HOGG

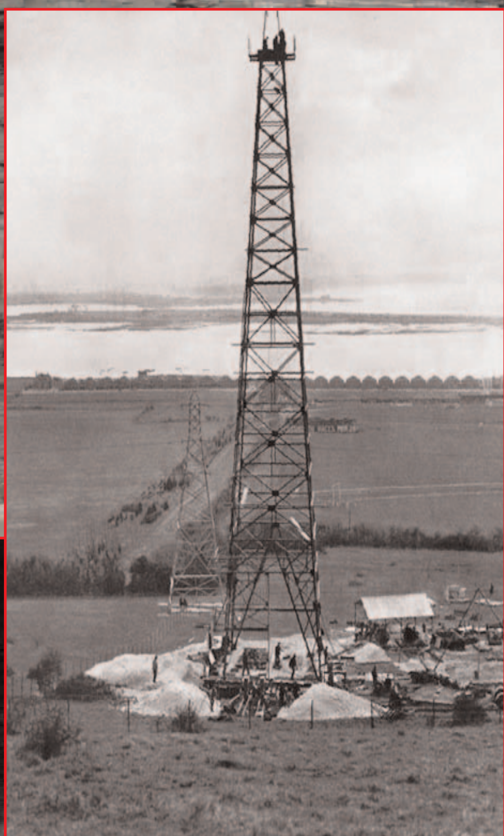
The History of On-Shore Hydrocarbon Use in the UK

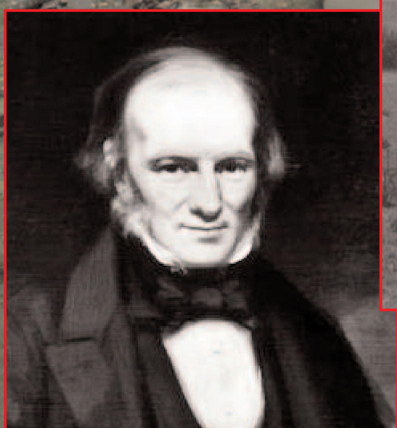
April 20th-22nd 2007

ABSTRACTS

Compiled by
Professor Richard Moody

PES GB





OIL & GAS SHALES, DEFINITIONS & DISTRIBUTION IN TIME & SPACE

Richard Moody
Moody-Sandman Associates Kingston University

Hominids have played with fire for the last 1.5Ma. with evidence from the Swartkrans (SA) indicating that they could kindle high temperature, hearth bound fires to cook meat at 600oC.

The historical use of hydrocarbons is punctuated by numerous, major discoveries and inventions each of which has raised hominid hopes and aspirations for a better future. Wood, charcoal, coke and coal were the initial sources of light and heat with the first use of charcoal in cave paintings recorded 32,000 years ago. Around 7000 B.C. charcoal was first used in smelting of copper (800oC) and around 500 B.C. the Chinese started using coal for smelting.

Of the alternative fuels the Mesopotamians used rock oil for architectural adhesives, ship caulks, medicines, and roads around 3000 B.C. whereas the Chinese (circa 2000B.C.) were able to refine crude oil for use in lamps and heating homes. By 200 B.C. the Chinese used natural gas to make salt from salt water (brine) heated in 'gas-fired' evaporators. Between 600- 700 A.D. Arab and Persian chemists discovered that petroleum's lighter elements could be mixed with quicklime to make Greek fire, the napalm of its day. Sealed in an earthenware pot you had the first handgrenade. The Mongol Hordes, also realised the potential of arrows capped with flaming oil shales in spreading fear across the known world.

From the Sumerians through to Aztecs and the North American Indian cultures-the early use of hydrocarbons was effectively governed by the natural occurrence of seeps and outcrops. The main uses of oil being for building, caulking ships, lamps and medicinal purposes. Moses was himself was placed in a reed basket coated with tar and in 1596 the personal physician of Duke Frederick of Württemburg noted that a mineral oil distilled from shale could be used in healing.

In 1694, British Crown Patent No. 330 was granted to three subjects who had found"a way to extract and make great quantities of pitch, tarr, and oyle out of a sort of stone." Around the same time enough oil was produced by the distillation of oil shale to light the streets of Modena in Italy.

In the Carpathians during the 18th Century people lined shafts with woven reeds to tap oil seeps and dug mineshafts to exploit layers of oil shales. In 1791, 6678 litres of oil was produced at a rate of approximately 22 litres a day. The kerosene lamp, was first constructed by the Polish inventor Ignacy Lukasiewisc

A commercial shale oil industry to manufacture lamp oil founded in 1838 in Autun, France and by the mid 19th Century whale oil had become too expensive that oil-shale industries sprang up in several countries including the UK.

By definition oil shales are fine-grained sedimentary rocks that contain significant amounts of organic matter (kerogens) from which shale oil and combustible gas can be extracted by destructive distillation. Other names given to oil shales include black shale, bituminous shale, carbonaceous shale, coaly shale, cannel shale, cannel coal, lignitic shale, torbanite, tasmanite, melenite, coorongite, maharahu, kukersite, gas shale, organic shale, kerosine shalekerogen shale, algal shale, or simply the 'rock that burns'. According to W.Lundquist the term oil shale is a misnomer as the rock is not always shale and has not been through the 'Oil Window'.

Many oil shales are Palaeozoic in age but their range extends from Cambrian to Tertiary. They occur in many parts of the world and deposits are known to exist over thousands of square miles with the capacity to produce many billions of barrels shale oil. Oil shales are not typical of a given depositional environment as examples exist from freshwater, saline ponds and lakes; epicontinental marine basins and related subtidal shelves. They are often rich in algal material but higher plant debris is characteristic of the more coalified deposits.

This presentation offers an insight into the various types of oil shale and provides a few examples of shales laid down in different depositional settings. It gives a relatively brief introduction into the history of the oil industry and provides data on the main elements and history of the UK Oil Shale Industry from 1848 to 1963.

With oil prices soaring and the possibility of conflict for resource ownership and management the presentation offers a brief introduction in the devloping argument for the exploitation of the vast shale oil resources that exist worldwide but especially in the USA.

The Norfolk Oil-Shale Rush, 1916-1923
Ramues Gallois

The first published record of oil shale in Norfolk was that of William Smith on his geological map of the county (1819) where he noted that the "Oaktree Clay" [Kimmeridge Clay] was "part slaty and bituminous as at Kimmeridge in Dorset". Rose (1835) subsequently recorded inflammable shales "that burned like cannel coal" in the Kimmeridge Clay in a brickpit at Southery in west Norfolk, and oil seepages that were supposedly derived from the Kimmeridge Clay were observed in drainage ditches a few kilometres away at Setchey. These seepages and the prospect of finding oil shales comparable to those that had been worked at Kimmeridge, combined with the urgent need to find additional sources of oil within the U. K., caused oil-shale exploration to begin in Norfolk during the First World War.

English and Foreign Oil Finance Ltd was created for this purpose, and a pilot operation begun at Setchey in 1916 under the direction of the geologist W. Forbes Leslie. This work received much publicity from a paper by Forbes Leslie (1917) in which it was stated that at least three 1.8-m thick oil-shale seams were present and that two of these could be retorted to yield more than 50 gallons of oil per ton of dry shale. Up to 75% of the oil was described as free-oil filling cavities in the shale. In addition, yellow sandstones impregnated with bitumen were also said to be present.

English Oilfields Ltd was launched on the London Stock Exchange in 1918 with a share capital of £300,000 (c £50 million in modern money) in order to exploit Norfolk's oil-shale wealth. Throughout 1918 and 1919 Forbes Leslie produced regular statements for the shareholders in which the thickness and quality of the proved reserves steadily increased. Yields of 20 to 40 gal/ton of shale-oil with a sulphur content 4.5 to 8% were quoted in the 1918 share prospectus. By September 1919 yields of 50 to 80 gal/ton of "practically sulphur free" oil had been achieved, and in December 1919 an 85 to 95 gal/ton-seam had been discovered. In addition, large quantities of free oil had been found together with a 20-m thick seam of ozokerite (natural paraffin wax). It was envisaged that in addition to the production of fuel and lubricating oils, some of the oil would be used in an exceedingly profitable industrial complex that would produce Portland cement, high quality bricks, electricity and metalliferous minerals.

The shareholders approved an increase in the share capital to £1.5 million (c £250 million modern) in 1919. An opencast pit and a mine were dug, pilot retorts were operated, a railway link from the works to the nearby London to King's Lynn main line was built, and construction was started on four full-scale retorts that would process 1000 tons of shale per day. The company acquired a petroleum-exploration licence covering about 1000 km_ of west Norfolk, and between 1919 and 1923 drilled more than 50 continuously cored boreholes in the area. Encouraged by the English Oilfields results, several small syndicates of local landowners were formed to explore the oil shales in the adjacent areas.

The full-scale retorts were never completed, the mine and open-cast pit were abandoned, and there was little activity after about 1923. The company was a small-scale wholesale distributor of oils during the 1920s and 30s, but none of this oil came from Norfolk. None of the farmers' syndicates found yields comparable to those reported by Forbes Leslie and all were disbanded after only a few boreholes had been drilled.

HYDROCARBONS IN SUSSEX: A FALSE QUEST

Anthony Brook

People have been searching for Hydrocarbons (coal, oil and natural gas) in Sussex and Southeast England since the advent of the Industrial Revolution, but all to little avail. There are not any commercially -exploitable energy resources in Sussex, and few in the region, but that has not stopped people trying to find them, and losing lots of time and money in the process.

Viewed in historical perspective, there would seem to be 4 Factors, 2 Ages and 2 Stages. The Factors are Geology, Commerce, Finance and Technology, in constantly-changing combinations; the Ages are those of Coal (where carbonaceous strata are sought) and Oil (where particular structures are required), with an extended overlap in the first half of the 20th century: and the Stages are those of Exploration and Exploitation, absent in Sussex and Southeast England except for a small corner of Kent. Knowledge of strata and structures beneath Sussex and Southeast England has gone from poor to profound; the commercial imperative has been driven by real/perceived shortage and the escalating demands of economic growth; the raising of funds for projects relates to the expected return on capital and has shifted from wealthy individuals to public bodies and commercial corporations' and all the time, the technology of prospecting has become far more sophisticated, although it remains, fundamentally, a 'hole-in-the-ground' operation.

The search for Coal in Sussex will be considered in this 4-fold framework, starting with the abortive attempt to find coal in the Bexhill area of East Sussex, where the rocks of the High Weald reach down to the sea, in the early 19th century , at the height of the Napoleonic Wars; and later, in the 1870's, after the geologist Godwin-Austen had postulated a prolongation of the Coal Measures of the Bas Boulonnais under the Channel and the Weald. Although specifically only for scientific purposes, the Sub-Wealden Borings of 1873 and 1875 were also on the look-out for coal seams. Instead they found gypsum deposits at workable depths, which were mined for many decades: the only mines in Sussex. Similar deep borings were proposed for Kent, which led to the discovery of the concealed coalfield of East Kent in the 1890's.Despite such definitive results, there was still speculation of coal seams under Sussex in the 1920's!

The search for Oil and Natural Gas in Sussex began accidentally in August 1896 at Heathfield in East Sussex, when an isolated pocket of methane was tapped whilst boring for water. It was reported, in flamboyant fashion, to the Geological Society, by Charles Dawson, who later became exasperated that, apart from illuminating Heathfield Station, it all went to waste. Demand for petroleum products rose rapidly as the new century progressed. The serious search for petroliferous structures in Sussex only began in earnest in the late 1930's by the D'Arcy Exploratory Company. Seepages and other oily indicators raised hopes, but, of the various anticlinal traps, only the Henfield Structure potentially had the right combination of stratigraphy, structure and closure, and might be worth a test well. Prospecting for oil in Sussex still continues, as a recent exploratory drilling rig near Storrington demonstrates.

The first deep borings in the central Mesozoic Basin of Southern England in 1936-37 at Portsdown and Henfield reached 5105 ft at Henfield, including 215 ft of Carboniferous strata; and the more recent BGS deep borehole at Bolney passed through 521 metres of Kimmeridge Clay, with thin oil-shaly bands, and 47 metres of Carboniferous Limestone, to bottom out at 2440 metres in the Devonian. Profound geological knowledge, but no sign of any commercially-exploitable energy resources.

Escalating demand, capital investment and ultra-modern technology, but a severe paucity of energy resources in Sussex and Southeast England, just where it is most needed: a most uncomfortable mismatch.

THE SEARCH FOR OIL FROM OIL-SHALES IN PRE & POST FIRST WORLD WAR ENGLAND - 1910-1924.

TORRENS, HUGH S
School of Earth Science, Keele University, ST5 5BG, U.K.

Highly speculative attempts to urge the possibility of extracting oil from Kimmeridgian (Jurassic) oil-shales in England were made well before the First World War. A Scottish doctor, and a quite unqualified 'oil enthusiast', called Dr. William Forbes-Leslie was the leading light behind these attempts, made in Norfolk, near Kings Lynn. Such attempts were soon given a new 'urgency' by the First World War, which confirmed that the internal-combustion engine was to be the motive power of the future and gasoline (petrol) its fuel. But distortions of supply and demand, which necessarily existed under such wartime conditions, caused new problems when the War ended in 1918.

Attempts to apply good scientific principles to the search for, and extraction of, oil from these Jurassic oil-shales in England were hopelessly complicated by this. With 'laissez-faire' attitudes long dominant in Britain, 'market forces' were simply allowed full reign in the completely liberated markets which followed the War. This paper describes what actually happened during the search for indigenous English oil from such shales, both before and after 1918. Nearly £2 million, subscribed through publicly offered shares, were 'wasted' in attempts to extract non-existent oil from Jurassic shales, both in Norfolk and Somerset. The 'experts ' promoting these ventures were largely 'unqualified' and the British public simply gullible investors.

The role of Government Departments (the British Geological Survey in particular), and how the limited oil expertise available in Britain at this time was used, are described. There was also fascinating rivalry between the two Departments in British Universities which then offered Petroleum Geology & Technology courses. There was a doubly transatlantic connection, in that the concept of 'crisis' in oil supply then was a largely United States-led concept, while the archives of one of the major British protagonists, John Cadman (1877-1941) are now in Wyoming, and shed fascinating light on this remarkable episode.

Dukes Wood/Eakring Oilfield

David J. Evans

BGS.

The Second World War was the first war to rely upon the supply of oil. By August 1942 in the face of increasing losses of tankers crossing the Atlantic to German U-boats, the bombing of its fuel depots and with the launch of the allied offensive in North Africa, Britain faced an impending crisis in oil. Stocks were sufficient to meet only two months requirements. Britain's then secretary of Petroleum, Geoffrey Lloyd, called an emergency meeting in London of the Oil Control Board with members of the oil industry's advisory committee.

Sir Peter Southwell of D'Arcy Exploration Company (from which BP would emerge) addressed the meeting and told a stunned audience of how the UK's oilfields in the Eakring area (N. Nottinghamshire), only recently discovered in 1939, could be developed to help Britain's war effort. “What oilfields”, “Where are they” and “What is their production” were the immediate responses. All questions were answered, except one “Where?” for fear that even in this company, the enemy might find out and bomb the producing area.

At that time around fifty producing wells were delivering 700 barrels of high-grade crude oil per day. Southwell told the meeting that production would need to be increased by the drilling of another 100 wells, but that this was not possible with the type of rigs in use at that time. The only way to increase production was to enlist the help of American oilmen with their modern 'jack-knife rigs'. Immediately instructed by Lloyd to travel to the US, Southwell's mission was to obtain the most modern equipment available in order to develop the fields to their maximum potential. So began one of the Second World Wars and Churchill's greatest secrets.

Southwell travelled on Thursday September 3rd to New York via Montreal, with the secrets of Britain's oil in his briefcase. On arrival he held talks with American officials, who did not know of British oil. “”Few people do” was his reply, requesting “and such fact will not be revealed…..to anyone other than in the operations”.

On September 11th at 10.00 am the US Government agreed to allow US contractors, led by Lloyd Noble (Noble Drilling Corporation) and Frank Porter (Fain Porter Drilling Corporation), to supply the drilling equipment and crews to drill the required wells. However, Southwell had to make the difficult trip to Ardmore, Oklahoma to visit Noble at his house early in the morning and convince him of Britain's need to obtain his assistance. By the end of October 1942 final agreement was reached and Eugene Rosser and Don Walker started recruiting a crew of 43 'roughnecks' (“the soldiers of oil”) to man four drilling rigs.

The crews departed the USA on Friday March 12th 1943, eventually arriving at Kelham Hall on 18th March 1943. Over the next year, the 106 wells required were drilled, securing Britain's secret oil supply and providing a vital part of the war effort. The 43 roughnecks departed, their mission accomplished and not even the locals knew of their mission - believing the Americans were extras in a film awaiting the arrival of John Wayne.

The veil of secrecy was not officially lifted by the Government until April 1944 and remained largely unknown for a further 35 years after that.

The Legacy of Oil-shale in West Lothian; from pre-history to post-industry.

Barbra Harvie
CECS, University of Edinburgh.

This whistle-stop account of oil-shale and the shale-oil industry in West Lothian, Scotland ranges from the geological formation of the shale in the Carboniferous era to its current, post-industrial, socio-economic value including:

The importance of 19th Century Scottish chemists and engineers to the development of the industrial processes to extract crude oil from deep mined shale.

The range of oil-based products and by products manufactured in West Lothian throughout the industry's 110 year history.

The impact of oil on the social structure of the county over the same period.

The lasting legacy of the industry in West Lothian - the bings and their current usage
Is there any future for the shale-oil industry in Scotland?

“Alternative Fuels, Innovation and Entrepreneurialism”.

Richard Moody

Domestic fuel use changed rapidly during the early 17th Century from wood burning to coal. Coal generated more heat and therefore fireplaces, flues and chimneys became smaller; resulting in more homes being heated more efficiently and at lower cost.

Coal mining and the use of coal resulted in greater employment, industrialisation, a greater interest in social awareness and a dramatic increase in pollution. It became the major source of energy and coal gas until the latter half on the 20th Century.

In 1618 coal gas was produced by experiment by Dr Jean Tardin, in France (Stephen Hales repeated the experiment in 1727). By 1764 Mr Carlisle Spedding the manager at Whitehaven Colliery had developed a process by which he lit his office with mine gas (Methane). The first ‘industrial use of coal gas for lighting employed by Boulton and Watts of Birmingham in 1798.

Street lighting by gas was demonstrated by Phillipe Lebon in Paris in 1802 and in 1807 gas lit lamps were erected in Pall Mall, London. On the domestic front James Sharp put an experimental gas cooker into his house in Northampton in 1826 and T. S. Lacey invented first pre-payment gas meter in 1870. The use of gas was limited by the method of illumination which improved dramatically after 1887 when Carl Auer von Welsbach (Student of Bunsen) invented incandescent gas mantle.

Although electricity experiments were initiated in 1808 the first carbon arcs only appeared in 1876 and light bulbs in 1879.

Before the dawn of the 19th Century animal fats and plant (rape), were used for early street lamps or torches. In 1784, Ami Argand invented the first lamp with a tubular wick and a colleague the first glass chimney. Whale Oil was smelly to burn and increasingly expensive to buy and therefore the discovery of paraffin (kerosene) by Reichenback and Christison in 1830 was a great step towards the use of an alternative source of energy. In 1836, Houghton invented the very first portable lamp that used a pressure device to force fuel oil into the burner. Strangely there evidence that the UK patent was also granted to "some foreigner abroad" (a Mr Franchot from Paris. (UK Patent 7265, 1836) .

1848. The first plant to produce paraffin fuel oil for lamps was started in in Derbyshire, England, and the process was patented by Dr James Young. Young was to become known as “Paraffin Young” and was termed the “The Scot who became the World’s First Oil Man”. Young was the most prominent of a host of scientists and entrepreneurs who gave the UK the lead in the production of shale oil and numerous other by-products. Co-eval industries grew up in many parts of the world during the second half of the 19th Century. In the UK the industry was driven by a number of individuals from different backgrounds with the ‘British Tar and Oil Industries” tracing their origins back over 3 centuries.

Bings and Biodiversity

Barbra Harvie
CECS, University of Edinburgh.

This talk gives an insight into the importance of the West Lothian bings (oil-shale spoil heaps) as havens of biodiversity at both a local and a national (UK) level.

In the UK and Western Europe, shale bings are found only in the county of West Lothian, Scotland There are 19 bings still existing; they have been unworked from between 87 and 43 years. The industrial exploitation of oil-bearing rocks has created a unique landscape with its own distinctive flora and fauna. The ecology and biodiversity of the bing sites make them ideal for describing and monitoring the processes and mechanisms of vegetation dynamics over a wide range of conditions. They provide an insight into the best-suited ecosystem structures for similar sites in other countries.

Shale bings are of great ecological and scientific importance as examples of primary succession. They provide a refuge for locally rare species, both plant and animal, in an agricultural landscape and are therefore important to conservation and increased local biodiversity.

The vegetation and environment of the bings were recorded in an extensive study that generated some unexpected data on the heterogeneity of spent shale, available nutrients and the plethora of plants and animals that have made these spoil heaps their home.

Biodiversity is not only about rare species but about variety of species.

The evolution of the Wessex Basin.

Alan Holiday, B.Sc., M.Sc.

Weymouth College, Cranford Avenue, Weymouth, Dorset. DT4 9PA

Events following the Variscan Orogeny through to the present time have resulted in the evolution of the Wessex Basin and the development of source and reservoir rocks which have made this area the most important oil producer on shore in Western Europe. The post orogenic molasse and later marine sediments provided both suitable organic rich sediments to act as source rocks as well as porous and permeable sediments to act as reservoir rocks. Subsequent tectonic events have formed structures which have become major trap structures but also led to the destruction of much of the potential petroleum production in the Wessex Basin.

Oil shale resources in the Kimmeridge Clay
R W Gallois

Britain holds an important place in the historical development of oil-shale working. The first oil-shale patent "A way to extract and make great quantities of pitch, tarr and oyle out of a sort of stone" (Crown Patent No.330) was granted to a group of English entrepreneurs in 1694, and the first substantial shale-oil industry was begun in the Lothians of Scotland (based on Carboniferous oil shales) in 1851 by John Young and others. Production peaked in 1913 when over 3.2 million tons of oil shale was processed. The industry declined slowly but steadily until it closed down in 1962. Oil shales occur at a number of other stratigraphical levels in Great Britain, notably in the Devonian Caithness Flags and in the Jurassic Lias, Dun Caan and Brora oils shales, Oxford Clay and Kimmeridge Clay. Of these, the Kimmeridge Clay has long seemed the most economically interesting prospect, but repeated attempts at commercial exploitation have ended in failure.

The occurrence of oil shales in the cliffs of Kimmeridge Clay at Kimmeridge Bay, Dorset, has been known since the Iron Age. The most famous seam, the Blackstone, has been used locally as a coal substitute and has yielded at various times products ranging from lubricating oil to sanitary deodoriser. During the latter half of the 19th century 8 companies were set up to exploit this oil shale, but none was lastingly successful. In each case, the failure was blamed on the unacceptably higher sulphur content (4 to 8%) of the shale-oil combined with the high cost of working thin seams.

Combustible shales have been recorded in the Kimmeridge Clay throughout its English outcrop. Assessments were made of their potential value as fuel in Dorset and Lincolnshire (Strahan, 1918, 1920) and Norfolk (Forbes Leslie, 1917) during the First World War, and although substantial quantities of good quality oil shale were reported to be present, no major industry was developed. They were re-assessed by the British Geological Survey in the 1970s as a result of the economic crisis caused by a rapid increase in crude oil prices in 1973.

Oil shales are present throughout the outcrop and subcrop of the Kimmeridge Clay, locally with over 100 seams with potential oil yields ranging from 10 to 90 gal/ton. However, major economic and environmental problems would need to be solved before they could be worked on a large scale. The seams are thin (mostly < 0.2 m) and separated by barren mudstones that would have to be removed before the oil-shale concentrate was retorted at 500°C to yield shale oil. This pyrolysis produces sulphurous gases and large volumes of spent shale, and the shale oils and spent shale can contain low concentrations of carcinogens. In addition, the shale oils would have to be distilled to make them comparable to naturally occurring crude oils that can be used as a refinery feedstock.

The oil shales in the Kimmeridge Clay have the potential to produce millions of tons of shale oil, but only by removing and processing tens of cubic kilometres of material from open-cast excavations, an impossible task in a densely populated country such as Britain. Even if this were possible, the energy used in the winning and upgrading processes might be greater than the energy value of the finished product. The oil shales in the Kimmeridge Clay could never, therefore, make a major contribution to the energy supply of the United Kingdom.

The fossils of The Kimmeridge Clay

Steve Etches

The Steve Etches Kimmeridge Clay Fossil Collection is renowned worldwide and has global significance. As well as being aesthetically attractive the specimens are of great palaeontological importance and many are new to science.

The collection consists of some 1600 specimens to date all beautifully prepared and preserved. There are ammonites with multiple horns (it is normal to have only one); limb bones with bite-marks showing that they were prey to larger animals; lobsters crawling out from under ammonites, petrified after being caught by a surge of sediment, and teuthoids (cuttlefish) with multiple pairs of fins (previously thought to have only two pairs) - this soft-part preservation is very rare.

Then there are the fishes: many types, shapes and sizes. Some have large shiny scales; some have their original colour preserved. Here also there are signs of predation as several fish have ink-sacs from teuthoids in their guts. Some fish were predators with rows of long, sharp, protruding teeth whilst others have rows of crushing teeth indicating that they were invertebrate eaters. Some fish have both types so existed on a varied diet.

Then there are the marine reptiles: the large pliosaur jawbone being the piece de resistance of the collection. Huge pliosaur vertebrae (backbones); equally huge pliosaur limb bones; smaller, but still large plesiosaur bones some showing predatory tooth marks where they were bitten by pliosaurs. Distinctive conical ichthyosaur vertebrae and their teeth-lined snouts predominantly to feed on fish. Huge crocodile bones and teeth, still bearing their original sharp edges but also showing signs of wear. Very special are the eighty or so pterosaur (flying reptile) bones, thought to be very rare, but not if you know where to look! One slab bears the bones of a complete wing with one of the bones broken in life - a very rare find indeed.

The Jurassic sea floor was not as sterile as had been thought as it was home to many invertebrates: lobsters, still retaining their original colour; oysters, bivalves, belemnites (squids), brachiopods, starfish, gastropods (snails) all left their shelly remains to be fossilised and collected by Steve some one hundred and fifty million years later.

There are also some unusual specimens: a dragonfly wing, preserved in all its delicacy, surprising as these rocks were laid down far from land; coral polyps clinging to a piece of sea-soaked wood (this specimen has to be kept under water). One very unusual find is a sac of ammonite eggs - in fact two sacs on a small block; subsequently several more clusters were found, some still inside the cavity of the mother ammonite. One egg was teased off and studied under a scanning electron microscope which revealed several internal layers and possibly the remains of the bacteria which consumed the egg.

The Age of Oil - past present and future

Daniel D Clark-Lowes

Since the first commercial oil wells were drilled in the mid to late 1800's oil has revolutionised human existence, with its extraordinary capacity to supply cheap energy. Taken together with coal, the exploitation of these fossil fuels has been associated with unparalleled economic growth and associated population explosion. The versatility of oil as an energy source, the large reserves and cheap production costs have been major factors in this economic explosion bringing with it incredible advances in medicine, travel, foods and living conditions. Throughout most of the time since oil was first produced commercially it has cost between $15-$25 per barrel in today's money - it has been the source of exceptionally cheap energy.

Oil overtook coal because it was commercially more attractive and allowed steady economic growth - this translated into growth in oil consumption at about 2% per annum. Now, oil production is declining in many countries. Once oil production has started to decline, it is very rare for any technological or economic factor to reverse the decline. It is true that there are examples where economic and technical factors have caused a perturbation or “bump” in the decline curve but never a return to sustained oil production growth over any length of time.

It should be possible to undertake a calculation whereby the world's oil reserves (its total endowment of oil) is compared with the volume of oil produced to date to achieve a balance of what is left to produce. The problem with this is that the estimates of remaining reserves in the public realm are unreliable. As work by the present author on the reserves of Libya has shown, this particular OPEC country has exaggerated its reserves for political reasons. Recent articles in the petroleum industry press have shown that similar exaggeration has taken place in the case of Saudi Arabia, Iran and Kuwait among others. The position is further complicated by the fact that the “total endowment of oil” depends upon assumptions about the proportion of in-place oil resource that can be produced - assumptions that are changing because of technological developments. Consequently there is no consensus about the world's remaining oil reserves.

The famous geologist, M. K. Hubbert, showed that oil production in an oil-producing province peaks or plateaus and then declines when about half of the total endowment of oil has been produced. Since about half of the world's oil producing provinces have reached their peak and commenced their decline, and (although predictions vary) the remaining non-OPEC countries are expected to peak and decline well before the year 2020, the OPEC countries peaking at the most 10 years later, it seems fair to say that within the next 25 years we will have used up half of the world's endowment of conventional oil. We have produced just under one trillion barrels of oil to date. So on that basis, the original total world oil endowment is about 2 to 2.5 trillion barrels oil. But whatever the correct figures are for the oil endowment, it is inescapable that as more and more countries peak and commence decline, it is impossible for the past level of oil production growth (2% per annum) to continue.

The above volumes of oil refer to conventional oil. If we take into account heavy oil and other types of non-conventional oil (tar sands, oil shales, oil from coal etc.) then the evidence is strong that this cannot fill the gap in increasing demand that results from the fall off in conventional oil production - but only delays the problem by about 10 years at most.

So fossil fuels cannot support the levels of growth we have got used to over the last century. The challenge is to find a non fossil fuel energy source that will fill the gap. Oil reserves have take millions of years to be created - indeed much of the resource of North Africa has taken 400 million years to develop. In only 150 years - a mere blink of an eye in geological terms - half of the most valuable natural energy source known to man has been exploited. Unless there is a change of heart, it is planned to exploit the rest within the next 100 years. If we fail to rise to the challenge of replacing this quite exceptional energy source, it is hard to see how the current world population, itself a product of the Age of Oil, can be sustained.

POSTER ABSTRACTS

Richard Ponkap Bature
Essie Apenteng
Paul Taylor

All Msc students at Kingston Unversity, Surrey

(Authors will be available for discussion at their posters during the lunch break)

TAR SANDS : GREAT POTENTIAL

Richard Ponkap Bature

Tar sands (often called Natural bitumen) are hydrocarbon deposits that are heavily biodegraded and oxidized (Tiscot, 1984). They consist of bitumen, sand mineral rich clays and water. Tar sands share the attributes of heavy oil but they are highly viscous with viscosity greater than 10,000 CcP., and are more dense, a characteristic that makes them to show high resistance to flow at reservoir temperature. Bitumen requires upgrading before it can be suitable as a feedstock for a conventional refinery.

Tar sands and heavy oil are distributed mostly in Cretaceous and Tertiary reservoir. (Hu, 1988; Chilingarian and Evans, 1978). They occur in many places around the world including, Russia, China, Nigeria, USA, Venezuela, and the largest deposits with large scale commercial exploitation in Alberta, Canada.

The formation and distribution of these deposits are mainly controlled by basin evolution (Earth tectonic movements), in which large oil bodies were lifted to shallow depths where they were biodegraded and oxidized.

The Alberta tar sands are the greatest known concentration of hydrocarbons in the world (World Energy Council, 2006). The deposits are estimated to contain 174 billion barrels of proven reserve, second to Saudi Arabia's 259 billion barrels of petroleum reserves.

Tar sands are found mostly along margins of geologic basins and can be identified by the thick oil seeping from ground or along river banks. Deeper deposits can be identified using 2-D electrical imaging technique and can be extracted in many different ways including open pit mining, steam assisted gravity drainage (SAGD), cyclic steam stimulation (CSS), vapour extraction (VAPEX) and toe -to-heel air injection (THAI) techniques.

There are a number of environmental impacts associated with the development and production of tar sands such as land degradation, destruction of wildlife, forest, rivers and water pollution. The emission of greenhouse and disposal of oily sand-clay tailings are current major problems. In 2003, emission of CO2 from tar sands plants in Canada is estimated at about 0.16 tonnes per barrel of synthetic crude oil produced.
Tar sands and heavy oil development and production in Canada and Venezuela have lead to significant economic impacts. In Canada, total revenue generated as a result of these activities is estimated at $213 billion. Oil sands activities have also created employment and is expected to continue up to 5.4 million persons (National Energy Board, 2005; CERI, 2005).

Alberta tar sands production is projected to reach 5 million barrels per day by 2030. About 3 million barrels per day of synthetic crude oil production is expected by 2015 (National Energy Board, 2006).

Tar sands however, will surely make a significant impact in the world's future oil supply as technology for bitumen extraction continues to improve.

REFERENCES

Alberta's Energy Reserve, 2005. Supply/ Demand Outlook/Crude Bitumen

Alberta Energy and Utilities Board, 2004. World Proven Oil Reserves

Alberta oil sands consultations. www.oilsandsconsultations.gov.ab.ca

Carl, C., 2002. Oil review, V14, no. 3. p. 50

CAPP. Canadian Association of Petroleum Producers. www.capp.com

Carrigy, M 1963. Athabasca oil sands - The Karl Clark Volume

Chilingarian G.V and Evan V.P, 1978. Bitumen, asphalt and tar sands. Elsevier 15-22.

CERI, 2005. Canada Energy Research Institute Report, 2005.

Dusseault, M 2004. The Future of Heavy Oil: Opportunities for Canadian Expertise

Fustic M, Bennett B and Larter S., 2006. Geological control on Bitumen Heterogeneity in **Athabasca oil sands.** 2006 CSPG-CSEG-CWLS Cconvention.

Gray D. Oil sands conference report, May , 2004.

National Energy Board, 2005. Canadian's Oil sands: Opportunities and challenges to 2015. http://www.neb-one.gc.ca/energy/EnergyReports/

Niu J and Hu J.,1998. Formation and distribution of heavy oil and tar sands in China. Marine and **Petroleum Geology.** 16 (1999) 85-95.

Robert L. H. Peaking of world oil production: Impacts, mitigation and Risk Management.

Rubinstein I., Strausz O., Spyckerelle C., Crawford R., and Westlake D., 2003. Origin of tar sands bitumen of Alberta. Chemical and microbiology study .2003

Stot J. CERI: Alberta oil sands industry outlook Very Robust. OGJ, March 22, 2004.

Tiscot, B.P, 1984. Petroleum formation and occurrence. New york: Spring-Verlag, Berlin Beidelberg 6-8.

USGS, 2003. Heavy oil and Natural bitumen - Strategic Petroleum Resources. USGS Fact sheet FS-070-03. August, 2003.

“Methane Hydrates: The Ice that Burns”

Source: Bentley, 2003

Essie Apenteng

Kingston University

As the world's population thrives, demand for energy resources also increases steadily. To be able to sustain the world's thriving population, the demand for energy resources should match the supply of energy resources. Unfortunately, it is increasingly becoming obvious that other forms of energy such as oil, coal and gas (fossil fuels) which supply about 80 percent (Geol, 2006) of all the energy consumed for work and power generation are running out. As such, there is the need to exploit other alternatives of energy resources to supplement the existing energy resources because energy resources are the lifeblood of most developed and developing economies.

Methane hydrates or clathrate hydrates are clean and form as a result of the crystallization of solids composed of water and natural gas which forms when gases mainly methane of biogenic or deeper thermogenic origin and other light gases such as butane, propane and ethane combine with water under low temperature and high pressure conditions in permafrost zones and ocean floors. The quantitative and qualitative proviso of methane hydrates obviously provides the world with an astonishing amount of natural gas. Many seismic surveys have revealed that their vast accumulations in marine environments could represent an alternative natural fuel resource because they contain significant amounts of natural gas (Takeya et al, 2006).

There are three main methods by which commercial production of methane hydrates can be achieved. These methods; Depressurization, Thermal injection and Chemical inhibition are believed to modify the thermodynamic conditions in the hydrate stability zone such that the gas hydrate decomposes and can be captured for energy production.

Even though a great deal of research is currently being carried out on methane hydrates, not much are known about their recent and current world production levels and consumption. However, Kohl (2006) has recently predicted that the world consumption of natural gas alone will rise by 91 percent to 182 trillion cubic feet in less than twenty-five years.

The demand and supply of natural gas is widely expected to be the fastest-growing primary energy source in the world over the next 25 years (EIA, 1998).

Collett and Kuuskraa (1998) as cited by Geol (2006) stated that world-wide estimates of gas from in situ hydrates have revealed that about 20 million cubic metres can easily fulfill current and future supplies of natural gas.

Methane hydrates can be used to sequester carbon dioxide and store it as natural gas, thereby overcome the economic impediment of carbon dioxide sequestration and methane hydrate dissociation (Goel, 2006). Methane hydrates do not only provide energy, they also have an added potential of transporting and storing natural gas (Hashemi et al, 2006).

Methane hydrates are known to play a major role in global climate changes, in the blocking of cold-region natural gas pipelines and seafloor instability. Despite these problems, methane hydrates are characterized by two unique qualities which make their production and usage economical. These qualities include;

The vast amounts of methane hydrates buried in sediments within 2000metres below the sea level which makes their supply unlimited.

The ability of methane hydrates to develop and accumulate near high-demand areas and generally over extensive marine areas worldwide.

These features of methane hydrate have made their study and exploitation more attractive and useful for human well-being since the other forms of energy resources are gradually becoming scarce. This therefore indicates that, methane hydrates, if harnessed effectively and efficiently, will represent a vital, potential alternative to energy resources which will satisfy human needs.

References

American Bureau of Shipping (2005). "Gas Markets- Emerging Technologies". [Online]. Available from : http://www.eagle.org/prodserv/offshore/gasmarkets/emerging.html.
[Accessed10 October 2006].

Bentley, M. (2003). "Methane theory gets frosty response". BBC. [Online]. Available from:http://news.bbc.co.uk/2/hi/science/nature/2940045.stm#pictures. [Accessed10 October 2006].

Dickens, G. R. (2004). "Methane Hydrate and Abrupt Climate Change". American- Geological Institute-Geotimes. [Online]. Available from http://www.agiweb.org/geotimes/nov04/feature_climate.html#authors. [Accessed 20 October 2006].

Dillon, W. (1992). "Gas (Methane) Hydrates -- A New Frontier". United States Geological Survey. [Online]. Available from: http://marine.usgs.gov/fact-sheets/gas-hydrates/title.html.
[Accessed 17 October 2006].

Dwyer, S. [n.d]. "METHANE HYDRATE ICE :A Possible Mechanism For Ice Age And Global Warming Cycles".[Online]. Available from: http://utopiasprings.com/methane.htm. [Accessed18 October 2006].

Energy Information Administration-EIA. (1998). "Natural Gas (1998): Issues and Trends- Future Supply Potential of Natural Gas Hydrates". International energy Outlook. [Online]. pp: 73-90. Available from:
http://www.eia.doe.gov/pub/oil_gas/natural_gas/analysis_publications/natural_gas_1998_issues_trends/pdf/chapter3.pdf. [Accessed10 October 2006].

Evans, A. M (1997). "An Introduction to Economic Geology and its environmental impacts".Oxford: Blackwells.

Geol, N. (2006). 'In situ methane hydrate dissociation with carbon dioxide sequestration: Current knowledge and issues'. Journal of Petroleum Science and Engineering. [Online]

Glass, J. (2006). "Methane Mimosas on Ice". Northwest Science and technology. [Online]. Available from:https://depts.washington.edu/nwst/issues/index.php?issueID=fall_2006&storyID=792. .
[Accessed22 November 2006].

Hashemi, S, Macchi, A, Bergeron, S, Servio, P, 2006. "Prediction of methane and carbon dioxide solubility in water in the presence of hydrate". Fluid Phase Equilibria. [Online] 246 (1-2): 131-136. Available from : http://dx.doi.org/10.1016/j.fluid.2006.05.010 . [Accessed 20 November 2006].

Kohl, K. (2006). "Where you can find gas to fuel the world for 4,000 more years". Energy and Capital. [Online]. Available from: http://energyandcapital.com/editorials.php?id=297. [Accessed30 November 2006].

Maynard, B. (2006). "Popular Mechanics: Methane Hydrates - Energy Source of the Future?" Hearst Communications Inc. [Online] pp:1-2 Available from
http://www.popularmechanics.com/science/earth/2558946.html?page=1. [Accessed 15 November 2006].

.**Mienert, J., M. Vanneste, S. Bunz, K. Andreassen, H. Haflidason,** and **H.P. Sejrup**, (2005).“Ocean warming and gas hydrate stability on the mid-Norwegian margin at the Storegga Slide”. Marine and Petroleum Geology. [Online]. 22 (1-2):233-244. Available from : http://www.ig.uit.no/~maarten/publications/Mienert_Vanneste_etal_MPG_2005.pdf. [Accessed 17 October 2006].

Mochizuki,T. and Mori Y.H. (2006). “Clathrate-hydrate film growth along water/hydrate-former phase boundaries-numerical heat-transfer study”. Journal of Crystal Growth. [Online] 290(2):642-652.Available from: http://dx.doi.org/10.1016/j.jcrysgro.2006.01.036. [Accessed 20 October 2006].

Morel, L (2006). “ The Methane Hydrate Paradigm Shift: Just do it, is not just for Nick Anymore”. American Institute for Chemical Engineers-AIChE. [Online]. Available from: http://www.wise-intern.org/journal/2006/Morel-AIChE.ppt#283,15,Methane Hydrates Background. . [Accessed11 October 2006].

Park, J., Seo, Y., Lee, J. and Lee, H (2006). ”Spectroscopic analysis of carbon dioxide and nitrogen mixed gas hydrates in silica gel for CO2 separation”. Marine Geology. [Online] 115(1-4):279-282. Available from: http://dx.doi.org/10.1016/j.cattod.2006.02.059. [Accessed 20 October 2006].

Svandal A, Kuznetsova T and Kvamme, B. 2006. “Thermodynamic properties and phase transitions in the H2O/CO2/CH4 system “. Fluid Phase Equilibria. [Online] 246 (1-2):177-184 . Available from : http://dx.doi.org/10.1016/j.fluid.2006.06.003. [Accessed 25 October 2006].

Takeya , S., Kida, M., Minami, H., Sakagami, H., Hachikubo, A., Takahashi, N., Shoji, H., Soloviev, V., Wallmann, K., Biebow, N., Obzhirov, A., Salomatin, A. and Poort, J. (2006).“Structure and thermal expansion of natural gas clathrate hydrates” Chemical Engineering Science. [Online]. 61(8): 2670-2674.
Available from: http://dx.doi.org/10.1016/j.ces.2005.11.049. [Accessed 25 October 2006].

The National Academies Press (2004). “Charting the Future of Methane Hydrate Research in the United States”. National Academy of Sciences. [Online]. pp:193. Available from: http://lab.nap.edu/openbook/0309092922/html/193.html#p2000b1fa9960193001-plate. [Accessed11 November 2006].

USGS. [n.d]. “Natural Gas Hydrates”. The Mallik Production Test well. [Online]. pp. 1-26. Available from: http://energy.usgs.gov/flash/NaturalGasHydrates.swf.
[Accessed15 November 2006].

.

Oil Shale Commodity Review, Executive Summary

Paul Taylor

Oil shale Properties

Oil Shales are defined as a, "compact laminated rock of sedimentary origin, producing over 33% ash when burnt and containing organic matter that yields oil when distilled."g They are of significant importance due to their global abundance and potential use as a replacement for crude oil. Oil shales do not have a singular mineralogy, often containing a wide variety of organic and inorganic minerals including quartz, feldspars, clays, and carbonates. Oil Shale's organic constituents are chiefly derived from fossilised algae, diatoms and Radiolarians.

Feasibility of Oil Shale as a replacement for Conventional Oil.

With appropriate refining techniques Oil shale can be used as a direct replacement for many crude fractions including aviation, Fuel and Diesel Oil". However, separating the organic Syncrude product from Oil Shale requires energy intensive destructive distillation. This and Oil shales high proportion of contaminants (e.g.) Sulphur, make it environmentally a very poor energy source.

Resource Distribution

Oil Shale deposits are found on all major continents with the USA holding the largest volume of undeveloped economic reserves. However, currently there are only 3 areas which have commercial mining operations (China, Estonia and Brazil.)

Future Extraction Methods

Shell believes a more efficient way to extract Syncrude from Oil Shales exists. By using In Situ Conversion (ICP) the whole deposit is transformed into a refinery allowing the Syncrude product to be extracted while leaving the source rock intact,. ICP works in the following way:

> Using heaters inserted through a series of boreholes the deposit is heated to around 750°F
>
> At this temperature Syncrude begins to separate from the source rock, and is pumped to the sur face via another series of boreholes.
>
> The whole deposit is encased with a freeze wall produced by injecting refrigerant into bore holes in the surrounding area. This minimises product loss and prevents ground water contamination.

Preliminary results suggest ICP is a much more efficient refining process, substantially reducing costs, yielding a wider range of products including natural gas while allowing Syncrude to be extracted for as little as 30$/barrel. However significant safety questions still remain over the effect of Syncrude extraction on surrounding water supplies. It is likely therefore we will not see full scale oil production by ICP in the near future.

Current mining techniques and the energy intensive nature of refining Syncrude, puts the cost of developing an Oil shale reserve at around 70 dollars a barrel'. Therefore a high Oil price is required before Oil Shales can be considered an economically viable replacement for conventional crude. This has only occurred once in the last few decades, during the Oil crisis in the 1970's. However, due to the heavy Oil demand from industrialising Asia and political turbulence in the Middle East. Oil Shales are again being considered as a crude replacement.

Currently two major mining techniques exist for the extraction of Oil Shale; Surface mining and Room and Pillar mining, both of which are used at the Worlds longest running commercial Oil Shale plant in

Estonia 13.

Both techniques have an extreme effect on the surrounding environment. Surface mining produces substantial waste products, contaminating the surrounding areas with alkaline waste water necessitating extensive remediation, while underground mining causes subsidence. Direct combustion of Oil Shalealso has significant effects on air quality due to the high proportion of Sulphides and Volatile phenols released.