European Oil and Gas Industry History Conference

3-4 March 2016

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Thursday 3 March

Session One: History of the United Kingdom Oil Industry

Keynote: UK Shale Gas Exploration: From 1875 to Now

Professor Dick Selley, *Department of Earth Science & Engineering, Imperial College*

The UK's first well to encounter shale gas was drilled into the Upper Jurassic Kimmeridge Clay in 1875, though its significance was not realised at the time. 25 years ago research at Imperial College identified the UK's shale gas resources in the Lower Carboniferous basins of the Midlands, and in Jurassic shales of the Weald basin. Without encouragement from Her Majesty's Government no exploration resulted from this initial research. Publication of the results of the project was rejected by many UK journals. It was finally published in the USA in 1987. Subsequent evaluations of UK petroleum resources by the Department of Energy and its descendants published in 2001 and 2003 made no mention of the UK's shale gas resources. In 2008 the 13th Round of Onshore Licensing resulted in the award of several blocks for shale gas exploration in the Midlands and in the Weald. Cuadrilla Resources drilled the first well to specifically test for UK shale gas in 2010. Unfortunately it triggered two minor seismic tremors which irritated opponents of shale gas production and set back shale gas exploration for a couple of years.

Re-evaluation of the UK's shale petroleum resources has been carried out by the British Geological Survey on behalf of the Department for Energy & Climate Change. In 2013 BGS calculated 1329 tcf of gas in place at P50 for the Lower Carboniferous shales of the Midlands. In 2014 BGS calculated that there is 4.4bbl of oil in place at P50 in the Jurassic shales of the Weald. The press often ignorantly, and some promoters wilfully, fail to differentiate between in place resources and recoverable reserves.

80% of UK homes use gas for heating and cooking. With declining North Sea production the UK started importing gas in 2000. This is a financial 'double whammy' for the UK's economy. HM Treasury taxes some 60% of the profits of petroleum production. Declining petroleum production results in declining government revenue. Purchasing gas from overseas degrades the UK's balance of payments. The shale gas & oil revolution in the USA provides a paradigm for the UK. Benefits include diminishing CO2 emissions, cheaper energy, and energy security. Hydraulic fracturing has been a routine well completion in the UK for decades and has taken place beneath some of the most expensive property in the country. Not many people know that. UK regulation is far more robust than in the USA. A report by the Royal Society and the Royal Academy of Engineering in 2014 made recommendations, since acted upon by HMG, to enhance the robustness existing legislation. Bids for the 14th round of onshore licensing were invited in 2014 and, at the time of writing (August 2015) announcement of the results are imminent. HMG has faced up to the so-called energy 'Trilemma' of balancing economic, environmental and security issues, and is easing many of the planning procedures that delay shale gas and oil exploration. As of now, without the results of prolonged production tests, it is not yet known if shale gas and oil will be a valuable and secure source of energy for decades to come.

NOTES

Early 20th Century Oil Exploration in the English Midlands; the New Persia?

Jon Gluyas[1] & Jonathan Craig[2]

[1]*Durham University*
[2]*ENI*

Dr George Martin Lees, Chief Geologist and head of exploration at the Anglo-Persian Oil Company (1930-1955) likened the anticlines he observed in England to those in the Zagros Mountains of Iran (then Persia). He further recognized that the numerous surface petroleum seepages in the UK as well as accidental discoveries of flowing oil in mines boded well for the prospectivity of many parts of the UK including the English Midlands (Kent, 1985). It was not that the UK lacked an oil industry at this time (early 1930s); it was just rather a small one with oil-shale retorting in Midlothian (Scotland) dominant over two small discoveries pumping just a few barrels per day from Hardstoft (Derbyshire) and D'Arcy Farm (Midlothian).

Not everyone shared Lees' optimism as to the petroleum potential of the UK. An anonymous news article from the March 1934 edition of Nature told of new legislation that would vest ownership of all discovered petroleum with the state adding that after 99 years of endeavor the chances of finding commercial petroleum accumulation in the UK "preclude even faint hope."

Faint hope was not precluded and Lees was proved correct. Eakring 1 in Nottinghamshire operated by his own company D'Arcy Petroleum became the first commercial discovery in the UK. Eakring became one of 25 discoveries made over the next 30 years (until 1964) a period which was effectively Britain's first oil boom. Persia it was not but the oilfield skills honed by oil workers in Nottinghamshire played a key role in the successful search for petroleum in the North Sea a petroleum province that was worthy of analogy with Persia.

NOTES

The History of Oil & Gas Exploration and Development in the Wessex and Weald Basins

From Oil Shale to Shale Gas

Alastair J. Fraser, Howard D. Johnson & Gary J. Hampson, *Department of Earth Science & Engineering, Imperial College, London.*

It is interesting to go back in time almost 100 years when the precursors of British Petroleum fresh from their success in drilling large anticlines with carbonate reservoirs in the Zagros mountains of the Middle East finally turned their attention closer to home and to the large surface anticlines in Southern England. It is easy to reflect on the obvious attraction and similarities. Large undrilled Jurassic anticlines and numerous surface seeps such as at Mupe Bay and Osmington Mills on the Dorset coast. Add this to historical evidence of gas production from Heathfield Station in the Weald from a well drilled in 1896 and the mining of the oil shales of the Kimmeridge Clay Formation in Dorset which had been retorted to provide gas for street lighting in the mid 19th century. All the planets were seemingly aligned for a successful exploration campaign or were they?

In this paper we will explore the exploration history of the Weald and Wessex Basins from the largely unsuccessful BP campaign in the 1930s to the hugely successful Wytch Farm discovery in 1973 - the largest onshore oilfield in Northwest Europe with over 1 billion barrels of in-place resources. We will discuss the key success/failure factors for conventional petroleum particularly the part played by modern 2D seismic and petroleum systems analysis. Finally we will touch on the potential for Shale Oil & Gas in the Weald and Wessex basins.

NOTES

Development of the Manufactured Gas Industry in Europe

Russell Thomas

One of Britain's great technological contributions of the industrial revolution was the invention of manufactured gas. Gas lighting replaced oil lamps and candles, making our factories and city streets brighter and safer environments.

Whilst William Murdoch, the great Scottish Engineer was the undoubted champion of commercialised gas manufacture in Britain, lighting his office in Redruth with coal gas in 1792, he was not alone. Across Europe, others were active, in experimenting with coal gas. Jean Pierre Minckelers a professor at the University of Louvain, had lit his lecture room in 1785. Herr Pickel had lit his laboratory in Wurzburg, Bavaria in 1786. But most notably, in France in 1791, Philippe Lebon developed an apparatus called a Thermolamp, which he used to light a room by gas obtained from sawdust. Lebon is recognised as the father of the French gas industry. The son of a court official of Louis XV, he was an engineer and scientist of considerable reputation and devoted great efforts to gas lighting, being awarded a patent in1799 for this purpose. It was Gregory Watt's observation of Lebon's work whilst in Paris, which spurred on William Murdoch Employers Boulton and Watt, to invest resources in making gas manufacturing commercial.

Whilst Britain took the lead in exploiting manufactured gas, it took a notable European character to help the industry develop. The philosophy of William Murdoch had been to build single gasworks to provide gas to a single factory establishment. However the charismatic German entrepreneur Friedrich Albrect Winzer realized the wider vision of centralized gasworks providing gas to multiple establishments through gas mains under the street. Winzer moved to Britain after witnessing Lebon's early experiments in Paris changing his name to Fredrick Albert Winsor, He spent many years campaigning for the creation of the Gas Light and Coke Company, which received its Royal charter in 1812, over 200 years ago. Following this gas quickly spread across Britain to light every city, town and large village.

It did not end there as it was soon realized that Britain could export this technology across Europe and the world and the Imperial Continental Gas Association (ICGA) was formed in 1824 by Major-General Sir William Congreve. By this time the manufacture of gas had already been introduced in some European towns. Congreve toured Europe in 1825 to establish business ventures, with mixed success. Their first venture was a small gasworks in Ghent which they had purchased from a local company. From this small venture a huge business developed operating gasworks in the Netherlands, Belgium, Germany, Austria, Hungary and France. The gas works were generally leased and due to these types of contracts, political changes and war in Europe the business changed considerably from decade to decade. Other British companies such as the European Gas Company and the Continental Gas and Water Company followed them. British engineers also looked abroad to seek their fortune. Aaron Manby established the Compagnie Anglaise to light some of the streets of Paris. Other gas engineers such as George Bower, exported entire gasworks as kits to be built abroad in countries from Russia to Argentina. Britain was not alone in exporting gas engineering expertise. French, Belgium and German companies were also very active in building the European gas industry. Whilst almost all European countries formed a manufactured gas industry, the experience and development in each country has its own unique story.

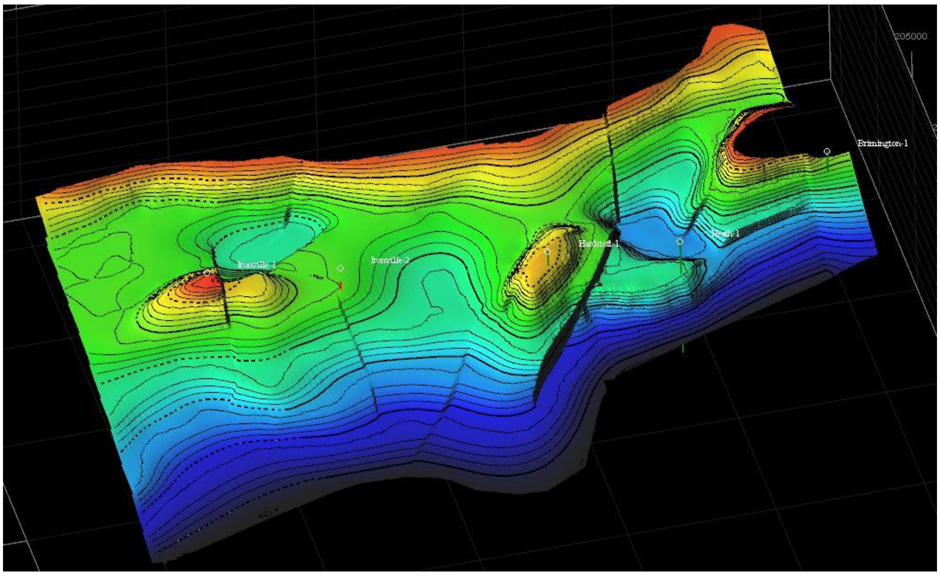
NOTES

The Geological Background to the First Drilling Campaign in the UK, 1918-1922

Stephen Corfield, *Corfield Geoscience Ltd, Stafford, UK*

The story of UK onshore exploration goes back to the days of the First World War and was prompted by the increasing use of oil for the war effort. Unfortunately, the war was drawing to a close as the campaign commenced in 1918. The UK government sponsored the drilling with a budget of £1,000,000 and the work was undertaken by Pearson and Sons, a UK engineering company owned by Lord Cowdray (Weetman Pearson). Pearson also had oil interests and he owned the Mexican Eagle company that had considerable success in its exploration efforts in Mexico. Pearson hired a team of American geologists to select suitable drilling locations in the UK. The Carboniferous rocks in the area surrounding the Derbyshire Dome in England and the Midland Valley in Scotland were chosen because of their similarity to the oil producing areas of Pennsylvania and West Virginia in the US. Eleven wells were sunk: seven in Derbyshire, two in North Staffordshire and two in Scotland. The first well to be spudded was at Hardstoft in Derbyshire in October of 1918 and it was also the first oil discovery.

The talk will introduce the main characters behind the drilling campaign: Lord Cadman representing the UK Government, Lord Cowdray as the drilling contractor and the Duke of Devonshire, who was the owner of the land upon which the first discovery was made. A review will be made of the geological reasoning behind the selection of the drilling sites. Pre-drill assumptions of the source of the oil and the predicted reservoir rocks will be compared with the actual results from 1918-1922 and also what is now known about the Carboniferous onshore play. The geological structures drilled will be illustrated using maps and cross-sections from the 1920's which will be updated using more recent seismic data and coal mine plans from the author's own unpublished work.



Map of the Silkstone Coal (Westphalian) illustrating the location of five of the wells drilled in Derbyshire. The Hardstoft discovery well is located on the anticline in the centre of the image

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The West Lothian Oil-Shale Formation in Scotland – The Oil Shale That Changed the World.

Graham Dean, *ReachCSG*

The first large-scale commercial production of oil in the world started in 1851 in West Lothian in Scotland. This oil production led to major developments in oil refining and as a result a large demand for oil products was created. This new demand for oil products stimulated the search for oil around the world and resulted in the first modern-day oil well being drilled in the Tittusville Pennsylvania in 1859.

Over the next 100 years an estimated 75 million barrels of oil was produced from the shales of West Lothian. Initially the oil was produced from a thin layer of shale with a very high TOC of over 40%. This shale was at Torbanehill near Bathgate and was described at the time as “the cannel coal of Boghead”. This shale is Carboniferous Lower Westphalian age. Later the much thicker deposits in the West Lothian Oil-shale formation in the Dinantian were used to produce the oil. These shale form a thick lacustrine sequence.

In addition to oil products a large amount of gas was also produced and used as fuel for the retorting process and also to produce ammonia.

Near the surface, the West Lothian Oil-shale formation is geochemically marginally mature for oil. The vitrinite reflectance (Ro) at surface is close 0.6 (see fig 1). To produce the oil, the shale was mined, then heated in retorts and then further refined.

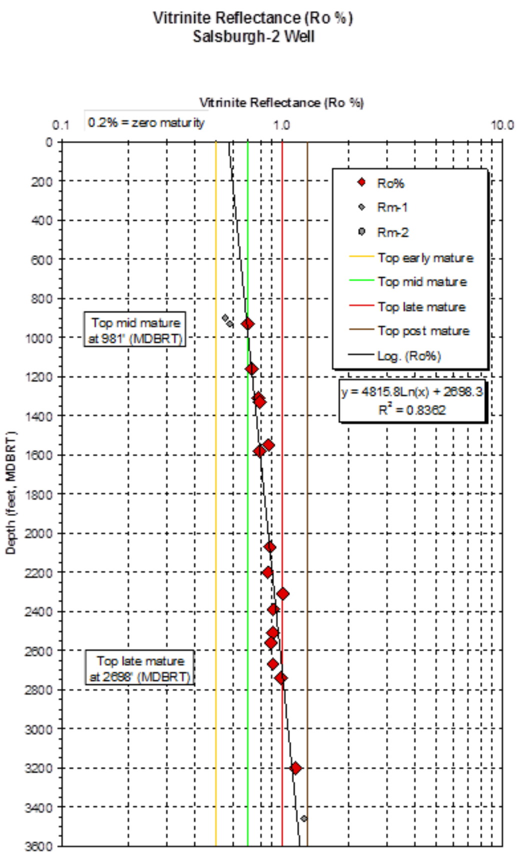

Figure 1. Vitrinite Reflectance measurements performed on drill cuttings from the Salsburgh- 2 well. When the data is extrapolated to surface the shale has an Ro of close to O.6 indicating approximately 6000 ft of inversion.

Figure 2. The oil shale bings (waste heaps) are a common site in West Lothian

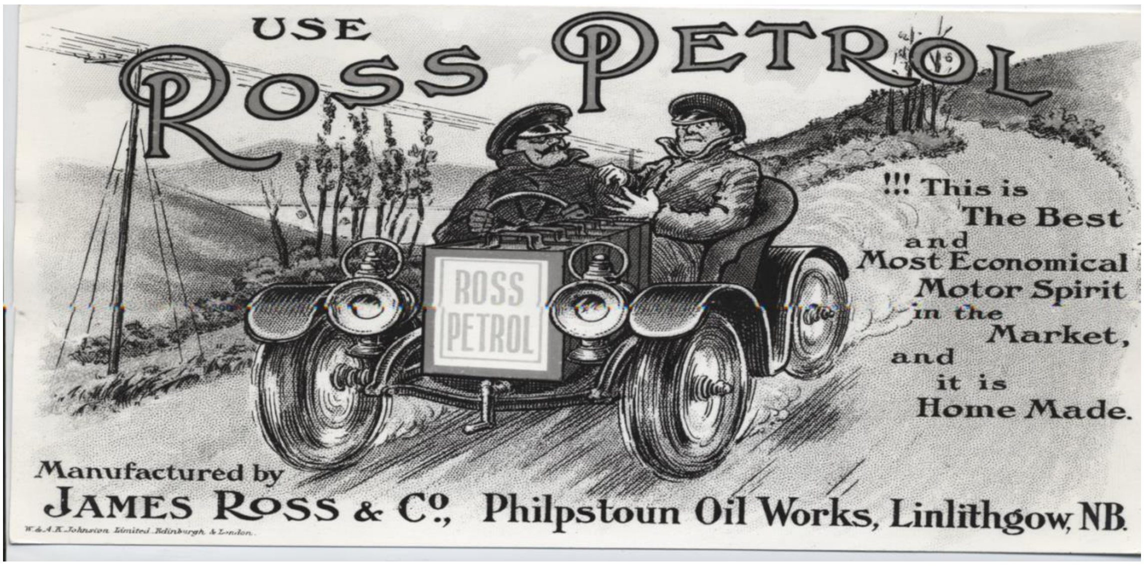

Figure 3. An advertisement from 1912

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"Derbyshire's Oil and Refining History: the James "Paraffin" Young connection"

Cliff Lea, *North East Derbyshire Industrial Archaeology Society*

This Conference marks the Centenary of plans to sink what was to become Britain's very first successful deep oil well, Hardstoft No 1, in Derbyshire, and the exploitation of the country's first oil field at the end of World War1. A further five other sites in Derbyshire within 5 miles North and South of Hardstoft No 1 were also evaluated within the same Government sponsored programme; Derbyshire had been selected for this first systematic search for oil in the UK because of earlier oil-shows and unexpected strikes that had occurred in local coal and lead mines over a number of centuries.

The success of Hardstoft No 1 is the subject of a separate paper at this conference, but this presentation looks at findings at the other Derbyshire sites, and particularly at one historic site just a few miles from Hardstoft. Two wells, Ironville No 1 and No 2, had been sunk near the village of Riddings, near Alfreton. The Riddings area had been especially selected because this had been the historical site where 70 years before, in 1847, following an adventitious oil seepage in a coal mine, James "Paraffin" Young was to carry out his seminal work into the development of oil refining technology, technology which was to become the basis for his later cannel coal refinery for which he subsequently made his reputation.

It was at Riddings that in 1847 Young evaluated distillation and fractionation of the oil, producing light hydrocarbon fuels for lamps, lubricating oil fractions, and paraffin wax for candles. Shortly afterwards at the Great Exhibition of 1851, Young's work and some of this oil, the end products and paraffin wax candles were to be displayed.

More importantly, it was to be the very refining technology which Young developed that was to be required within the next ten years as oil started to be exploited in North America and elsewhere as the global oil industries emerged.

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Keynote: Argyll: A Field Reborn; Twice

Jon Gluyas, Adam Law, Tang Longxun and Katie Overshott

In June 1975, oil from the Argyll Field became the first to be produced from the UK North Sea. Hamilton Brothers, a US company had beaten BP and their giant Forties Field into production. Seventeen years later the Argyll Field was abandoned with all production facilities removed. The first chapter of UK offshore oil production closed. Argyll lay forgotten by most and unwanted by all.

A new millennium dawned and with it two new companies Acorn Oil and Gas and Tuscan Energy. Both had identified Argyll as a potential field redevelopment. An alliance formed. The UK's Department of Industry was approached with a request to relicense the Argyll Field out of round in order to redevelop the field. No company previously had sought to obtain a licence for production rather than exploration. It worked, as did the quest by both companies to obtain equity and debt funding.

In September 2003 the first well was drilled on the newly renamed Ardmore Field since abandonment. It flowed unaided at 20,000 barrels of dry oil per day; significantly in excess of expectation. However, after two months of sustained high rate the well cut water. With a second well on stream production peaked at 28,000 barrels of oil for one day before the facilities, designed for 50,000 barrels of fluid per day, tripped-out. All was not well; during the next two years, facilities and well issues limited production. Debt was not adequately serviced and funding withdrawn. In mid-2005 the field was abandoned again. Five from an expected 25 million barrels was produced. Argyll/Ardmore chapter 2 ended but the story was not yet done. By 2013 Enquest had acquired the licence and drilled 6 wells. Production restart is set for mid-2015. Chapter 3 has opened for the newly named Alma Field.

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The History of Exploration and Development of Gas Fields in North Yorkshire

Matthew Haarhoff, David Harrison, Fred Hughes, Colin Taylor, Andrew Pearson, Grant Emms and Andy Mortimer, *Third Energy Ltd*

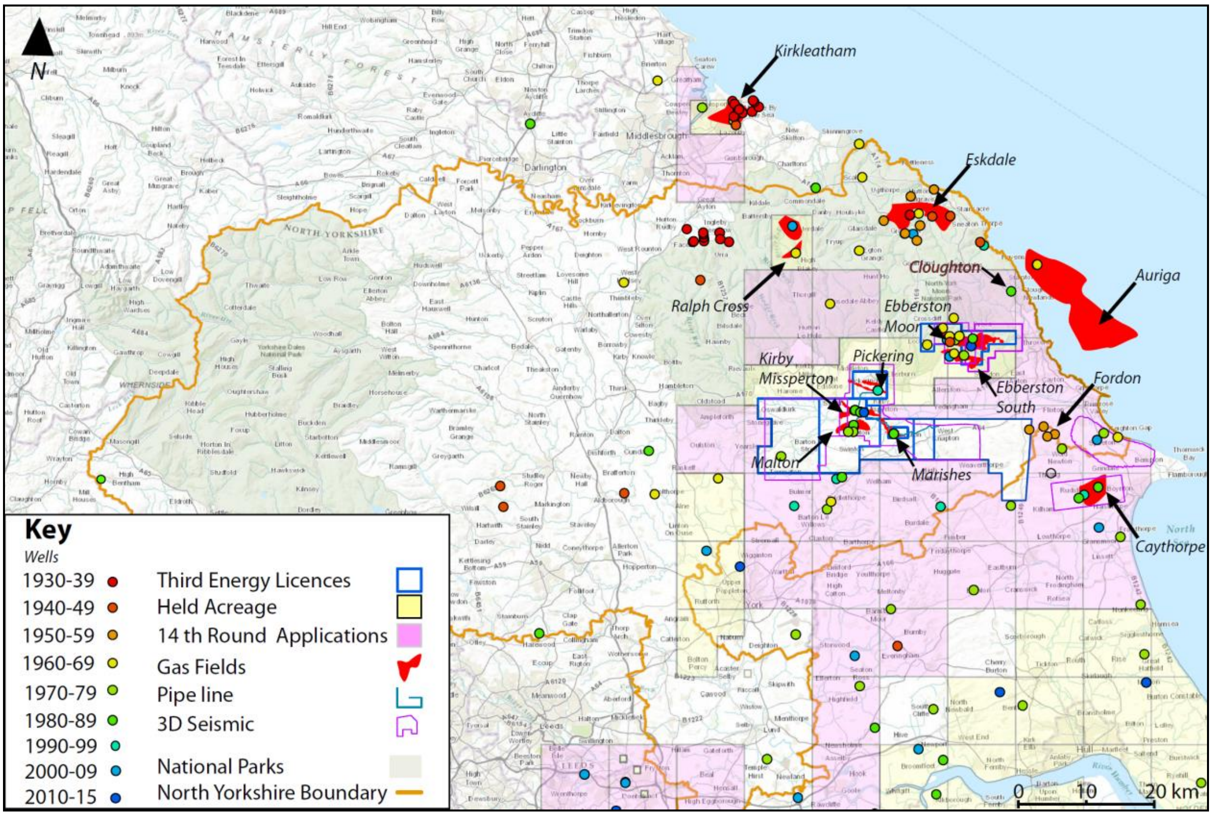

Figure 1: Map of NE Yorkshire showing the location of the wells drilled and gas fields.

The first gas discovery well in North Yorkshire (Eskdale-2) was drilled in 1937 by D'ARCY, now BP, and flowed at approximately 2 mmscf/d from the Permian carbonates of the Brotherton and Kirkham Abbey (KAF) formations. Drilling continued in the 1940s, 50s and early 60s, and included 12 appraisal and development wells on the Eskdale Field. Production from this field began in 1960 but high levels of water production led to the field's early abandonment in 1967 after producing just 0.8 bcf.

Lockton-2a was spudded just north of Ebberston Village by Home Oil in January 1966. After several months of drilling, the well reached the KAF reservoir and discovered the Lockton Gas Field. Six more wells were drilled in the area of the field during the 60's and 70's and another two in the 1980's. However, as wells were targeted using sparse, poor quality 2D seismic data the appraisal of the structure was not very effective. Only Lockton-7, successfully appraised the structure, whilst Wykeham-1 discovered a separate gas accumulation, now recognised to be part of the Ebberston South Field.

The Lockton Field produced from 1971 to 1974 from just two wells. Lockton-7 was abandoned because of water loading within one year, after producing 1.1 bcf. Lockton-2a performed significantly better, producing 10.2 bcf. This superior performance was due principally, to its crestal position within the structure and also to the active water management performed by the operator, who successively shut off deeper perforation zones in the well as water broke through. However, by 1974, the Lockton-2a gas rate had declined to less than 1 mmscf/d with a high water cut. The decision was taken to abandon the field as the facilities were not designed to deal with the increasing water cut and it was not economically viable to upgrade the facilities at a time of cheap gas from the SNS fields.

Subsequently, a further five gas fields were discovered to the south, in the Vale of Pickering (VoP). They are known as Malton (1970), Kirby Misperton (1986), Caythorpe (1987), Marishes (1988) and Pickering (1992), which collectively contain GIIPs exceeding 150bcf. There were also multiple minor discoveries in the basin, which have yet to be developed, including Ralph Cross, Cloughton and Fordon. Given the sparseness and poor quality of the 2D seismic data in the basin, coupled with the low relief of the traps, it is perhaps surprising that such success was achieved in this hydrocarbon province.

Since 1994, the VoP fields have produced gas predominantly from the KAF reservoir, with some exceptions. Kirby Misperton-1 produced 6.8 bcf from Namurian sandstones immediately beneath the Base Permian Unconformity and Caythorpe produced from the Rotliegendes before the gas in the overlying Permian carbonates was also developed.

As these fields were developed using 2D seismic data, many of the production wells were poorly located down dip and often intersecting faults. With the exception of Malton, the KAF reservoirs in the VoP repeated the previous development failures of Eskdale and Lockton with recovery factors of less than 15%. This was again due to early water production. The introduction of 3D seismic data has improved well positioning and targeting up-dip reservoir but overall has not led to a material improvement in the long term performance.

Until recently the dynamic behaviour of the KAF reservoir has been poorly understood. Gas production was characterised by high initial rates, declining rapidly with the onset of water production. Wells producing from this reservoir typically yield around 2 bcf.

This characteristic production behaviour is attributed to the dual porosity nature of the KAF which has a moderate porosity/ low permeability matrix and a low porosity/ high permeability natural fracture system. As a result wells initially produce at high rates from the fractures, but once pressure declines the aquifer expands into the fractures, effectively isolating the bulk of the GIIP in matrix from the wells.

Third Energy is now implementing a programme of active water production. Modelling shows that this will limit the expansion of the aquifer into the reservoir, allowing the matrix to be drained. Operations are under way to re-instate production from three wells in the VoP using electric submersible pumps to prove this principle. Successful implementation will substantially enhance production rates and ultimately significantly improve overall field recovery factors.

This de-watering scheme is expected to increase recoveries up to 70-80% in existing fields and could lead to the development of a number of KAF discoveries. Third Energy is also in the process of re-developing the former Lockton area fields, now renamed the Ebberston Moor and Ebberston South Fields. It is anticipated that collectively through this process of field rehabilitation the VoP and Ebberston fields could yield up to 120 Bcf of additional recoverable gas.

The Cleveland Basin is also currently undergoing a renaissance, as the boom in production from unconventional resources in the US has generated considerable interest in the onshore UK. Thirty eight licence blocks were applied for in the Cleveland Basin during the recent 14th Onshore licencing round. Underpinning this interest is the fact that Third Energy successfully drilled Kirby Misperton-8 in 2013 to assess the tight gas trapped within the Carboniferous succession under the Kirby Misperton Field. Fraccing operations are planned for early 2016 and achieving gas production through the existing field facilities could yield the UK's first unconventional resource production. This will be a significant step forward in demonstrating the unconventional resource potential of the region and will undoubtedly lead to a major new phase of exploration in North Yorkshire in the coming years.

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Hardstoft – Britain's First Oil Field

Craig, J.[1], Gluyas, J.[2], Laing, C.[3] and Schofield, P.[4]

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[2] *Department of Earth Science, Durham University, South Road, Durham DH1 3LE, U.K.*

[3] *Laing Engineering and Training Services Ltd., 63 Ness Circle, Ellon, Aberdeenshire, AB41 9BR, U.K.*

[4] *Oilwell Nurseries, Chesterfield Rd., Tibshelf, Alfreton, Derbyshire, DE55 5NP, U.K.*

In 1911, Winston Churchill was appointed as First Lord of the Admiralty. During his time in office, Churchill took the strategic decision to power British Naval ships with oil and to phase out the use of coal. It was a strategic decision based on the need to improve the performance of the naval fleet, but also to deal with a chronic shortage of manpower in the Royal Navy by eliminating the need for 'stokers'. It was a brave decision. At the time, Britain had almost unlimited supplies of coal, but no indigenous supplies of oil whatsoever and, in the opinion of most knowledgeable experts at the time, little chance that it ever would. Churchill's decision gave the ships greater efficiency, speed and range, but it left the Navy dangerously dependent on foreign oil supplies. Britain would have to rely entirely on importing foreign oil supplies, mainly from her vast colonial empire – with Burma (then, of course, part of 'British India), Trinidad and, eventually, Persia supplying the 'lion's share'.

When Britain eventually declared war on German in 1914, it soon became clear that German submarines posed a significant threat to those oil supplies as U-boats repeatedly attacked and sank tankers bringing essential oil supplies to Britain from the Indian Subcontinent, the Middle East and the Caribbean.

By 1915, the British Government finally realized the scale of the threat and, in somewhat of a panic, commissioned a company called 'S. Pearson and Sons' to undertake a survey of potential oil resources in Britain. S. Pearson and Sons was owned by Lord Cowdray and was heavily involved in the oil industry in Mexico, through Cowdray's Mexican Eagle Oil Company. The staff of S. Pearson and Sons' identified three main areas of Britain as having significant potential for oil – the Lothians area in the Midland Valley of Scotland, the Potteries Region of Staffordshire and the Derbyshire Coalfield.

Eventually, after much debate, the decision was made to drill a series of 11 exploration wells – 7 in Derbyshire, 2 in Staffordshire and 2 in Scotland. There is now little information available to indicate why the particular drilling locations were chosen, but it is clear that the combination of suitable geology, the location of surface anticlines and the presence of oil seeps in nearby coal mines – particularly in the Derbyshire Coalfield - were significant factors. Of course, at this time, Britain had absolutely no experience of drilling oil & gas wells, or equipment to drill them with, so the derricks, all the ancillary equipment and more than 50 drillers where shipped over from the United States to undertake the task.

The first well drilled was at Hardstoft in the parish of Tibshelf in the county of Derbyshire and oil was struck 'in quantity' in the Hardstoft No 1 well on 27th May 1919. There was a subsequent successful well at D'Arcy Farm near to Dalkeith in the Lothians of Scotland. There are few data available for either of these wells and those that do exist are of dubious quality and open to differing interpretation.

Hardstoft No.1 was the first successful oil exploration well ever drilled in the United Kingdom. It was drilled on a prominent surface anticline on land belonging to the Chatsworth Estate that was, and still is, owned by the Duke of Devonshire. It encountered light oil in a fractured sandy limestone unit at the top of the Lower Carboniferous Limestone at a depth of 3,070 ft in what subsequently turned out to be a rather small tilted fault block. The well was completed and produced about 7bbl/day for many years before a subsequent work-over doubled the production rate to about 14 bbl/day. The original intention was to 'shoot' the well with nitroglycerin to stimulate the production, until it was pointed out that the transportation of nitroglycerine over public roads in England was illegal.

The Hardstoft oil was light, of good quality and exceedingly 'mature'. It was stored in a 12,000 barrel tank at the site and was initially transported by road to the nearby railway station at Pilsley and then, via the Great Central Railway to the Pumpherston Refinery in Scotland. Eventually, a 4,500ft gravity-fed pipeline was laid direct from the well to Pilsley Station. In 1924 a 'pump-jack' was installed, but between 1924 and 1927 the well began to produce an increasing amount of water, which was, at the time, thought to indicate that the well was 'watering-out' as the bottom water encroached. By 1927, the production rate at fallen to a level at which it was no longer worth selling the oil to the refinery and the Chatsworth Estate used the unrefined oil to power a sawmill at nearby Hardwick Hall.

Two further wells were drilled on the Hardstoft structure in the 1920s. Both encountered numerous drilling problems. The No.2 well because it drilled through the main fault high up in the section and the No.3 well because it drilled through some old mine workings, encountered a gas bearing sand at 400ft, that was only discovered when the driller dropped a light match into the hole and there was an explosion – and finally, because the casing collapsed! Although no additional oil production was obtained from these wells, the gas found in sandstones within the Coal Measures succession was used to power the site for several years.

The Hardstoft No.1 well was put back in production in 1938, when Britain again found itself at war and in 'dire straights' over the supply of foreign oil – having, apparently, learnt absolutely nothing from the situation during the First World War. The total production from the Hardstoft No. 1 well between 1920 and 1946 was about 30,000 bbl.

The aim of this paper is to tell the story of Britain's first oil well, its subsequent production and attempts at continued development. We also re-examine the history from a modern perspective, report on new analyses, both of the oil and of the trap, in order to evaluate the potential for redevelopment and examine the implications of the Hardstoft discovery for current shale oil and shale gas exploration in the East Midlands. .

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Thursday 3 March

Session Two: History of the Oil Industry in Eastern Europe

Birth of Oil Industry in the Northern Carpathians

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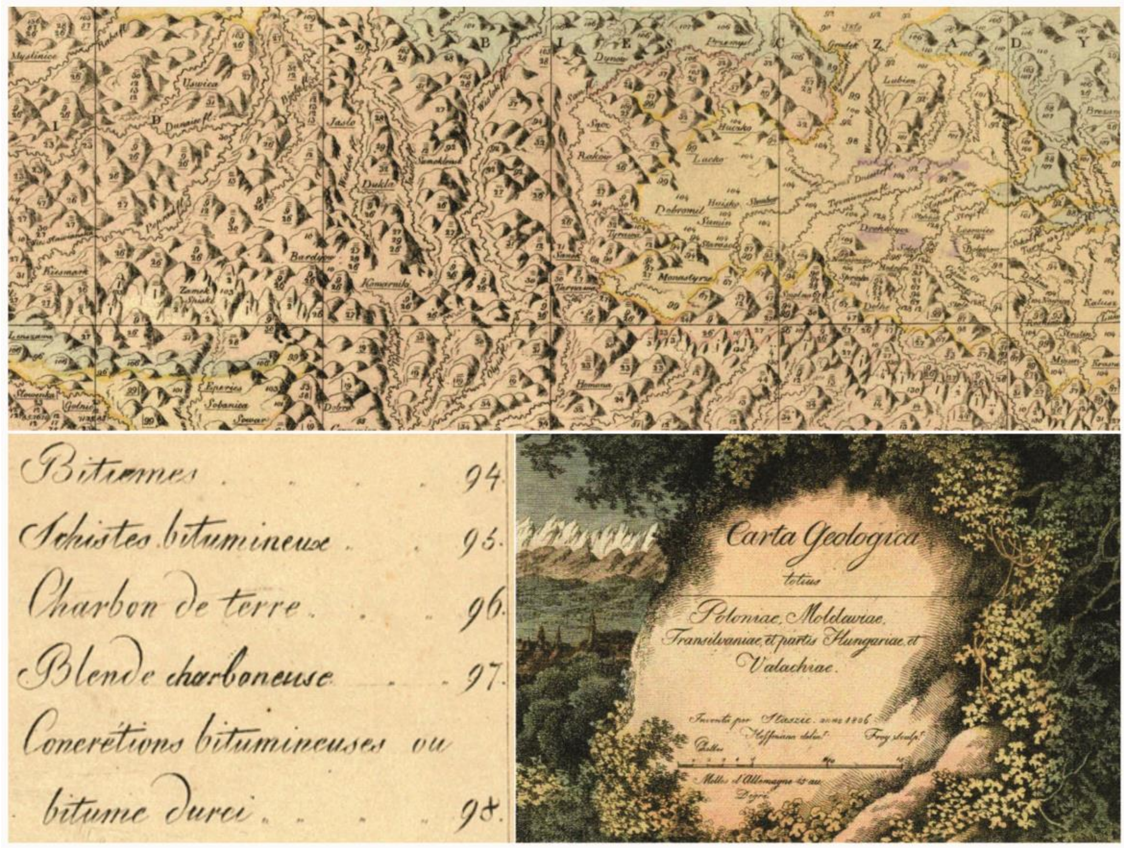
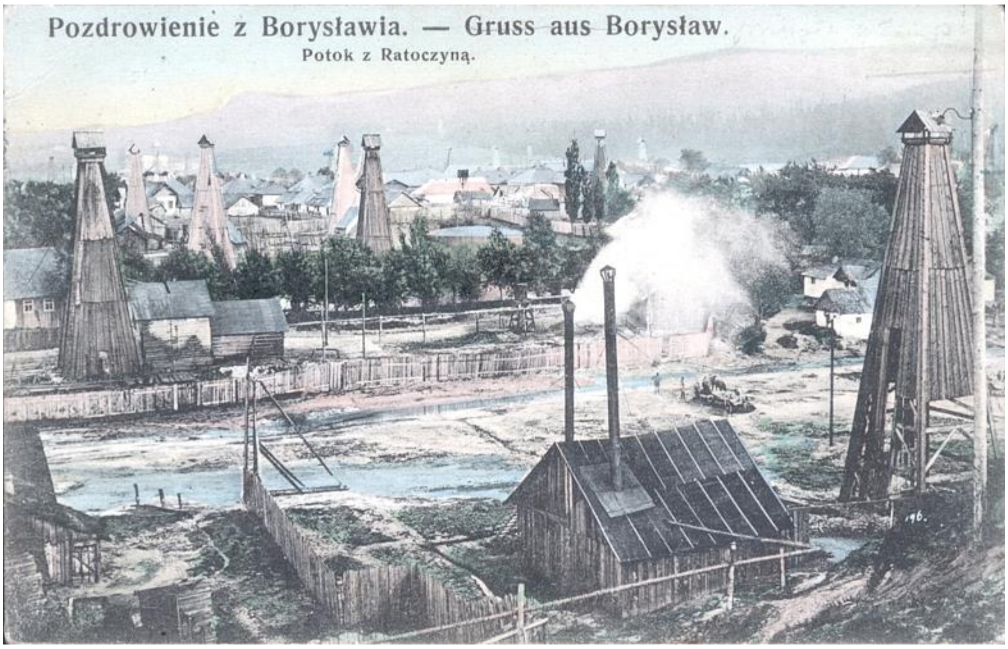
Northern segments of the Carpathians belonged in late XIX and in early XX centuries to the most prolific hydrocarbon provinces in the world. The earliest written account of natural occurrences of hydrocarbon (oil seeps, gas leakages) in the Carpathians date back to the 15th – 16th century. In 18th century G. Rzączyński and K. Kluk provided first fairly detailed accounts of those phenomena, including methods of the practical use of oil by local inhabitants.

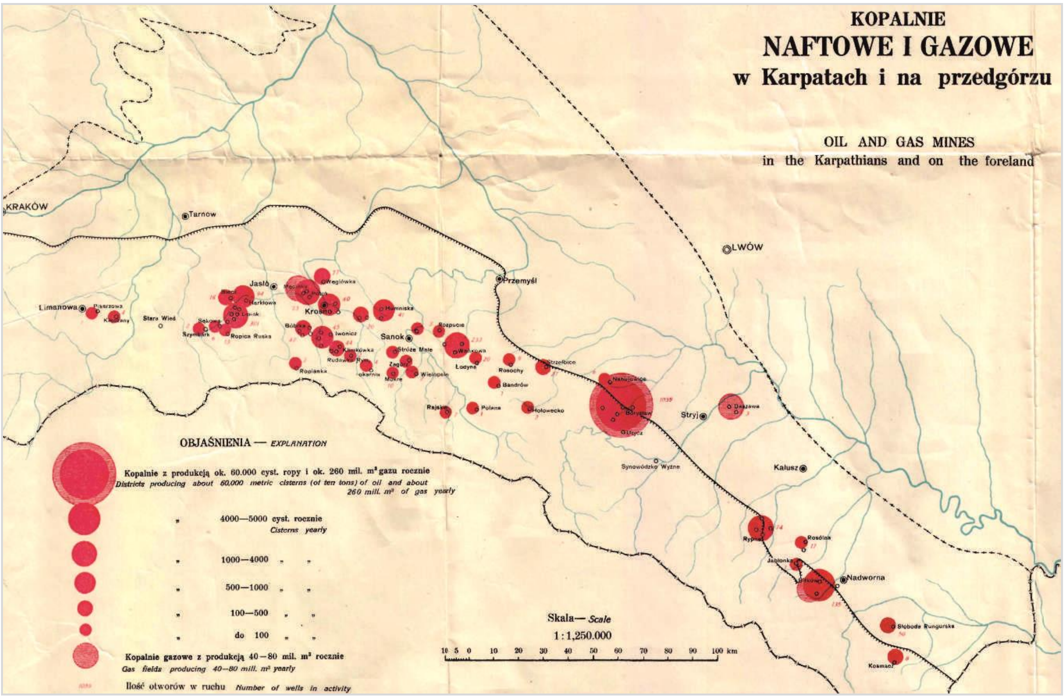
Stanisław Staszic (1755 – 1826), Polish priest, philosopher, statesman, geologist, scholar, poet and writer, a leader of the Polish Enlightenment, showed on his geological map *Carta Geologica totus Poloniae, Moldaviae, Transylvaniae, Hungariae et Valachiae* (1806) numerous oil seeps and different rock types containing hydrocarbons.



The development of oil industry was triggered by Ignacy Lukasiewicz's discovery of kerosene lamp and effective oil distillation process. Following this, oil industry flourished in the Carpathians, with wells being drilled already in mid-XIX century. By early XX century oil production peaked up to 2 million tons of crude oil in 1910 in the Austrian Galicia, in the area stretching between Stary Sącz (present-day Poland) and Borysław (present-day Ukraine).



At that time it was the third oil producing province in the world, behind USA and Russia. In the subsequent years, level of oil production was steadily decreasing due to turbulent economy and plummeting oil prices, however, northern Carpathians oil fields were constantly remaining the important local source of crude oil. In the XIX century, increasing demand for oil - connected with growth of various branches of industry - as well as a rapid growth of oil production in this area, resulted in the development of various geological services. For example, modern paleontology was born in the Carpathians and was heavily used to correlate reservoir rocks between wells and to construct detailed geological cross-sections. Local and regional geological mapping projects were undertaken, with prime example of regional coverage of almost entire northern Carpathians provided by Geological Atlas of Galicia consisting of 99 high quality geological maps in scale 1:75 000.



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History of Oil Industry in Czech-Slovak Region

Pavla Benadová, *Museum of Oil Mining and Geology, Czech Republic*

Pic.1: View on oilfield Nesyt, 1924

The beginning of the history of oil industry in the Czech-Slovak region is dated to January 10, 1914, the day when began oil production at the first deposit Gbely 1. The aim of this paper is to acquaint the reader with more than hundred-year history of oil industry on the territory of the Czech and Slovak Republic, focusing on interesting moments with respect to the local specifics when territory became the property of the various state establishment in the past century.

In 2006, small group of people founded the Museum of Oil Mining and Geology, where we aim at preserving and reviving this interesting history and familiarize the general public with the specific history of a small South Moravian region.

WHAT PROCEEDED...

Written records of oil production appear since 1788, when we can hardly talk about the oil industry, as we know it today,in the area of Galicia (now Polish-Ukrainian border), which, like Czechoslovakia was part of the Austro-Hungarian monarchy. In Galicia the oil was produced from digged wells, using a rope winches. The depth does not exceed 100 m.

Great influence on the development of drilling methods of oil and especially the growing demand was due to the discovery of oil destillation to petroleum. Ignac Łukasiewicz (1822-1882) pharmacist in Lvov conducted experiments with distillation of crude oil, he gained from oil the kerosene and in the years 1852 to 1853 constructed the first kerosene lamp. A year later, Łukasiewicz (pic.2) founded in Bóbrka at Krosno first Galician oil company.

Pic.2: Ignac Lukasiewicz

Austrian-Hungarian government realized the importance of oil, from 1893 supported oil drilling by financial subsidies, and in 1911 launched the oil monopoly. Despite all the attempts that have been in eastern Slovakia and southern Moravia implemented, no substantial oilfield was founded. The situation has changed by the coincidence.

FIRST DISCOVERY AND JAN MEDLEN

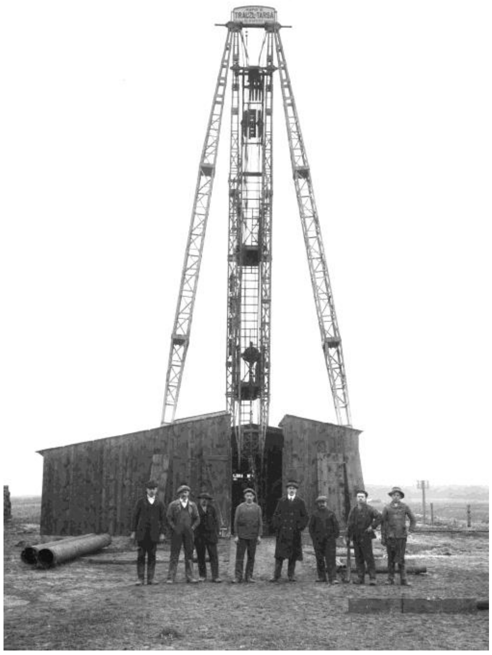
Pic.3: Jan Medlen

In 1910 Gbely citizen Jan Medlen (pic.3) dug drainage ditches on his swampy land and hid the flammable gas that flowed out in the area. He built a simple reservoir and brick pipe to his round house, where he used gas for heating and work with metal. One night in the year 1913, gas escaped into the house and created a combustible mixture. There was an explosion, which shattered his wooden and brick house to distance of 20 m and damaged the nearby railway line.

Almost immediately after this accident, 28 October 1913 was launched by modern drilling rigs Trauzl-Rapid exploration well under the leadership of Arnost Thon (pic.4). First traces of gas have been encountered at a depth of 114 m and surprisingly at a depth of 163.8 meters were drilled the first local oil.

On January 10, 1914 began oil production from the first Czech-Slovakian deposit Gbely 1 and it was also the first positive oil well in Vienna basin. Initial daily production from this well was about 15 tons. This oilfield played a key role in the First World War, especially in 1915 when Galicia was occupied by the Russian army. Galicia was the most important oilfield of Monarchy (2.26% of world oil production). The lack of oil caused skyrocketing price by almost 56 % compared with the price before war.

In 1915 the Austro-Hungarian government issued a statement that "today for national defence is oil reserve as important as national ammunition and soldiers" (Petroleum, 23/1915, p. 893). Skilled oil workers were even waivers for military service. In 1915, 91 % of the total produced oil (4319 tons) came from oilfield in Gbely. In Gbely, during the war were drilled positive 51 oil wells and 4 gas wells (only 14 were negative).



Pic.4: The first well in Gbely

AFTER COLLAPSE OF THE MONARCHY

In one of articles newspapers “Moravian eagle” considered oilfield Gbely as the most valuable assets in Slovakian part for the new state Czechoslovakia. Reports on the inclusion of

Slovakian are into Czechoslovak state appeared on November 3, 1918. Until the end of 1918 most of the oil experts already left from Gbely oilfield, so the number of employees dropped from 400 to less than 40 who had no chance to operate all 56 production wells. There was not enough food or money to pay salaries. As the former owners, the peasants demanded land on which oilfield was situated. Also there still existed danger of invasion of Hungarians, because the demarcation line after war was defined in December 1915 and the boundaries have been set up by Trianon Treaty in 1920. In this difficult time, leadership was taken by Arnost Thon, chief engineer of first Gbely well. In 1919-1920 occurred in our country a dire shortage of petroleum products, which has led to agreements with other, larger oil producers (Poland, Romania, USA). In our country most industries remained of the former Austro-Hungarian Empire, among other things, also a total of 18 oil refineries. There was concern that these refineries will not be able to continue to operate while in our country at that time, there was only one oil deposit. Although a new state wanted to establish a monopoly on the exploration and production of crude oil, the Czechoslovakia was forced to rent private individuals mining areas because all its state funding fell on payment of war reparations "fee for liberation" and Czechoslovakia could not afford to pay for expensive exploration work. There was placed great emphasis on research and hiring of mining areas, which would lead to the desired goal - new deposits of oil.

In 1919, the first commercial oilfield in the Czech Republic was found in dry pond close to town Hodonín. This oil deposit is the classic deposit of the Vienna Basin. Although there was already in 1900 first exploration well set on the basis of natural gas and oil in old river Morava, discovery of recoverable oil accumulations occurred in late 1919 in a depth of 217 m in area called Nesyt. This oilfield was called Karel and was registered by Moravian mining company. About ten years later, on this area 28 drilling towers were working, using the impactor technology. Yet the most important source of oil in the interwar period was oilfield Gbely.

SITUATION DURING THE NAZI OCCUPATION

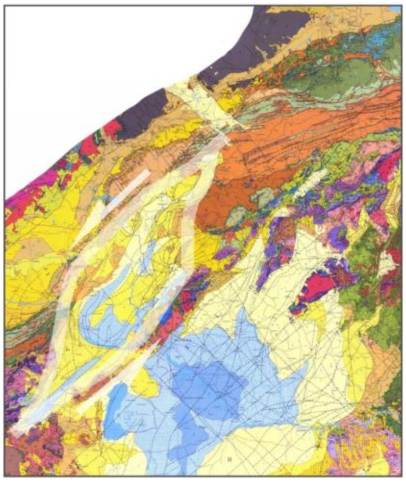
In the Protectorate of Bohemia and Moravia (1939 - 1945) German private companies dominated to almost all of our oil business, based on the direct orders of the German Reich. The basic task was use as much as possible the most sophisticated workforce, industrial potential and natural resources of occupied countries. Paradoxically German companies have brought to our country new technology the use of rotary drilling rigs, thereby increasing the speed of drilling and achieving greater depths. In addition to deposit Gbely and Nesyt was modestly begun finding smaller deposits in the Vienna Basin. At the end of the war, the Nazis carried out on occupied territories the so-called “ARLZ plan”. The purpose of “ARLZ Plan” was to kidnap or destroy the values that they did not want to leave to the winners of war. But in the oil industry this plan was implemented very carefully and always at the last moment because German army every ton of oil urgently needed. For example on Nesyt deposit the production ran until midnight on 5 April 1945, when Hodonín was already in a combat zone. This allowed the resumption of oil production in 2 weeks after the end of the war, although there were missing many important skilled labour, machinery and equipment. Oil workers often used forgotten and military equipment (pic.5) and the first few months they managed to repair and complete 30 drilling rigs. After the second war in 1946 Ministry of Industry established by the law state company The Czechoslovakian oil company settled in Hodonin, where worked until today thousands of employees.

AFTER 1945

Oil industry began to develop in Czechoslovakia and belonged to its strategic military importance to prominent careers. Salaries in the oil sector significantly exceeded the average. In the 50s continued searching for additional oil deposits. Depth of wells ranged from 1 to 2 km. Since 1959, our country uses new technology turbine drilling (Durica-Suk et al 1991).

Pic.5: using military tank as a winch

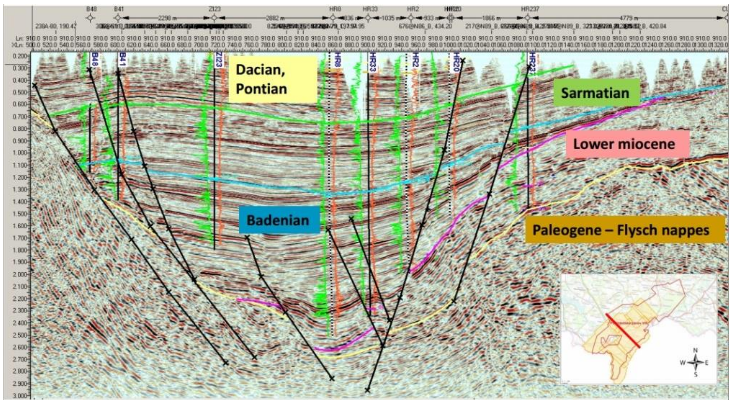
Altogether in southern Moravia since its beginning in 1919, when began production in Nesyt, was produced about 10 mil. tons of crude oil, but in terms of the total consumption of the state it represents only about 4 %. After 1990, when Czechoslovakian oil company (today MND a.s.) was privatized, production dynamically increased. Historical maximum over 360 000 tons was reached in 2003 since then the production slowly decreases.



Pic.6: The Vienna Basin

The oil and gas fields in Czech-Slovakian region are in the northern part of the Vienna Basin (Pic. 6) and the western part of the Carpathians. The Vienna Basin is a sedimentary basin between the Eastern Alps and the Carpathian Mountains. A thickness of Neogene sediments is up to 6km and contains marine, and freshwater brackish sediments of the Eggenburgian to Pliocene age.

The potential of this basin is significant as the foreland of the Carpathian nappes. The Carpathian region is one of the oldest and the richest oil and gas areas in Europe. A long history of exploration and production of hydrocarbons in this area give us hope that we will find more commercial reserves of oil and gas in future. The Vienna Basin still conceals its secrets.



Pic.7: Seismic profil of Vienna Basin (source

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NOTES

Geology and Geodynamics Characteristic of the Oil and Gas Field and History of Oil Production, Azerbaijan

Vusala Aghayeva, Nariman Narimanov, *Azerbaijan State Oil and Industrial University*

Since the ancient times oil has been applied in households, medicine, construction and for other purposes by the people in Azerbaijan. One of its main reasons is that, oil-gas horizon lay very close or expose to the ground surface and is spread largely in Azerbaijan territory. This case might be met on the dry surface and Azerbaijan part of Southern-Caspian aquatorium. For example: Girmaki valley, Balakhani-Sabunch-Ramana deposit and other places where oil-gas layers are spread largely. Sometimes, as a result of oil leakage to the ground surface, natural asphalt covers have been formed. The oil and gas leaking to the bottom of Caspian Sea might appear in the form of gas bubbles and thin oil layer on the sea surface.

On the other hand, up 30% of mud volcanoes developed in the world are located in Azerbaijan territory. Obviously, the development of mud volcanoes is originally related with the formation of oil-gas.

Such a feature related to spread of oil-gas in the settlement strata of Azerbaijan territory has facilitated extraction and use of oil and gas by the people from the ancient times. Wide-spread of such cases in Azerbaijan, especially in Absheron peninsula have served for search and exploration of oil and gas, as well as the development of oil extraction industry.

Therefore, it is not particularly surprising that, industrial method of oil extraction was first applied in Absheron peninsula in 1847. As can be evidenced from the foregoing, wide-spread of natural oil-gas outlets and mud volcanoes has played a specific role in early and fast development of oil industry. Wide-spread of natural oil and gas outlets, in its turn, is related with the location of Azerbaijan territory in tectonically and geo-tectonically very active region.

In this research work, we have tried to study formation of natural-gas outlets tectonically and geo-tectonically and their roles in the development of oil-gas industry in Azerbaijan.

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Friday 4 March

Session Three: History of the Oil Industry in Western Europe

Keynote: The Main Tectono-Sedimentary Domains of the Pyrenees
Comparison of the Petroleum Systems in the Aquitaine and Ebro Foreland Basins

Jean-Jacques Biteau[3], Jean-Marie Masset[2], Michel Le Vot[1]

[1]TOTAL Geoscience Division, Paris, France
[2]Former Geosciences Reservoir VP, now retired
[3]TOTAL E&P, VP Geoscience Americas

-This presentation covers extensively the whole area located between the Charentes, in France, to the North, and the Ebro Basin, in Spain, to the South.

It aims to describe components of the very contrasted Petroleum Systems (P.S.) n this area, where there has been more than 60 years of hydrocarbon exploration and production:

→ structural framework and geometry of the P.S. ingredients;

→ type of generative systems;

→ trapping mechanisms;

→ conditions for the main petroleum successes /failures in the periphery of the Pyrenees.

-1-On a structural point of view, and from north to south, the studied area can be divided into nine units:

→ the Medoc Platform is located to the south of the Gironde Arch, where a thin sedimentary section of Upper Cretaceous and Tertiary age overlies a reduced Jurassic substratum;

→ the Parentis sub-Basin corresponds to a thick sedimentary section affected by folds that have been associated to salt Pyrenean displacements formed on inherited salt gravity driven Lower Cretaceous structures;

→ the Landes Saddle (also called the Landes high) represents an intermediate domain exhibiting large salt gravity driven structures with very thin Jurassic and Lower Cretaceous sections;

→ the North Aquitaine Platform is a domain without Lower Cretaceous sedimentation and also with halokinetic structures;

→ the Sub-Pyrenean Zone or Northern Folded Foreland is composed of the Adour (Arzacq-Tarbes) and Comminges sub-Basins. These are Lower Cretaceous lozenge- shaped basins which are the result of salt gravity driven extension linked to the opening of the Bay of Biscaye;

A strong compressive Pyrenean phase is superposed to these former translated trends and characterized by the formation of blind thrusts and diapiric features. To the South this area is limited by the North Pyrenean Thrust Front (NPTF);

→ the North Pyrenean Zone (NPZ) is characterized by the presence of north verging thrusted and folded units. In its southern part it is affected by a Pyrenean metamorphism associated to schistosity. It is limited to the South by the Iberian fault which separates it from the High Chain and corresponds to a thrust verging change from north to south. Intensively deformed it is also metamorphised and injected by lherzolites;

→ the High Chain is represented by the highest mountains outcropping with Palaeozoic sediments that have been folded during the Hercynian orogeny. Very discontinuous Permian and Upper Cretaceous sections overlie this substratum;

→ the South Pyrenean Zone (SPZ) presents a thick sedimentary section, Mesozoic and Paleogene in age in the central Graus-Tremp and western Jaca sub-Basins. In the northern domain of this zone have developed the south verging allochthonous units of Gavarnie, Cotiella and Pedraforca. To the south, the SPZ is limited by the South Pyrenean Thrust Front (SPTF) which can be identified along the Aragon and Catalunya Pyrenees;

→ the Ebro sub-Basin contains thin marine and continental Triassic, Jurassic, Upper Cretaceous and Tertiary series.

The evolution of the Pyrenees and of its associated foreland Basins is the consequence of a complex and polyphased history that gave to the area its present configuration:

Devono-Carboniferous Hercynian inheritage;

Permo-Triassic intra-continental rifting;

Jurassic stable shelf to the north of the Ebro massif;

Lower Cretaceous aborted oceanic opening and salt and shale gravity driven associated phenomena;

Upper albian to Upper Cretaceous EW sinistral transtension;

Eocene inter-plate tectono-genesis, resulting in a shortening of about 80-100 km;

Neogene and Pleistocene orogeny which originated the present reliefs.

-2-Petroleum research started since or just after the Second World War in the Aquitaine and Ebro foreland Basins. At the early beginning hydrocarbon exploration targeted the surface anticlines, such as Saint Marcet, the first gas discovery made in July 1939.

During the 1950’s and 1960s several successes, on which the Lacq gas giant field and the Parentis oil giant field, were recorded in the northern foreland leading currently to 2,5 billions Barrels oil equivalent cumulated initial reserves number.

The Parentis, the Arzacq, the Tarbes, and the Comminges sub-Basins correspond to these petroleum prolific areas.

To the south, in the western South Pyrenees spanish sub-Basins, unfortunately only two small fields, today reconverted into gas storages, were discovered in the 1970-1980’s: the Gaviota gas condensate field, 220 BCF of gas and 5 MMbbls of condensate and the Jaca-Serrablo dry gas field, 40 BCF.

This represents a total of 50 millions Barrels oil equivalent, which means fifty times less than the recoverable volumes already found in the northern Pyrenees foreland.

The origin of these differentiated exploration results can be simply explained by the distribution of the Petroleum System components themselves:

→ In the northern domain, the generative system is represented mainly by the Kimmeridgian transgressive section, which is developed in the related sub-Basins as a continuous layer with a fair organic content.

The reservoirs consist of fractured and diagenetically modified carbonates, Lias to Tithonian shelf section (the Lacq play) and Barremian shelf deposits (the Parentis play), Albian and Senonian to Lower Tertiary shelves and clastics (Lower Cretaceous transgressive sandstones, Albian turbidites, Eocene turbidites).

Regionally extended shaly-marly sections provide efficient seals for these different reservoirs.

Petroleum traps are mainly developed along Paleozoic inherited large paleostructures. The Triassic and Lower Jurassic evaporites are evidenced as ductile layers in the Aquitaine Basin. Diapiric and gravity sliding paleo-structures involved the main Jurassic and Lower Cretaceous petroleum plays and generative system. The present structuration of the traps results from the Lower Cretaceous extension, which has given their shapes to the main traps and from the Upper Albian to Eocene contractional regimes which have both slightly or highly modified the initial Cretaceous structures. These structural and hydrocarbon play extension conditions are generally very good points for the existence of a compact petroleum habitat.

Although exploration of remaining areas appears today as a very difficult challenge, there is still room to develop innovative methods and to improve oil and gas recovery from the Aquitaine mature fields.

→ In the southern area, the Jaca sub-Basin and the Cantabrian coastal offshore, i.e the Gaviota area, do not develop any Jurassic Petroleum system.

The reservoirs are represented by Eocene or Upper Cretaceous fractured carbonates. Source rocks are found respectively in the Eocene type III layers and in the Stephanian type III-II substratum.

These correspond to very restricted and marginally functioning P.S.

Structures are small, complex and mainly related to the Pyrenean orogeny.

For all these reasons, petroleum systems and petroleum habitat remain very scattered.

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Keynote: "The Early History of the Oil & Gas Industry in Italy"

Ferdinando Cazzini

Among the European countries, Italy has one of the richest evidences of hydrocarbons seepages. The populations that inhabited the country during the various historical periods took advantage of these phenomena harvesting oil and bitumen at the surface. An interesting testimony of such activity is represented by an ingot of purified bitumen dated first century AD. “Aloni Sagittae”, the name of the mine owner, has been carved on it. This could indicate the existence of state concessions for the mining of solid hydrocarbon, such as the well documented ones related to metallic substances mined all over the Roman Empire. During the 19th century, seepages attracted the interest of several companies that began to explore the Northern and Central Apennines. Only one year after the Drake 1859 project ,conventionally considered the start of world modern petroleum industry, it was recorded the drilling of the first oil producing well near Ozzano (Parma, Italy). From mid-19th century the oil industry ,triggered by material discoveries, quickly developed in the USA and other countries. In Italy, the oil exploration proved only minor volumes. The small size of the discoveries was strictly linked to the complex geology of Italy. The Alpine and Apennines over trusted chains are poorly preserving the traps integrity and this is one of the reason for the abundancy of seepages. During the early 20th century , geologists suggested to move the exploration from the outcropping compressional chains to the tectonically undisturbed foreland. The idea was excellent but it was not yet available a reliable tool to reveal the hidden traps buried by thick alluvium. Starting from 1920, the seismic reflection method developed and within a few decades it became the dominant tool for oil exploration. AGIP, the Italian national oil company established in 1926, contracted a seismic crew from the Western Geophysical Company to work in the Po Valley. The survey started in 1940 and prematurely ended in 1941 due to the Italy-USA war declaration. However, Italian technicians replaced USA repatriate personnel and the survey was completed. The interpreted seismic lines showed an anticline feature of 8 x 3 kilometers named Caviaga. The prospect was drilled in 1944 during the dramatic events of the Italian Civil War. It discovered a gas field of 12 Bcm of reserves (75 Mboe) within the Lower Pliocene sandstones. It was one of the major European gas field of that time, second only to the Rumanian Deleni field. Caviaga has proved for the first time the presence of large amounts of hydrocarbons within the buried anticlines of the Po Valley and it is considered the starting point of the modern Italian petroleum industry. More than 7000 wells have been drilled so far proving a total discovered reserves in the range of 10 Bboe and distributed among 581 oil and gas fields. 19 fields hold recoverable reserves above 100 Mboe and , therefore, are classified Major. Two of them are of Giant size having reserves above 500 Mboe. Italy still has a considerable amount of resources yet to find, especially as concerns the oil play, the biogenic gas play being considered too mature to reveal further substantial volumes.

NOTES

Ayoluengo – 50th Anniversary of Spain's Only Onshore Oil Field

Jorge Navarro, *president of the Association of Spanish Petroleum Geologist and Geophysicists (AGGEP)* http://www.aggep.org/

The Ayoluengo field, commonly cited as the only oil field in onshore Spain was discovered in June 1964. Now, 50 years later the field is still active, with an average production of some 100 barrel oil per day and a total cumulated oil production of nearly 17 million barrels of oil.

The Ayoluengo field is located about 300 km north of Madrid, in the Basque-Cantabrian Basin, a geological region where natural oil seeps, tar and asphalts have been recognized since the early 20th century. The region was considered as highly promising and most of the hydrocarbon exploration effort in Spain during the 1940s and 1950s was focused in this area. Some basic underground mining was carried in the region during the 1940s to exploit the tar sands, but eventually abandoned because of poor economic results. On the early 1960s, surface geological mapping and modern refection seismic equipment allowed identify a faulted anticline in an Upper Cretaceous carbonate flat plateau, an agricultural terrain mostly dedicated to growing potatoes, where the exploration well Ayoluengo-1 was located to test the Jurassic carbonates at some 4000 meters depth.

On June 6th 1964, the Ayoluengo-1 oil discovery well tested 85 barrels oil per day from an unexpected 5-meter thick sandstone bed of Late Jurassic-Early Cretaceous age located at 1350 meters depth. It was the first oil discovered in Spain after more than 100 exploration dry holes. It brought great expectations in the region, presumed to become a prolific 'black gold' region. The oil discovery gained national attention, with a large coverage of the media and attracting many curious and visitors to the wellsite as shown in the photographs taken in June 1965. A 'Texas oil boom in Spain' was headlined by some national newspapers. The discovery also revitalized the seismic and drilling activity in the region, but subsequent exploration drilling only tested uncommercial oil flow rates. Now, even after years of intense exploration activity, surprisingly the Ayoluengo field still remains as a unique oil discovery, being the only onshore commercial oil field not only in Spain, but also in the entire Iberian Peninsula. This anomalous geological singularity has brought recurrent discussions among petroleum geologists because it is difficult to explain why an oil petroleum system is uniquely working at this particular field within a vast land territory.

The Ayoluengo field consists of a NE-SW oriented and fractured anticline with a series of thin lenticular sandstones packages of Late Jurassic-Early Cretaceous age. More than 50 separated oil and gas sandstones beds have been identified. Some are as thick as 10 meters, but the average is only 2 to 3 meters. Areal extent of these lenticular sandstone bodies varies widely. Some are quite restricted, while others are laterally continuous. The sandstones have mean porosity values of 18% and permeability up to 1 Darcy. Most of the individual reservoirs layers are isolated by shales and compartmentalized by faults, what makes the Ayoluengo field to be considered as not a single field but the grouping of more than 100 independent small fields. The organic-rich marls and black shales of Liassic age have been largely considered as the only source of the oil, but this is still far from clear. The deep erosion by rivers in nearby areas allows observe on outcrops most of the elements of the Ayoluengo petroleum system: tar impregnated sandstones, the claimed Liassic source rock and text-book faulted anticlines.

The first Ayoluengo oil production started on 1967, reaching the peak production at 5200 barrels of oil per day in 1969 and since then production has gradually declined. Oil is produced by rod pumps, locally and popularly known in Spanish as ‘caballitos’. The small amount of produced natural gas is used to power the rod pumps motors and to generate the electricity used in the field. A total number of 52 wells have been drilled in the field, the last one on year 1990. At present time only 10 wells are active. Many of the infill wells encountered undepleted oil bearing sandstone beds, indicating the field complexity. A 3D seismic of 390 km2 was acquired on year 1988 aimed at identify undrained reservoir beds and better estimate remaining reserves, but unfortunately poor results were obtained.

On June 2014 the 50th anniversary of the discovery was commemorated, including the inauguration of an oil Museum in Sargentes de la Lora, the first and only one of this category in Spain. The Museum is aimed to illustrate visitors about the oil industry and their products, but mainly is focused on the upstream, introducing into the petroleum system concept and the wide variety of geological, geophysical and engineering techniques used on the exploration and production industry. An important part of the exhibition is dedicated to the Ayoluengo field geology and its history, captured in an excellent collection of photos provided by the villagers and local newspapers, together with press clippings, documentaries of the mid-60s, educative panels, geological 3D models, rock samples, drilling and production material and an authentic working rod pump.

The possibility of observe working rod pumps on the Ayoluengo field and visit the surface facilities, together with the large amount of well data and seismic coverage available and the spectacular geological exposures in the nearby areas has long time provided Ayoluengo field as an excellent opportunity to introduce students and non-technical people into the oil exploration and production industry. This is now enhanced by the inauguration of the oil Museum, which will introduce visitors in the world of petroleum science and technology together with the history of the Ayoluengo field.

NOTES

Petroleum System, Migration and Hydrocarbon Charge History in the Neo and Meso-Proterozoic Series of the Taoudenni Basin, Adrar, Mauritania, Consequences on Exploration.

Biteau Jean-Jacques[1], *Girard Jean-Pierre*[2], *Kabbej Amir* [1]

[1]*TOTAL E&P, Paris, France ;*
[2]*TOTAL E&P, Pau, France*

Exploring ancient Palaeozoic–Proterozoic cratonic Basins is a very challenging undertaking because it is often difficult to achieve sufficient understanding of complex burial/thermal histories and evaluate old petroleum systems in terms of preservation and retention of hydrocarbons through time.

Total historically has been mainly involved since the late 50's in Algeria petroleum exploration leading to the finding of two giant Palaezoic fields respectively the Hassi Messaoud oil discovery and the Hassi R'Mel gas discovery. In Libya Total has been involved offshore in Sabratha and Cyrenaic Basins as well as in the Murzuq onshore Basin.

The Algerian successes have shown that despite a strong erosional Hercynian event as well as Pyreanean and Alpine compressional phases and constraints on Petroleum timing and trapping a very slow migration process can preserve accumulations from ultimate dysmigrations.

The hydrocarbon preservation issue is particularly true in the Taoudenni basin where the Cambrian evaporites, which constitute very efficient ultimate sealing intervals for Proterozoic layers in the prolific provinces of Eastern Siberia or Oman Basins, are lacking.

As part of a Frontier exploration campaign, two exploration wells were drilled and tested in 2011 and 2013 in the northern area of the Taoudenni basin, in the Adrar region of northern Mauritania.

Prior to exploration through deep wells, field work and coredrill surveys on different outcrops documented the existence of a good quality source rock of Meso-Proterozoic age, composed of organic-rich black shales of the Atar Group.

The main targets of the two exploration wells were Meso- and Neo-Proterozoic reservoirs in the Assabet-El-Hassiane and Atar Groups located above the source rock, at present-day depths of 1800 to 3700m.

Basin modeling, compaction studies and temperature reconstructions indicate that the deep part of the prospected series suffered greater burial and maximum temperature in the western well (~7km ~175°C) compared to the eastern well (~5km ~120°C).

This was corroborated by the documented presence of pyrobitumen in the western well, indicating that an early oil charge was later submitted to in-situ secondary cracking and dismigration.

Both wells were investigated with several techniques including FIS (Fluid Inclusion Stratigraphy) in order to document the existence and functioning of an ancient Proterozoic petroleum system in the Adrar sector of the basin.

The results allowed to:

1) identify the sedimentary formations/layers that were the focus of hydrocarbon migration or accumulation;
2) identify the formation in the investigated series that acted as the ultimate regional seal to HC migration;
3) document the oil or gas nature of the primary paleo-hydrocarbons that circulated/accumulated in the series.

The different studies confirmed cracking and dismigration of an early oil charge in the western well, and documented an original charge as liquid oil in the eastern well subsequently lost by leaking.

This information provides valuable guidance and possible re-orientations for future extensive exploration in the area into much less buried areas.

NOTES

Myron Kinley and the "Torch of Moreni"

Jeff Spencer[1] and Marius Furcuta[2]

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Myron M. Kinley (1898-1978) has been called the first, the dean, the grandfather, and the original pioneer oil well firefighter. In 1913 he and his father Karl are credited with being the first to use explosives to extinguish an oil well fire. Myron formed the M.M. Kinley Company in 1923, specializing in controlling well blowouts and extinguishing well fires. During Kinley's long career he fought over four hundred oil well fires throughout the world.

On May 28, 1929, while drilling at a depth of 1460 meters, the No. 160 Romana-Americana well in Moreni, Romania blowout and caught fire. The derrick was destroyed and the 100 m high flames could be seen in the city of Ploiesti over 50 km away. Attempts to extinguish the well were unsuccessful and the well burned for over two years. More than one hundred workers were injured and fourteen died. By the spring of 1931, the "Torch of Moreni" had created a crater 76 meters wide and 20 meters deep.

Kinley first visited the No. 160 well in 1930, but was unable to convince the operators to allow him to try his firefighting methods. It took a second visit, one year later, before he was hired by the Romana-Americana Company, an affiliate of Standard Oil. Kinley arrived in Romania on crutches. A few months earlier, Myron had broken his leg while fighting an oil well fire in the huge East Texas (United States) oilfield. The Sinclair No. 1 Cole fire, where nine oilfield workers died, was extinguished by Myron and his brother Floyd in May, 1931.

A 1932 Ames, Iowa (United States) newspaper detailed Kinley's efforts at the No. 160 well. *Kinley usually sets off a gelatinized nitroglycerin at the mouth. First, however, the red-hot debris must be cleared away so that the flames will be concentrated into a single upright column. Grappling hooks and huge cables are used to pull away the debris. Kinley rushes into the tremendous waves of heat to hook the metal parts. Occasionally bad valves have to be pulled out 'by their roots'. The whole job sometimes takes days. Then comes the task of carrying ''gelatin'' wrapped in asbestos about the size of a large suitcase to the edge of the flame. "I may have had narrow escapes; one never knows in this business says Kinley.'' A wind may whip the flames around and then it's all over. "Danger, ingenuity, perseverance and the help of the Lord, as the Rumanian newspapers stated, were combined in extinguishing the European blaze. The Rumanian engineers agreed on a series of complicated plans which consumed two years and claimed a number of lives before Kinley took over the job. A 60 meters tunnel was dug, tapping the well about 20 meters below the surface. The object was to lay a pipe in the tunnel and divert the flow of gas, thus shutting off the flow of gas at the well opening and automatically extinguishing the blaze. Unfortunately, the tunnel became filled with gas an explosion followed and four men in the tunnel were killed. Porous ground of a sandy character prevented a second and deeper tunnel from being completed. A third tunnel 240 meters in length which reached the well 80 meters below the ground, was dug and a second explosion killed four more men This tunnel was cleaned out and in drilling into the casing a third explosion took the life of a ninth man and injured several others . Following the third explosion the well began to crater The heat from the flames burned the sand about the well mouth to a fine dust which the gas carried into the air to be blown away .This, together with erosion by rains and snow, created a deep hollow in the ground . Some gas was diverted* *through the soft ground and escaped along the walls of the crater. Ignited by the main fire, numerous ground fires were formed. So when Kinley arrived on August 1. 1931, he found a seething furnace. By the 10th of the month he had demonstrated that explosives would put out the fire by snuffing out the flame for four and a half minutes. Hot materials and ground fires in the crater ignited the gas again. "I decided" says Kinley "that we must get the gas away from the bottom of the crater with the terrific heat it was difficult to drag out the hot metal and put out the ground fires. So we installed a 9 meters sheet metal stack with a funnel base over the top of the well and this removed the main flame from the bottom of the crater, allowing us to cool off the metal and put out the ground fires. This done, on August 24 and 25 we set off two shots of "gelatin" but both missed and the stack fell when guy wires were blown loose. The flame was again at the bottom of the crater. I knew the flame would require a heavy charge of ''gelatin ''so we next directed our attention to the first tunnel in which the 10 inch pipe was still in place. This was cleaned out and a suction fan placed at the end drew some of the gas from the main flow, reducing the flame at the crater bottom about 50 per cent. But the metal at the bottom of the crater was again glowing with heat, so in order to cool this and the ground, streams of water were turned into the pit. Finally the softened walls slid over the well mouth and plugged the opening. This was on September 18. Most of the gas was diverted to the 10 inch pipe, but some broke through the soft ground around the crater. The fire was out (temporarily as it proved), it is true, but this was but our work, for the well had to be put under control. It was feared that the gas would settle and accumulate in the valley surrounding the property and present a very dangerous fire hazard. Thus mud and water in the crater were removed by a steam injector. This mud boiled like lava as the gas bubbled up through it .It was still hot as the ground had not had time to cool. The mud removed, the gas again caught fire 10 days later; was shot out but caught again. Things looked discouraging. I charged the banks of the crater and the slide following the explosion smothered the fire on November 4. This was the last fire in the crater. But we had not yet put the well under control, and we had no assurance that the gas would not again catch fire. Sparks from the iron debris, caused by dragging the metal from the pit, often set the gas again. We would clean out the crater and cavings would refill it. Finally, however, we succeeded and placed a second stack over the mouth of the well. Cement 10 feet deep was poured around the stack and earth to a depth of 25 feet packed on top of that, clear to the depth of the first tunnel. Then, at last, we were able to divert all the gas out of the first tunnel. Thus the well had been conquered as the flow of the gas was connected with a gasoline plant."*

NOTES

A History of UK Petrol Retailing - Oligarchy versus Dynamism

Dr Neil H Ritson[1] and **Ian Byrne[2]**

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[2] *Deputy Director, National Energy Foundation Milton Keynes, United Kingdom*

Neil Ritson has extensive industrial experience in HR/IR with ExxonMobil and the UK's Engineering Employers' Federation. He extended this to strategic business management via consultancy with the Urwick Orr/PA group, and subsequently contracting with Ingersoll Engineers. His main interests are Corporate Strategy in MNCs in the petrochemicals sector

Ian Byrne is the Deputy Director of a charity primarily working on improving the use of energy in the UK. Qualified as a Chartered Accountant and Chartered Environmentalist, he has been studying the retail petrol industry globally and contributes articles to periodicals in the USA, Australia and France.

Acknowledgments We are grateful for funding by Lincoln University and for the comments on an earlier draft by anonymous referees and from the then Editor of Business History. An earlier version of this paper was presented at the Centre for the History of Retailing and Distribution conference on 'Retailing and Distribution History', 5 and 6 September 2012 at the University of Wolverhampton, UK.

A History of UK Petrol Retailing: Oligarchy versus Dynamism

Abstract

The development of the retail petroleum industry in the UK has received only sporadic attention by academics. Yet the major oil companies - are vertically integrated and so this industry is usually thought of as an oligarchy. However there have been significant exchanges of retailing sites as between the majors themselves, and the rise of competitors. These constitute both the multiple retailers - the supermarket chains - and , at the ‘competitive fringe’, there is a ‘tail’ of smaller independents. In this paper we identify the changes and analyse the factors underlying them.

Keywords Retail petroleum; UK; oligarchy; dynamism

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Friday 4 March

Session Four

Challenges in Writing a History of E&P Technology

Henry Edmundson[1] & **Mark Mau**[2]

[1]*R9 Energy Consultants Liited*
[2]*Professional Historian*

In 2011 the authors embarked on a book project describing the technical evolution of the E&P industry since its beginnings in Azerbaijan in the mid-19th century to the present. The book, entitled “Groundbreakers: the Story of Oilfield Technology and the People Who Made it Happen” was published in June 2015. The target was to be technically comprehensive, objective in terms of covering contributions from all players and all countries, and enjoyable in terms of readability and illustrations.

The four-year project proceeded in three phases. First we covered the story of drilling technology, then exploration technology, and finally reservoir and production technology. The final book, however, mixes the content of all three phases in a more or less continuous chronological narrative. Researching and writing the book required an extensive bibliographic research and more than 120 oral history interviews with leading figures in industry and academia.

This paper will discuss the challenges we faced during the project. Among the challenges was creating the right balance between oil company, service company and academic contributions. A second challenge was covering satisfactorily contributions that are poorly covered in the literature and/or hard to interview, for example Soviet/Russian advances. A third challenge was evolving a style of exposition, in terms of both writing and illustration style, that emphasized the human side of the E&P technology story and targeted industry professionals whatever their seniority.

NOTES

German Petroleum Geologists in World War II

Martina Kölbl-Ebert, *Jura-Museum Eichstätt, Willibaldsburg, 85072 Eichstätt,*

In the 1930s, Alfred Bentz, August Moos and Karl Krejci-Graf were among the most noteworthy petroleum geologists in Germany. Being scientific modernists, they systematized the search for oil, introducing modern exploration methods. All three essentially worked for the German state on providing the petroleum needed by the German military during WWII. The three colleagues seem to have been friends. They were, however, very different. Bentz was never a member of the National Socialist party but obviously collaborated with the regime. Krejci-Graf seemed politically more deeply involved as a member of the SS, while Moos, due to his Jewish background, was murdered in January 1945 in the concentration camp of Buchenwald.

The talk will endeavour to sketch the lives of the three colleagues, highlighting their relationship and the interconnectedness of contemporary moral issues with professional and scientific demands.

NOTES

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Ground Floor Plan of the Geological Society, Burlington House, Piccadilly