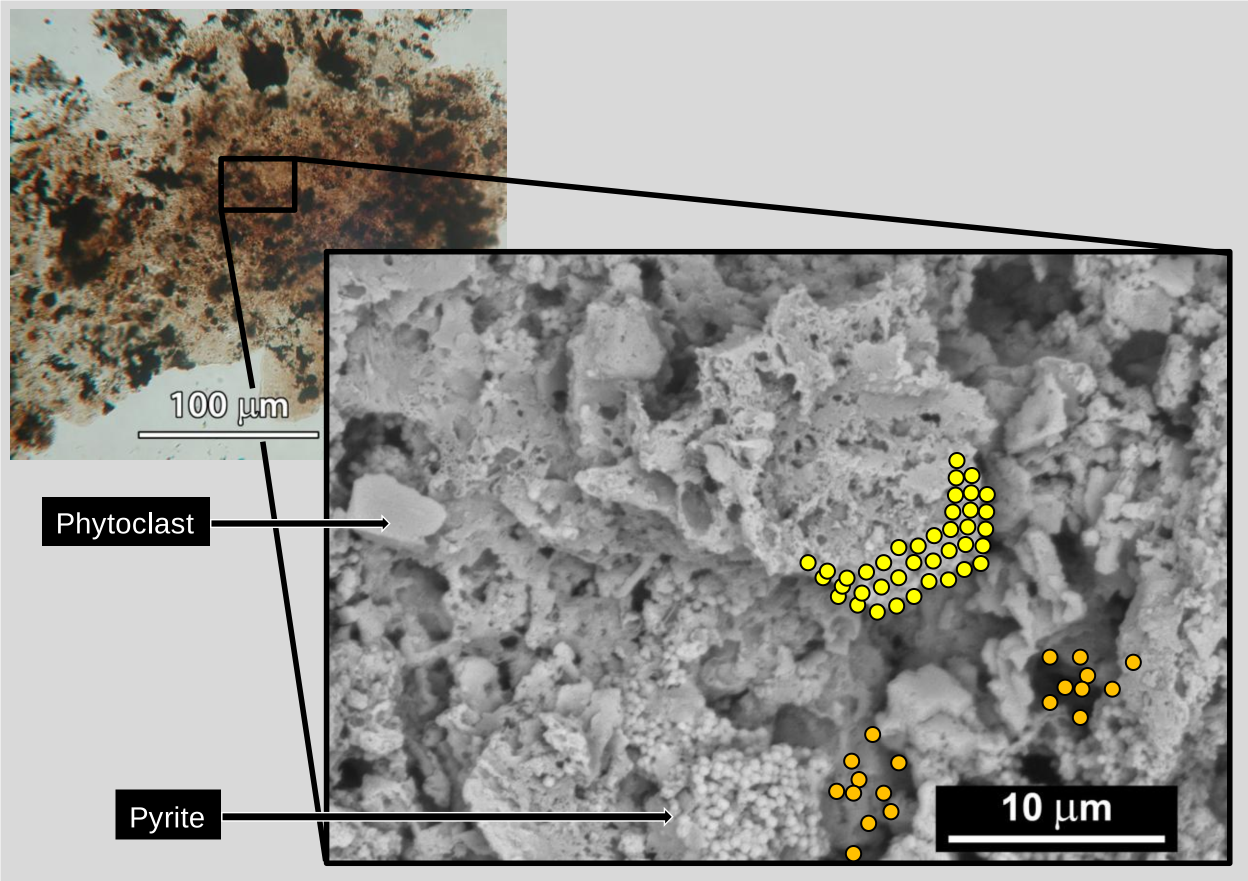


shale



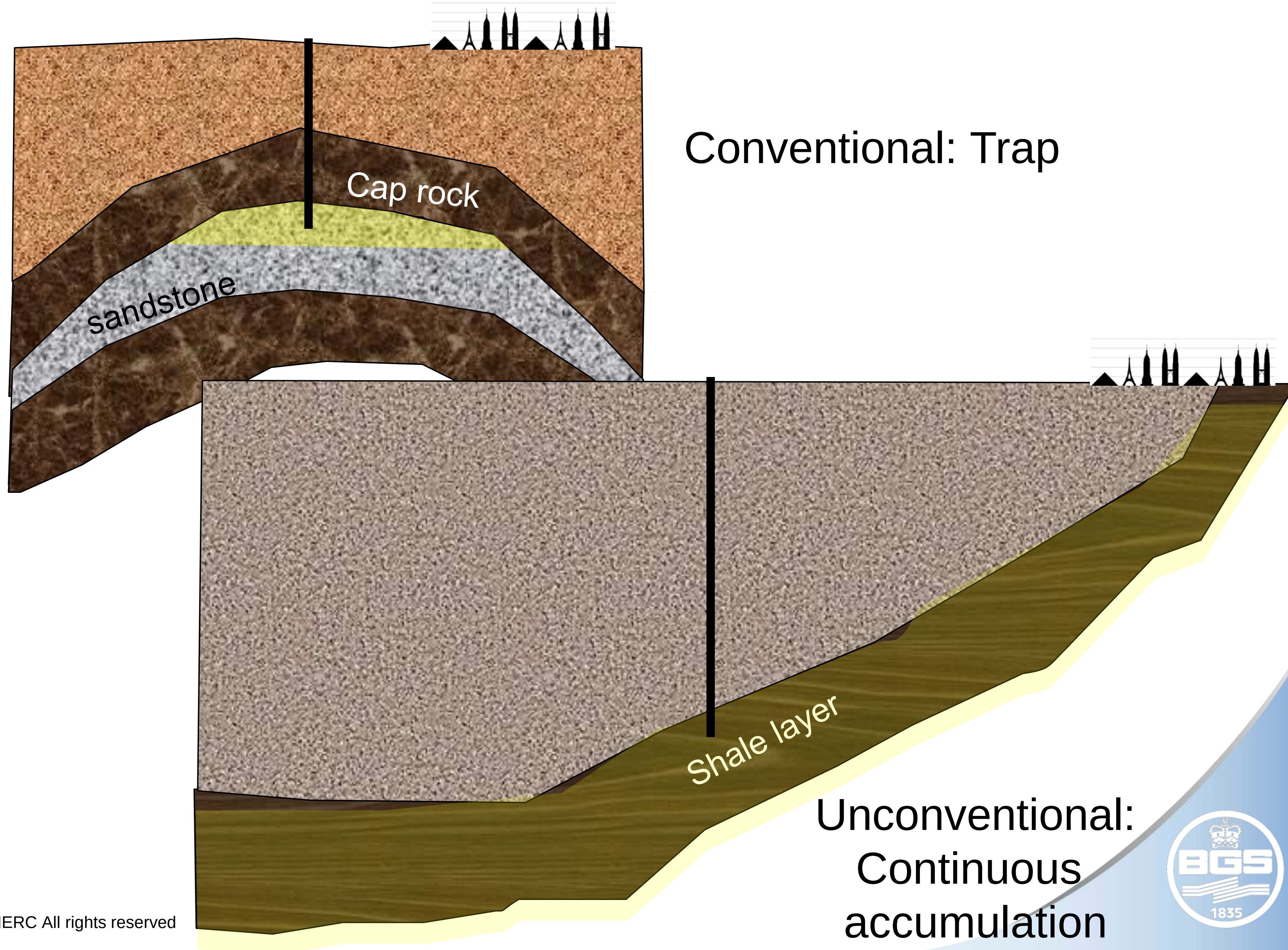


Adsorbed gas and gas in pores



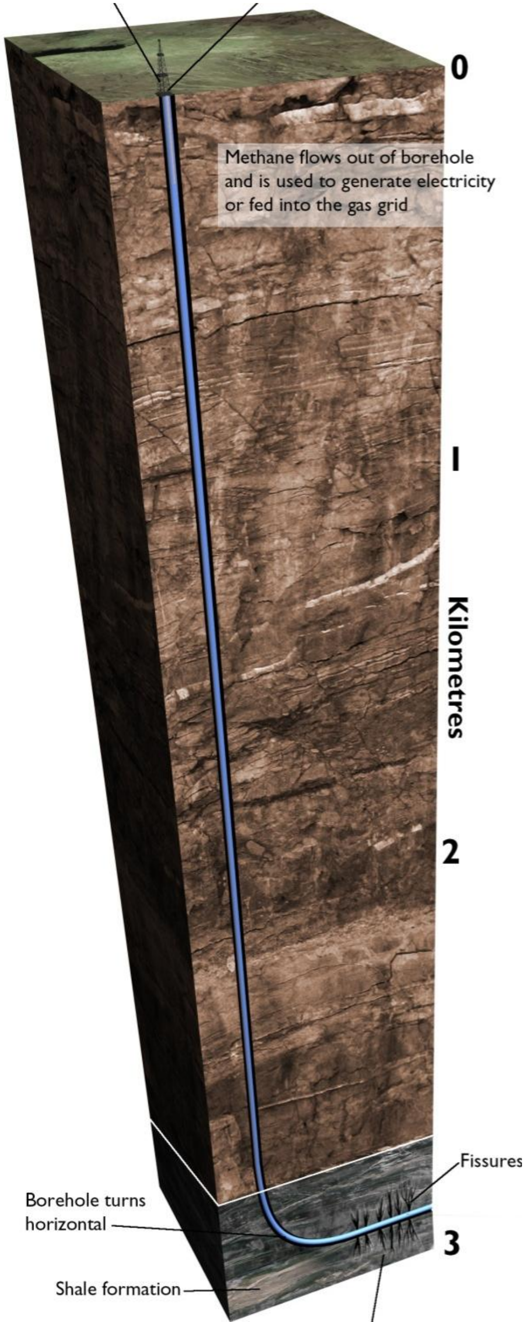
- Pore space gas
- Adsorbed gas
- calculation of gas in place per unit volume
- We have to measure how much shale

Conventional and unconventional



Conventional: Trap

Unconventional: Continuous accumulation



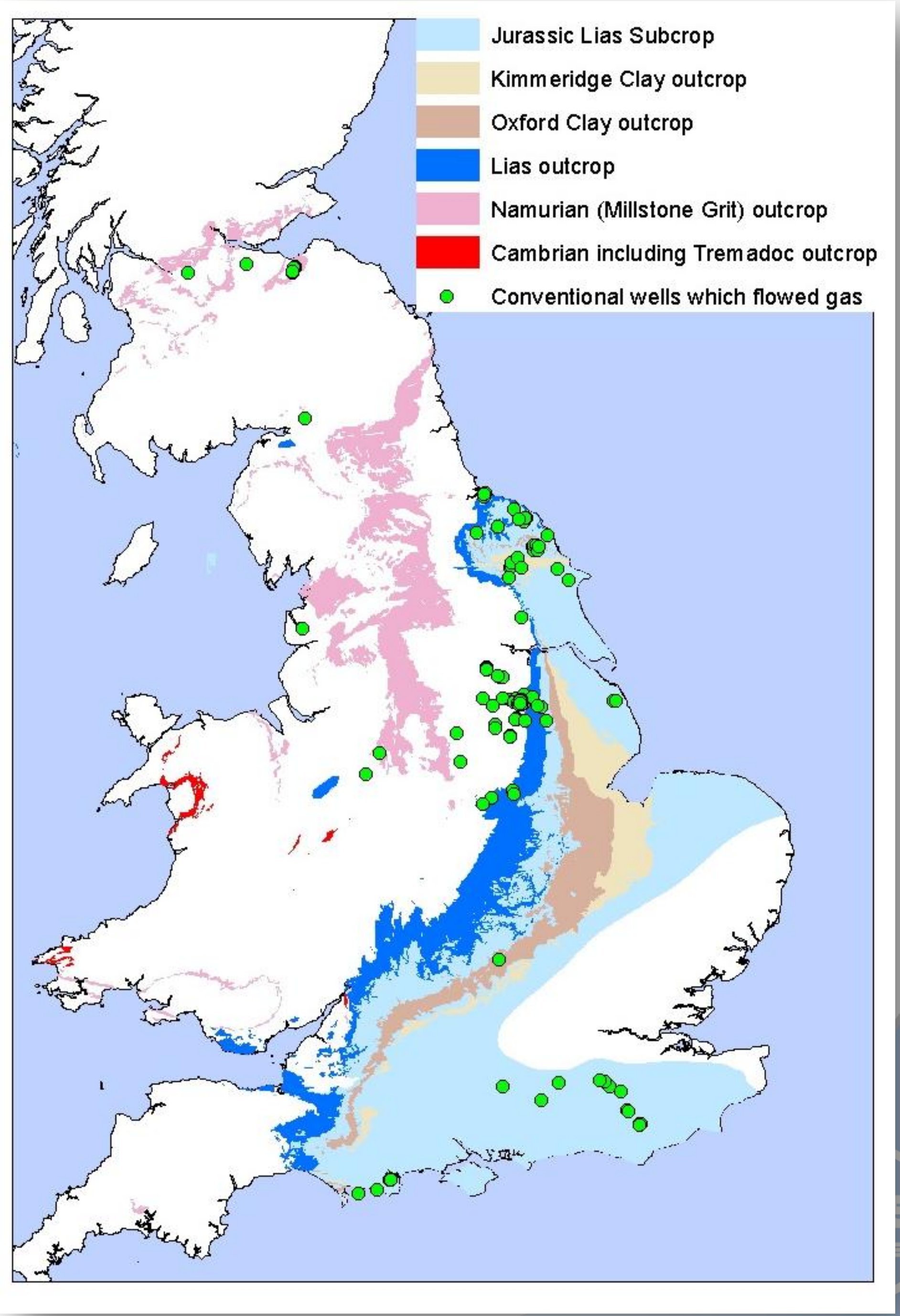
Fracking basics

- Cracks the shale
- High pressure water or nitrogen, 350-700 bar (350 to 700 atmospheres)

Where is it?

Where is it?

- Lower Carboniferous around the Pennines *and offshore*
- Three Jurassic layers in the Weald and Wessex
- Upper Cambrian in the Midlands
- ? Lower Palaeozoic black slate Wales and SW England



How much?

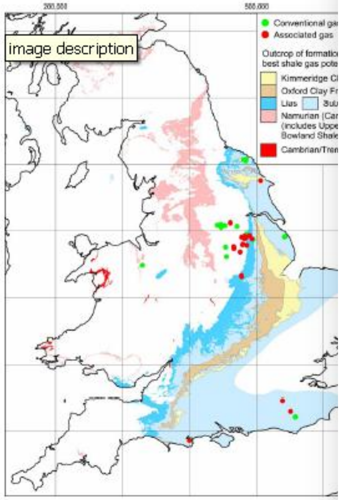
- Very varied estimates according to whether
  - Reserves
  - Resource
- BGS early estimate 150 BCM
- BGS are doing a new estimate for the Blackpool area and the UK
- Contact DECC for more information

Where is it?

BGS publications 2010-11
DECC website

THE UNCONVENTIONAL HYDROCARBON RESOURCES OF BRITAIN'S ONSHORE BASINS – SHALE GAS Promote UK 2011

THE UNCONVENTIONAL HYDROCARBON RESOURCES OF BRITAIN'S ONSHORE - SHALE GAS



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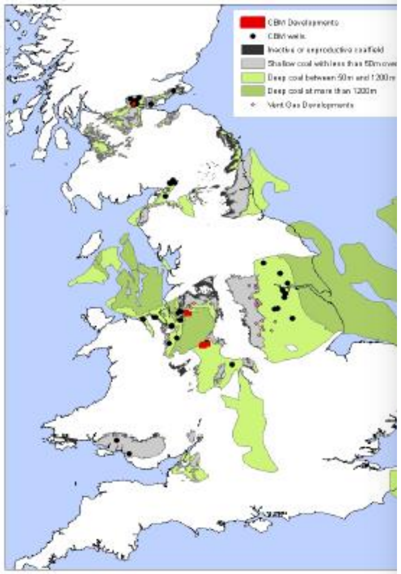
THE UNCONVENTIONAL HYDROCARBON RESOURCES OF BRITAIN'S ONSHORE BASINS – COALBED METHANE

THE UNCONVENTIONAL HYDROCA RESOURCES OF BRITAIN'S ONSHORE - COALBED METHANE (CBM)



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UK data and analysis for shale gas prospectivity

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Abstract: Organic-rich shale contains significant amounts of gas held within fractures and micropores and adsorbed onto organic matter. In the USA shale gas extracted from regionally extensive units such as the Barnett Shale currently accounts for 6% of gas production and is likely to reach 30% by 2015. Shale gas prospectivity is controlled by the amount and type of organic matter held in the shale, its thermal maturity, burial history, microporosity and fracture spacing and orientation. Potential targets range in age from Cambrian to the late Jurassic, within the main UK organic-rich black shales: younger shales have been excluded because they have not reached the gas window, but they may possess a biogenic gas play. A geographic information system, showing the distribution of potential reservoir units, has been created combining information on hydrocarbon shows, thermal maturity, fracture orientation, gas composition, and isotope data to identify potentially prospective areas for shale gas. Some of these data are shown as graphs and maps, but crucial data is lacking because earlier exploration concentrated on conventional reservoirs. The prospects include Lower Palaeozoic shale basins on the Midland Microcraton (a high risk because no conventional gas has been proved in this play), Mississippian shales in the Pennine Basin (the best prospect associated with conventional fields and high maturity), Pennsylvanian shales in the Stainmore and Northumberland Basin system (high risk because no conventional gas discoveries exist) and Jurassic shales in Wessex and Weald basins (small conventional fields signify potential here).

Keywords: shale, gas, maturity, thickness, source rock and reservoir

Organic-rich shale contains significant amounts of gas held within fractures and micropores and adsorbed onto organic matter. In the USA, shale gas extracted from regionally extensive units such as the Barnett Shale accounts for *c.* 6% of gas production. The success of US shale gas exploitation (over 28 000 wells producing *c.* 380×10^9 SCF per year) has stimulated significant interest in identifying potential reservoirs throughout the world. The depth range of the US shale gas plays extends down to 4500 m at present. Selley (1987, 2005), farsightedly, advocated shale gas exploration in the UK, based on Upper Devonian gas fields of the Appalachian Basin, which have been producing since 1821. However, in the past decade the Mississippian Barnett Shale of the Fort Worth Basin has become the most productive shale gas reservoir in the USA. US shales generally, and the Barnett Shale in particular, provide good analogues for potential shale gas plays in the UK, which has thick Mississippian shales both on and offshore; therefore the geology and geochemistry of the Barnett Shale are discussed briefly below.

The Barnett Shale

The Barnett Shale Formation (354–323 Ma) of the Fort Worth Basin is up to 300 m thick and underlies an area of *c.* 13 000 km^2 (Fig. 1). It contains *c.* 2.5×10^{12} SCF of proven gas reserves held in a low porosity and very low permeability shale matrix. Permeability is in the micro- to nanodarcy range and porosity rarely exceeds 6% …

… unit is overlain by the Marble Falls Limestone, also of Mississippian age, which is conformable with a thick succession of overlying Pennsylvanian sediments. Sedimentary structures suggest that the main shale units were deposited by distal turbidity flows in a sediment-starved anoxic basin environment. The Carboniferous sequence is truncated by a Cretaceous supercrop above the Variscan unconformity. The Ouachita (Variscan) fold belt lies at right angles to the Muenster Arch and impinges on the Fort Worth Basin in the SE.

The three main factors controlling prospectivity of the Barnett are the thermal maturity, thickness and total organic carbon (TOC) content of the shale (Zhao *et al.* 2007). Local and regional structures such as joints, folds and faults control fracture porosity and thus influence production potential at a variety of scales. Most natural fractures are sealed but these can potentially be exploited by artificial fracturing techniques (Bowker 2007) to improve flow rates around a well. Siltstone bands and chert nodules can also affect prospectivity locally.

The Newark East shale gas field lies updip west of the depocentre of the Barnett Shale in the wedge between the Muenster Arch and the Ouachita (Variscan) fold belt (Fig. 1; Pollastro *et al.* 2004). The rest of the depocentre lies under the Fort Worth–Dallas conurbation. The Barnett Shale also produces oil from the area to the NW (Fig. 1), where overlying conventional reservoirs are also present.

VINING, B.A. & PICKERING, S. C. (eds) Petroleum Geology: From Mature Basins to New Frontiers – Proceedings of the 7th Petroleum Geology Conference.

VINING, B. A. & PICKERING, S. C. (eds) *Petroleum Geology: From Mature Basins to New Frontiers – Proceedings of the 7th Petroleum Geology Conference*, 1087–1098. DOI: 10.1144/0071087 © Petroleum Geology Conferences Ltd. Published by the Geological Society, London.

Environmental impact

Very few peer-reviewed papers

Osborn et al. 2011

Molofsky et al. 2011

Oswald and M. Bamberger Jan 2012: two instances of correlation between gas-drilling activity and mortality rates in livestock

Concerns about shale gas

Independent (peer-reviewed) science: assess risk

Low risk

Things we don't have to worry about

High risk

Things we need to regulate carefully for public safety and public opinion

Conclusions

- Shale is a common rock
- Holds a lot of old organic material (carbon)
- Britain might have substantial potential for shale gas
- Concerns over environmental impact
- Peer-reviewed independent science has a special role in building regulator, investor and **public** confidence

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http://www.bgs.ac.uk/research/energy/shalegas/